BS EN 12309-3:2024

BSI Standards Publication

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

Part 3: Requirements, test conditions and test methods

bsi.

National foreword

This British Standard is the UK implementation of EN 12309-3:2024. It supersedes BS EN 12309-4:2014, BS EN 12309-3:2014 and BS EN 12309-5:2014, which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GSE/37, Gas fired sorption and laundering appliances.

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

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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 3: Requirements, test conditions and test methods

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 3 : Exigences, conditions d'essai et méthodes d'essai

Gasbefeuerte Sorptions-Geräte für Heizung und/oder Kühlung mit einer Nennwärmebelastung nicht über 70 kW - Teil 3: Anforderungen und Prüfbedingungen

This European Standard was approved by CEN on 8 April 2024.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

European foreword

This document (EN 12309-3:2024) 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of an identical text or by endorsement, at the latest by November 2024, and conflicting national standards shall be withdrawn at the latest by November 2024.

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 supersedes EN 12309-3:2014, EN 12309-4:2014 and EN 12309-5:2014.

In comparison with the previous edition, the following technical modifications have been made:

— the content of previous standards EN 12309-3:2014, EN 12309-4:2014 and EN 12309-5:2014 has been merged;

— nomenclature has been updated to be aligned with Commission Regulation (EU) No 813/2013 of 2 August 2013, Commission Delegated Regulation (EU) No 811/2013 of 18 February 2013, Commission Regulation (EU) No 2016/2281 of 30 November 2016;

— test conditions have been rationalized;

— c_{pump} definition and application has been better detailed;

— test methods have been simplified;

— permissible deviations have been revised;

— informative Annex F (Measurement control criteria for water(brine) to water(brine) appliances) has been deleted.

This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

For the relationship with EU Legislation, see informative Annex ZA, ZB or ZC, which is an integral part of this document.

This standard comprises parts under the general title, Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW. A list of all parts in a series can be found on the CEN website.

These documents will be reviewed whenever new mandates could apply.

Any feedback and questions on this document should be directed to the users’ national standards body.

A complete listing of these bodies can be found on the CEN website. 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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

1 Scope

1.1 Scope of EN 12309 series

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

— gas-fired sorption chiller;

— gas-fired sorption chiller/heater;

— gas-fired sorption heat pump;

— hybrids based on gas sorption appliances.

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

This document applies to appliances having flue gas systems of Type B and Type C (according to EN 1749:2020) and to appliances designed for outdoor installations, including Type A.

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 12309-1:2023).

In the case of packaged units (consisting of several parts), this document 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 are to be used regardless of the language used.

1.2 Scope of this Part 3 of EN 12309

This part of EN 12309 specifies the requirements, test methods and conditions for gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW.

This part of EN 12309 deals particularly with test protocols and tools to calculate the capacity, the gas utilization efficiency and the electrical power input of the appliance. This data can be used in particular to calculate the seasonal efficiency of the appliance.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 437:2021, *Test gases — Test pressures — Appliance categories*

EN 1749:2020, *Classification of gas appliances according to the method of supplying combustion air and of evacuation of the combustion products (types)*

EN 12102-1:2022, *Air conditioners, liquid chilling packages, heat pumps, process chillers and dehumidifiers with electrically driven compressors — Determination of the sound power level — Part 1: Air conditioners, liquid chilling packages, heat pumps for space heating and cooling, dehumidifiers and process chillers*

EN 12309-1:2023, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW — Part 1: Terms and definitions*

EN 12309-2:2015, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW — Part 2: Safety*

FprEN 12309-6:2023,[1] *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW — Part 6: Calculation of seasonal performances*

EN 12309-7:2014, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW — Part 7: Specific provisions for hybrid appliances*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12309-1:2023 apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

4 Classification

4.1 Classification of gases

Gases are classified into three families, divided into groups according to the value of the Wobbe index. Families and groups of gas used in this document are in accordance with those of the EN 437:2021.

4.2 Classification of appliances

4.2.1 Classification according to the mode of air supply and evacuation of the combustion products

The types of appliances as defined in EN 1749:2020 apply.

[1] Currently in preparation.

4.2.2 Denomination

Appliances are denominated in such a way that the heat transfer medium for the outdoor heat exchanger is indicated first, followed by the heat transfer medium for the indoor heat exchanger. Examples of such appliances are given in Table 1.

Table 1 — Examples of denomination of appliances

Heat transfer medium		**Denomination**
Outdoor heat exchanger	**Indoor heat exchanger**	
Air	Water [a]	Air Cooled Liquid Chiller Air Cooled Liquid Chiller/Heater Air/Water Heat pump
Water [a]	Water [a]	Water Cooled Liquid Chiller Water Cooled Liquid Chiller/Heater Water/Water Heat pump
Brine	Water [a]	Brine Cooled Liquid Chiller Brine Cooled Liquid Chiller/Heater Brine/Water Heat pump

[a] This description also applies where the water contains additives to prevent corrosion as specified in the appliances instructions.

4.2.3 Classification of the operating conditions

The classification according to the temperatures of the heat transfer media is formed in such a way that the heat transfer media are indicated together with their temperatures (in °C). A short classification is formed in such a way that a characteristic letter is used for the heat transfer medium: A for air, W for water and B for brine.

Both for heating and for cooling appliances, the value indicated in the first place refer to the outdoor heat exchanger temperature and the value in the second place to the indoor heat exchanger temperature.

Temperatures for the outdoor heat exchanger are inlet temperatures. Temperatures for the indoor heat exchanger are outlet temperatures.

EXAMPLE 1 In cooling mode, A27W7 means an inlet temperature of air for the outdoor heat exchanger of 27 °C and an outlet temperature of water for the indoor heat exchanger of 7 °C.

EXAMPLE 2 In heating mode, B0W50 means an inlet temperature of brine for the outdoor heat exchanger of 0 °C and an outlet temperature of water for the indoor heat exchanger of 50 °C.

5 Testing conditions

5.1 Environmental conditions and electrical power supply

The tests to check the requirements shall be carried out under the environmental conditions and electrical power supply requirements specified in Tables 2 and 3 depending on the location of the appliance.

Table 2 — Environmental conditions and electrical power supply requirements for appliances designed for indoor installations

Type	Measured quantities	Test conditions
Water-to-water and brine-to-water appliances [a]	Ambient temperature (Dry bulb temperature)	20 °C ± 5 °C
Air-to-water appliances with duct connection on the air inlet and outlet side	Ambient temperature (Dry bulb temperature)	20 °C ± 5 °C
Air-to-water appliances without duct connection on the air inlet side	Air inlet temperature (Dry/Wet bulb temperature)	According to Tables 4, 5, 8, 9, 10
All appliances	Voltage	Nominal voltage
All appliances	Frequency	Nominal frequency

[a] Test conditions for water to water or brine to water appliances can be extended to water to brine and brine to brine appliances respectively (e.g. for reversible applications).

Table 3 — Environmental conditions and electrical power supply requirements for appliances designed for outdoor installation

Type	Measured quantities	Test conditions
Water-to-water and brine-to-water appliances in cooling mode [a]	Ambient temperature (Dry bulb temperature)	25 °C to 35 °C
Water-to-water and brine-to-water appliances in heating mode	Ambient temperature (Dry bulb temperature)	0 °C to 7 °C
Air-to-water appliances	Air inlet temperature (Dry/Wet bulb temperature)	According to Tables 4, 5, 8, 9, 10
All appliances	Voltage	Nominal voltage
All appliances	Frequency	Nominal frequency

[a] Test conditions for water to water or brine to water appliances can be extended to water to brine and brine to brine appliances respectively (e.g. for reversible applications).

For all appliances, electrical power voltage and frequency shall be stated in the appliance's technical documentation.

5.2 Test conditions

The appropriate test conditions shall be applied in accordance with:

— Table 4 for water-to-water, water-to-brine, air-to-water and air-to-brine appliances in cooling mode, when the scope of testing is establishing standard GUE, rated cooling capacity and sound power level (L_{WA});

— Table 5 for air-to-water and air-to-brine appliances in cooling mode with heat recovery, when the scope of testing is establishing standard GUE, rated cooling capacity and sound power level (L_{WA});

— Table 6 for water-to-water and brine-to-water appliances in heating mode, when the scope of testing is establishing rated GUE (GUE_{rated}), rated PER (PER_{rated}) and rated heat capacity ($P_{rated,h}$);

— Table 7 for water-to-water and brine-to-water appliances in heating mode, when the scope of testing is establishing establishing sound power level (L_{WA});

— Table 8 for air-to-water appliances in heating mode, when the scope of testing is establishing rated GUE (GUE_{rated}), rated PER (PER_{rated}) and typical heat capacity ($P_{typ(35)}$; $P_{typ(55)}$);

— Table 9 for air-to-water appliances in heating mode, when the scope of testing is establishing rated heat capacity ($P_{rated,h}$);

— Table 10 for air-to-water appliances in heating mode, when the scope of testing is establishing sound power level (L_{WA});

The prescribed test conditions shall be applied at full load of tested appliances, unless differently specified in the above listed tables.

For appliances with brine, the test shall be carried out with the brine specified in the technical documentation, see 7.1.6.

Table 4 — Standard rating conditions or reference design conditions for establishing standard GUE, rated cooling capacity and sound power level (L_{WA}) for water-to-water, water-to-brine, air-to-water and air-to-brine appliances in cooling mode

Type of appliance / Application	Outdoor heat exchanger		Indoor heat exchanger		NOTES
	Inlet temperature °C	Outlet temperature °C	Inlet temperature °C	Outlet temperature °C	
Water-to-water [a]	30	35 [d]	12	7	W30W7
Water-to-brine [a]	30	35 [d]	0	−5	W30B-5
Air-to-water [b] / Low temperature	35 [c]	/	12	7	A35W7
Air-to-water [b] / Medium temperature	35 [c]	/	23	18	A35W18
Air-to-brine [b]	35 [c]	/	0	−5	A35B-5

NOTE The supplementary heater of a reversible unit (chiller/heater unit) is not operated during the test. In addition, for an appliance with a recovery heat exchanger, no heat recovery medium is circulated during the test.

[a] Test conditions for water-to-water or water-to-brine appliances can be extended to brine-to-water and brine-to-brine appliances respectively (e.g. for reversible applications).

[b] The water shall contain any additive specified in technical documentation, but the test conditions remain the same as for water.

[c] Dry bulb temperature.

[d] Flow rate shall remain inside the range given by the manufacturer; in the opposite case keep the inlet temperature.

Table 5 — Standard rating conditions or reference design conditions for establishing standard GUE, rated cooling capacity and sound power level (L_{WA}) for air-to-water and air-to-brine appliances in cooling mode with heat recovery

Type of appliance / Application	Outdoor heat exchanger		Indoor heat exchanger		Recovery heat exchanger	
	Inlet temperature °C	Outlet temperature °C	Inlet temperature °C	Outlet temperature °C	Inlet temperature °C	Outlet temperature °C
Air-to-water [b] / Low temperature	35 [c]	/	a	7	40	50
Air-to-water [b] / Medium temperature	35 [c]	/	a	18	40	50
Air-to-brine [b]	35 [c]	/	a	−5	40	50

[a] With the flow rate as determined during the test with no circulation of heat recovery medium (see Table 4).

[b] If the air cooled condenser is ducted, then the test shall be carried out at the minimum flow rate specified in technical documentation.

[c] Dry bulb temperature.

Table 6 — Standard rating conditions for establishing rated GUE (GUE_{rated}), rated PER (PER_{rated}) and rated heat capacity ($P_{rated,h}$) for water-to-water and brine-to-water appliances in heating mode

Application	Outdoor heat exchanger		Indoor heat exchanger		NOTES
	Inlet temperature °C	Outlet temperature °C	Inlet temperature °C	Outlet temperature °C	
Water-to-water [a]					
Low temperature	10	7	30	35	W10W35
Medium temperature	10	7	47	55	W10W55
Brine-to-water [a]					
Low temperature	0	−3	30	35	B0W35
Medium temperature	0	−3	47	55	B0W55

[a] Test conditions for water-to-water or brine-to-water appliances can be extended to water-to-brine and brine-to-brine appliances respectively (e.g. for reversible applications).

Table 7 — Standard rating conditions for establishing sound power level (L_{WA}) for water-to-water and brine-to-water appliances in heating mode

Application	Outdoor heat exchanger		Indoor heat exchanger		Heat capacity	NOTES
	Inlet temperature °C	Outlet temperature °C	Inlet temperature °C	Outlet temperature °C		
Water-to-water [a], fixed capacity appliances						
Low temperature	10	7	30	35	Full capacity	W10W35
Medium temperature	10	7	47	55	Full capacity	W10W55
Water-to-water [a], variable capacity appliances						
Low temperature	10	7	30 [d]	35	35 % [b] of $P_{rated,h}$	W10W35
Medium temperature	10	7	47 [d]	55	35 % [c] of $P_{rated,h}$	W10W55
Brine-to-water [a], fixed capacity appliances						
Low temperature	0	−3	30	35	Full capacity	B0W35
Medium temperature	0	−3	47	55	Full capacity	B0W55
Brine-to-water [a], variable capacity appliances						
Low temperature	0	−3	30 [d]	35	35 % [b] of $P_{rated,h}$	B0W35
Medium temperature	0	−3	47 [d]	55	35 % [c] of $P_{rated,h}$	B0W55

[a] Test conditions for water-to-water or brine-to-water appliances can be extended to water-to-brine and brine-to-brine appliances respectively (e.g. for reversible applications).

[b] With the target capacity of point C, Average climate conditions, in Table 8 of FprEN 12309-6:2023 with a maximum deviation of ± 5 %. If the settings are such that this is not possible, then the operating conditions and/or settings of the unit within its boundary limits shall be such that at least the capacity and the leaving water temperature requirements are fulfilled.

[c] With the target capacity of point C, Average climate conditions, in Table 9 of FprEN 12309-6:2023 with a maximum deviation of ± 5 %. If the settings are such that this is not possible, then the operating conditions and/or settings of the unit within its boundary limits shall be such that at least the capacity and the leaving water temperature requirements are fulfilled.

[d] If requested heat capacity is not matched within a maximum deviation of ± 5 %, this value is adjusted.

Table 8 — Standard rating conditions for establishing rated GUE (GUE_{rated}), rated PER (PER_{rated}) and Typical Heat Capacity ($P_{typ(35)}$; $P_{typ(55)}$) for air-to-water appliances in heating mode

Application	Outdoor heat exchanger		Indoor heat exchanger		NOTES
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C	
Outdoor air					
Low temperature	7	6	30	35	A7W35
Medium temperature	7	6	47	55	A7W55
Exhaust air					
Low temperature	20	12	30	35	A20W35
Medium temperature	20	12	47	55	A20W55

Table 9 — Standard rating conditions or reference design conditions for establishing rated heat capacity ($P_{rated,h}$) for air-to-water appliances in heating mode

Application	Outdoor heat exchanger		Indoor heat exchanger		NOTES
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C	
Outdoor air					
Low temperature	Warmer climate conditions				
	2	1	a	35	A2W35
	Average climate conditions				
	−10	−11	a	35	A-10W35
	Colder climate conditions				
	−22	−23	a	35	A-22W35
Medium temperature	Warmer climate conditions				
	2	1	a	55	A2W55
	Average climate conditions				
	−10	−11	a	55	A-10W55
	Colder climate conditions				
	−22	−23	a	55	A-22W55
Exhaust air (all climate conditions)					
Low temperature	20	12	a	35	A20W35

Application	Outdoor heat exchanger		Indoor heat exchanger		NOTES
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C	
Medium temperature	20	12	a	55	A20W55

[a] All tests shall be carried out with nominal flow rates indicated in the technical documentation, provided that the difference between the inlet and outlet temperatures at the indoor heat exchanger is lower than a maximum temperature difference (ΔT_{max}) calculated using the following formula:

$\Delta T_{max} = 4 * (T_{out} / 9) - 6$

In case this condition is not respected, the flow rate shall be increased until ΔT is equal to ΔT_{max}.

If only a range of flow rates is given, tests shall be carried out at the minimum value of the range, provided that ΔT is lower than ΔT_{max}.

If a nominal flow rate or a range of flow rates are not indicated in the technical documentation, tests shall be carried out with $\Delta T = \Delta T_{max}$.

Table 10 — Standard rating conditions for establishing sound power level (L_{WA}) for air-to-water appliances in heating mode

Application	Outdoor heat exchanger		Indoor heat exchanger		Heat capacity	NOTES
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C		
Outdoor air, Average climate, fixed capacity appliances						
Low temperature	7	6	30	35	Full capacity	A7W35
Medium temperature	7	6	47	55	Full capacity	A7W55
Outdoor air, Average climate, variable capacity appliances						
Low temperature	7	6	30 [g]	35	35 % [a] of $P_{rated,h}$	A7W35
Medium temperature	7	6	47 [g]	55	35 % [b] of $P_{rated,h}$	A7W55
Outdoor air, Colder climate, fixed capacity appliances						
Low temperature	2	1	30	35	Full capacity	A2W35
Medium temperature	2	1	47	55	Full capacity	A2W55
Outdoor air, Colder climate, variable capacity appliances						
Low temperature	2	1	30 [g]	35	37 % [c] of $P_{rated,h}$	A2W35

Application	Outdoor heat exchanger		Indoor heat exchanger		Heat capacity	NOTES
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C		
Medium temperature	2	1	47 [g]	55	37 % [d] of $P_{rated,h}$	A2W55
Outdoor air, Warmer climate, fixed capacity appliances						
Low temperature	14	13	30	35	Full capacity	A14W35
Medium temperature	14	13	47	55	Full capacity	A14W55
Outdoor air, Warmer climate, variable capacity appliances						
Low temperature	14	13	30 [g]	35	14 % [e] of $P_{rated,h}$	A14W35
Medium temperature	14	13	47 [g]	55	14 % [f] of $P_{rated,h}$	A14W55
Exhaust air, fixed capacity appliances						
Low temperature	20	12	30	35	Full capacity	A20W35
Medium temperature	20	12	47	55	Full capacity	A20W55
Exhaust air, variable capacity appliances						
Low temperature	20	12	30 [g]	35	35 % of $P_{rated,h}$	A20W35
Medium temperature	20	12	47 [g]	55	35 % of $P_{rated,h}$	A20W55

[a] With the target capacity of point C, Average climate conditions, in Table 5 of FprEN 12309-6:2023 with a maximum deviation of ±5 %. If the settings are such that this is not possible, then the operating conditions and/or settings of the unit within its boundary limits shall be such that at least the capacity and the leaving water temperature requirements are fulfilled.

[b] With the target capacity of point C, Average climate conditions, in Table 6 of FprEN 12309-6:2023 with a maximum deviation of ±5 %. If the settings are such that this is not possible, then the operating conditions and/or settings of the unit within its boundary limits shall be such that at least the capacity and the leaving water temperature requirements are fulfilled.

[c] With the target capacity of point B, Colder climate conditions, in Table 5 of FprEN 12309-6:2023 with a maximum deviation of ±5 %. If the settings are such that this is not possible, then the operating conditions and/or settings of the unit within its boundary limits shall be such that at least the capacity and the leaving water temperature requirements are fulfilled.

[d] With the target capacity of point B, Colder climate conditions, in Table 6 of FprEN 12309-6:2023 with a maximum deviation of ±5 %. If the settings are such that this is not possible, then the operating conditions and/or settings of the unit within its boundary limits shall be such that at least the capacity and the leaving water temperature requirements are fulfilled.

[e] With the target capacity corresponding to the formula (+14–16) / ($T_{design,h}$ -16) in Table 5 of FprEN 12309-6:2023, where $T_{design,h}$ = +2 °C as per Warmer climate conditions, with a maximum deviation of ±5 %. If the settings are such that this is not possible, then the operating conditions and/or settings of the unit within its boundary limits shall be such that at least the

Application	Outdoor heat exchanger		Indoor heat exchanger		Heat capacity	NOTES
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C		

capacity and the leaving water temperature requirements are fulfilled.

[f] With the target capacity corresponding to the formula (+14–16) / ($T_{design,h}$ -16) in Table 6 of FprEN 12309-6:2023, where $T_{design,h}$ = +2 °C as per Warmer climate conditions, with a maximum deviation of ±5 %. If the settings are such that this is not possible, then the operating conditions and/or settings of the unit within its boundary limits shall be such that at least the capacity and the leaving water temperature requirements are fulfilled.

[g] If requested heat capacity cannot be matched within a maximum deviation of ±5 %, this value can be adjusted.

6 Measurements

6.1 Heat Input

6.1.1 General conditions for operation of the gas-fired part of the appliance

Tests are carried out with the appropriate reference gas (or gases) for the category to which the appliance belongs (see EN 437:2021), supplied at the corresponding normal pressure indicated in EN 437:2021.

Prior to carrying out any tests, the heat input of the burner(s) at full capacity is adjusted, if this is necessary, in order that it is within ± 5 % of the nominal heat input. This nominal heat input is determined when the appliance is operating at the appropriate test conditions given in 5.1.2, Tables 4, 5, 6, 8 and 9.

6.1.2 Measurement of heat inputs under test conditions

The appliance is installed as described in EN 12309-2:2015, 7.1.6, and adjusted as described in 5.2.1 and then operated at the test conditions given in 5.2. The heat input measurement is carried out when steady-state conditions described in Clause 7 have been achieved under the particular test conditions.

The measured heat input under the test conditions (P_{gm}) in kilowatts is given by the formula:

$$P_{gm} = 0,278 \cdot \frac{\sum_{j=1}^{n} \left(Mc_j \cdot NCV_{M(T)j} \right)}{n} \quad (1)$$

or

$$P_{gm} = 0,278 \cdot \frac{\sum_{j=1}^{n} \left(Vc_j \cdot NCV_{V(T)j} \right)}{n} \quad (2)$$

where

j	is the scan number;
n	is the number of scan of the data collection period;
P_{gm}	is the measured heat input, in kilowatts;
$NCV_{M(T)j}$	is the net calorific value of the test gas at the considered scan, in megajoules per

kilogram;

Mc_j is the mass flow rate of dry test gas at the considered scan, in kilograms per hour;

$NCV_{V(T)j}$ is the net calorific value of the test gas at the considered scan, in megajoules per cubic meter (dry gas, 15 °C, 1 013,25 mbar);

Vc_j is the volumetric flow rate of dry test gas corrected to 1 013,25 mbar and 15 °C at the considered scan, in cubic meters per hour and derived from the following formula:

$$V_{cj} = V_{mj} \times \frac{p_{aj} + p_j - p_{wj}}{1013,25} \times \frac{288,15}{273,15 + t_{gj}} \tag{3}$$

where

V_{mj} is the measured gas flow rate at the considered scan, in cubic meters per hour;

p_{aj} is the atmospheric pressure at the considered scan, in millibars;

p_j is the gas static pressure at the gas meter at the considered scan, in millibars;

p_{wj} is the saturated (water) vapour pressure in the gas used at the considered scan, in millibars;

t_{gj} is the gas temperature at the gas meter at the considered scan, in degrees Celsius.

NOTE 1 Gas static pressure at the gas meter is different from gas static pressure of the appliance.

NOTE 2 $p$wj covers the use of wet gas meters (equal zero if dry gas meter is used).

NOTE 3 The calculation and publication of heat input (P_g) on the basis of the gross calorific value is allowed only when the reference (GCV) is explicitly stated beside the value.

EXAMPLE P_g: *23 kW*$_{GCV}$

Elsewhere, the heat input (Pg) is always to be understood as based on net calorific value (NCV).

6.2 Electrical power input

6.2.1 General conditions for operation of the electrical part of the appliance

Tests are carried out with the nominal voltage.

The measured electrical power input shall be corrected for the contributions of the power input of the following devices:

— for air/water(brine) appliances, the outdoor fans (integrated or not in the appliance), if the appliance is ducted (no correction if the appliance is not ducted);

— the outdoor pump and/or the recovery heat exchanger pump and/or indoor pump (integrated or not in the appliance) circulating the heat transfer medium through the appliance.

6.2.2 Effective electrical power input

The effective electrical power input shall be determined using the following formula:

$$P_{Elec} = \frac{\sum_{j=1}^{n}\left(P_{Tj}\right)}{n} - c_{Elec,pump} - c_{Elec,\ outdoor} \qquad (4)$$

where

j	is the scan number;
n	is the number of scan of the data collection period;
P_{Elec}	is the effective electrical power input, in kilowatts;
P_{Tj}	is the measured (total) electrical power input at the considered scan, in kilowatts;
$c_{Elec,pump}$	is the electrical power input correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger and/or heat recovery heat exchanger, in kilowatts;
$c_{Elec,outdoor}$	is the electrical power input correction due to the fan(s) or pump(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatts.

6.2.3 Electrical power input corrections of fans

6.2.3.1 General

The following corrections of the electrical power input of fan(s) shall be made for fan(s) providing the air to the outdoor heat exchanger, where applicable.

6.2.3.2 Electrical power input correction of fan(s) for appliances without duct connection

In the case of appliances which are not designed for duct connection, i.e. which do not permit any external pressure differences, and which are equipped with integral fan(s), the electrical power consumed by the fan(s) shall be completely included in the effective electrical power consumed by the appliance (no correction).

6.2.3.3 Electrical power input correction of fan(s) for appliances with duct connection

6.2.3.3.1 Integrated fans

If the fan(s) is (are) an integral part of the appliance, only a part of the electrical power input of the fan motor(s) shall be included in the effective electrical power absorbed by the appliance. The part that is to be excluded from the total electrical power consumed by the appliance shall be calculated using the following formula (to be subtracted, the correction is positive: the electrical power input decreases):

$$c_{Elec,outdoor} = \frac{q \times \Delta p_e}{\eta \times 1000} \qquad (5)$$

where

$c_{Elec,outdoor}$	is the electrical power input correction due to fan(s), in kilowatts ($c_{Elec,outdoor} > 0$);
η	is the fan efficiency, equal to:

— η target, as declared by the fan manufacturer for fans driven by motors between 125 W and 500 kW;

— 0,3 by convention for fans driven by motors below 125 W;

Δp_e is the measured external static pressure difference, in Pascal ($\Delta p_e > 0$);

q is the measured air flow rate at standard air conditions (1 013,25 mbar and 20 °C), in cubic meters per second.

6.2.3.3.2 Separate fans

If no fan is provided with the appliance, the part of the electrical power input of the external fans which is to be included in the effective electrical power consumed by the appliance, shall be calculated using the following formula (to be subtracted, the correction is negative: the electrical power input increases):

$$c_{Elec,outdoor} = \frac{q \times \Delta p_i}{\eta \times 1000} \qquad (6)$$

where

$c_{\text{Elec,outdoor}}$ is the electrical power input correction due to fan(s), in kilowatts ($c_{\text{Elec,outdoor}} < 0$);

η is the fan efficiency, equal to:

— η target, as declared by the fan manufacturer for fans driven by motors between 125 W and 500 kW;

— 0,3 by convention for fans driven by motors below 125 W;

Δp_i is the measured internal static pressure difference, in Pascal ($\Delta p_i < 0$);

q is the measured air flow rate at standard air conditions (1 013,25 mbar and 20 °C), in cubic meters per second.

6.2.4 Electrical power input correction of liquid pumps

6.2.4.1 General

The following correction of the electrical power input of pump(s) shall be made to both the liquid pump circulating the heat transfer medium through the indoor heat exchanger ($c_{\text{Elec,pump}}$) and the liquid pump circulating the heat transfer medium through the outdoor heat exchanger ($c_{\text{Elec,outdoor}}$), where applicable.

When the liquid pump is delivered separately as a part of the appliance package, it shall be connected for the test according to the appliance's instructions and be considered as an integral part of the appliance (equivalent to an internal liquid pump).

6.2.4.2 Electrical power input correction for appliances with at least one internal liquid pump

If the liquid pump(s) is (are) an integral part of the appliance, only a part of the electrical power input to the pump motor(s) shall be included in the effective electrical power consumed by the appliance. The part which is to be excluded from the total electrical power consumed by the appliance shall be calculated using the following formulas (to be subtracted, the correction is positive: the electrical power input decreases):

$$c_{Elec,pump} \text{ and } c_{Elec,outdoor} = \frac{q \times \Delta p_e}{\eta \times 1000} \qquad (7)$$

where

$c_{\text{Elec,pump}}$	is the electrical correction due to liquid pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts ($c_{\text{Elec,pump}} > 0$);
$c_{\text{Elec,outdoor}}$	is the electrical correction due to pump(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatts ($c_{\text{Elec,outdoor}} > 0$);
η	is the efficiency of the pump calculated according to Annex A in kilowatts per kilowatt;
Δp_{e}	is the measured external static pressure difference, in Pascal ($\Delta p_{\text{e}} > 0$);
q	is the measured water flow rate, in cubic meters per second.

If the pump delivers a negative external static pressure ($\Delta p_{\text{e}} < 0$) due to a mismatch with the appliance, correction shall be calculated according to 6.2.4.3.

6.2.4.3 Electrical power input correction for appliances without internal pump

If no liquid pump is provided with the appliance, the part of the electrical power input of the external pump(s) which is to be included in the effective electrical power consumed by the appliance, shall be calculated using the following formula (to be subtracted, the correction is negative: the electrical power input increases).

$$c_{Elec,pump} \text{ and } c_{Elec,outdoor} = \frac{q \times \Delta p_i}{\eta \times 1000} \qquad (8)$$

where

$c_{\text{Elec,pump}}$	is the electrical correction due to liquid pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts ($c_{\text{Elec,pump}} < 0$);
$c_{\text{Elec,outdoor}}$	is the electrical correction due to pump(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatts ($c_{\text{Elec,outdoor}} < 0$);
η	is the efficiency of the pump calculated according to Annex A in kilowatts per kilowatt;
Δp_{i}	is the measured internal static pressure difference, in Pascal ($\Delta p_{\text{i}} < 0$);
q	is the measured water flow rate, in cubic meters per second.

6.3 Cooling mode

6.3.1 General

The cooling capacity of air-to-water(brine), water(brine)-to-water(brine) reversible heat pumps, chillers and chillers/heaters shall be determined in accordance with the direct method at the water or brine indoor heat exchanger(s), by determination of the volume or mass flow rate of the heat transfer medium, and the inlet and outlet temperatures, taking into consideration the specific heat capacity and density, or the enthalpy change of the heat transfer medium (see 6.3.2 and 6.3.3).

6.3.2 Measured cooling capacity

The measured cooling capacity shall be determined using the following formula:

$$P_c = \frac{\sum_{j=1}^{n}\left(V_{mj} \cdot \delta_j \cdot C_{pj} \cdot \Delta t_i\right)}{n} \tag{9}$$

where

j	is the scan number;
n	is the number of scans of the data collection period;
P_c	is the measured cooling capacity, in kilowatts;
V_{mj}	is the volume flow rate of the heat transfer medium at the considered scan, in cubic meters per second;
δ_j	is the density of the heat transfer medium at flow meter temperature at the considered scan, in kilograms per cubic meter;
C_{pj}	is the specific heat of the heat transfer medium at constant pressure at mean temperature of the heat transfer medium at the considered scan, in kilojoules per kilogram and kelvin;
Δt_j	is the difference between inlet and outlet temperatures of the heat transfer medium at the considered scan, in kelvin.

NOTE 1 The mass flow can be determined directly instead of the term $(V_{mj} * \delta_j)$.

NOTE 2 The enthalpy change ΔH_j can be determined directly instead of the term $(C_{pj} * \Delta t_j)$.

6.3.3 Effective cooling capacity

The effective cooling capacity is the measured cooling capacity corrected for the heat from the pump(s):

a) if the pump(s) is (are) an integral part of the appliance, the capacity correction due to the pump(s), $c_{th,pump}$, calculated according to 6.6.2 and 6.6.3, shall be included in the cooling capacity (to be added, the correction is positive).

b) if the pump(s) is (are) not an integral part of the appliance, the capacity correction due to the pump(s), $c_{th,pump}$, calculated according to 6.6.4, shall be excluded from the cooling capacity (to be added, the correction is negative).

The effective cooling capacity shall be determined using the following formula:

$$P_{Ec} = P_c + c_{th,pump} \tag{10}$$

where

P_{Ec}	is the effective cooling capacity, in kilowatts;
P_c	is the measured cooling capacity, in kilowatts;

$c_{th,pump}$	is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts.

6.3.4 Heat recovery capacity in cooling mode

6.3.4.1 General

The heat recovery capacity of air-to-water(brine) chillers or chillers/heaters shall be determined in accordance with the direct method at the water(brine) heat recovery heat exchanger(s), by determination of the volume or mass flow rate of the heat transfer medium, and the inlet and outlet temperatures, taking into consideration the specific heat capacity and density, or the enthalpy change of the heat transfer medium (see 6.3.4.2 and 6.3.4.3).

6.3.4.2 Measured heat recovery capacity

The measured heat recovery capacity shall be determined using the following formula:

$$P_{hr} = \frac{\sum_{j=1}^{n}\left(V_{mj} \cdot \delta_{j} \cdot C_{pj} \cdot \Delta t_{i}\right)}{n} \tag{11}$$

where

j	is the scan number;
n	is the number of scan of the data collection period;
P_{hr}	is the measured heat recovery capacity, in kilowatts;
V_{mj}	is the volume flow rate of the heat transfer medium at the considered scan, in cubic meters per second;
δ_j	is the density of the heat transfer medium at flow meter temperature at the considered scan, in kilograms per cubic meter;
C_{pj}	is the specific heat of the heat transfer medium at constant pressure at mean temperature of the heat transfer medium at the considered scan, in kilojoules per kilogram and kelvin;
Δt_j	is the difference between inlet and outlet temperatures of the heat transfer medium at the considered scan, in kelvin.

NOTE 1 The mass flow can be determined directly instead of the term ($V_{mj} \cdot \delta_j$).

NOTE 2 The enthalpy change ΔHj can be determined directly instead of the term ($C_{pj} \cdot \Delta t_j$).

6.3.4.3 Effective heat recovery capacity

The effective heat recovery capacity is the measured heat recovery capacity corrected for the heat from the pump(s):

a) if the pump(s) is (are) an integral part of the appliance, the capacity correction due to the pump(s), $c_{th,pump}$, calculated according to 6.6.2 and 6.6.3 shall be excluded from the heat recovery capacity (to be subtracted, the correction is positive: the heat recovery capacity decreases).

b) if the pump(s) is (are) not an integral part of the appliance, the capacity correction due to the pump(s), $c_{th,pump}$, calculated according to 6.6.4, shall be included in the heat recovery capacity (to be subctracted, the correction is negative: the heat recovery capacity increases).

The effective heat recovery capacity shall be determined using the following formula:

$$P_{Ehr} = P_{hr} - c_{th,pump} \quad (12)$$

where

P_{Ehr} is the effective heat recovery capacity, in kilowatts;

P_{hr} is the measured heat recovery capacity, in kilowatts;

$c_{\mathrm{th,pump}}$ is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the heat recovery exchanger, in kilowatts.

6.3.5 Gas utilization efficiency in cooling mode

The gas utilization efficiency in cooling mode shall be determined using the following formula:

$$GUE_c = \frac{P_{Ec}}{P_{gmc}} \quad (13)$$

where

GUE_{c} is the cooling gas utilization efficiency, in kilowatts per kilowatt;

P_{Ec} is the effective cooling capacity, in kilowatts;

P_{gmc} is the measured cooling heat input, in kilowatts.

6.4 Heating mode

6.4.1 General

The heating capacity of air-to-water(brine), water(brine)-to-water(brine) chiller/heater or heat pumps shall be determined in accordance with the direct method at the water or brine (indoor) heat exchanger(s), by determination of the volume or mass flow rate of the heat transfer medium, and the inlet and outlet temperatures, taking into consideration the specific heat capacity and density, or the enthalpy change, of the heat transfer medium (see 6.4.2 and 6.4.3).

6.4.2 Measured heating capacity

The measured heating capacity shall be determined using the following formula:

$$P_h = \frac{\sum_{j=1}^{n}\left(V_{mj} \cdot \delta_j \cdot C_{pj} \cdot \Delta t_i\right)}{n} \quad (14)$$

where

j is the scan number;

n is the number of scan of the data collection period;

P_{h} is the measured heating capacity, in kilowatts;

$V_{m\mathrm{j}}$ is the volume flow rate of the heat transfer medium at the considered scan, in cubic meters per second;

δ_{j} is the density of the heat transfer medium at flow meter temperature at the considered scan, in kilograms per cubic meter;

C_{pj}	is the specific heat of the heat transfer medium at constant pressure at mean temperature of the heat transfer medium at the considered scan, in kilojoules per kilogram and kelvin;
Δt_j	is the difference between inlet and outlet temperatures of the heat transfer medium at the considered scan, in kelvin.

NOTE 1 The mass flow can be determined directly instead of the term (V_{mj} * δ_j).

NOTE 2 The enthalpy change ΔHj can be determined directly instead of the term (C_{pj} *Δt_j).

6.4.3 Effective heating capacity

6.4.3.1 General

The effective heating capacity is the measured heating capacity corrected for the heat from the pump(s):

a) if the pump(s) is (are) an integral part of the appliance, the capacity correction due to the pump(s), $c_{th,pump}$, calculated according to 6.6.2 and 6.6.3, shall be excluded from the heating capacity (to be subtracted, the correction is positive: the heating capacity decreases);

b) if the pump(s) is (are) not an integral part of the appliance, the capacity correction due to the pump(s), $c_{th,pump}$, calculated according to 6.6.4, shall be included in the heating capacity (to be subtracted, the correction is negative: the heating capacity increases).

The effective heating capacity shall be determined using the following formula:

$$P_{Eh} = P_h - c_{th,pump} \quad (15)$$

where

P_{Eh}	is the effective heating capacity, in kilowatts;
P_h	is the measured heating capacity, in kilowatts;
$c_{th,pump}$	is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts.

6.4.3.2 Rated Heat Output

The rated heat output shall be calculated as the effective heating capacity at the specific test conditions given in Table 9 of 5.2, for average, warmer and colder climate conditions, in medium temperature application, except for low temperature heat pumps for which it shall be measured in low temperature application.

The rated heat output shall be determined using the following formula:

$$P_{rated,h} = P_h - c_{th,pump} \quad (16)$$

where

$P_{rated,h}$	is the rated heat output, in kilowatts;
P_h	is the measured heating capacity, in kilowatts;
$c_{th,pump}$	is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatts.

The rated heat output shall include the rated heat output of any supplementary heater, if applicable.

6.4.4 Gas utilization efficiency in Heating mode

The gas utilization efficiency in heating mode shall be determined using the following formula:

$$GUE_h = \frac{P_{Eh}}{P_{gmh}} \quad (17)$$

where

GUE_h is the heating gas utilization efficiency, in kilowatts per kilowatt;

P_{Eh} is the effective heating capacity, in kilowatts;

P_{gmh} is the measured heating heat input, in kilowatts.

6.5 Auxiliary energy factor

6.5.1 Cooling mode

The auxiliary energy factor in cooling mode is determined using the following formula:

$$AEF_c = \frac{P_{Ec}}{P_{Elec,c}} \quad (18)$$

where

AEF_c is the cooling auxiliary energy factor, in kilowatts per kilowatt;

P_{Ec} is the effective cooling capacity, in kilowatts;

$P_{Elec,c}$ is the effective cooling electrical power input, in kilowatts.

6.5.2 Heating mode

The auxiliary energy factor in heating mode is determined using the following formula:

$$AEF_h = \frac{P_{Eh}}{P_{Elec,h}} \quad (19)$$

where

AEF_h is the heating auxiliary energy factor, in kilowatts per kilowatt;

P_{Eh} is the effective heating capacity, in kilowatts;

$P_{Elec,h}$ is the effective heating electrical power input, in kilowatts.

6.6 Capacity correction

6.6.1 General

The capacity correction takes into account the heat output due to the indoor and/or outdoor pumps, integrated into the unit or not. For the calculation see 6.6.2, 6.6.3 and 6.6.4 and Annex B.

6.6.2 Capacity correction for integrated glandless circulators

If the unit is equipped with a glandless circulator, the capacity correction is calculated using Formula (20).

$$c_{th,pump} = q \times \Delta p_e \times \left[\left(1 - \eta \right) / \eta \right] / 1000 \quad (20)$$

where

$c_{th,pump}$	is the capacity correction, expressed in kW ($c_{th,pump} > 0$);
q	is the measured liquid flow rate, expressed in m^3/s;
Δp_e	is the measured available external static pressure difference, expressed in Pa ($\Delta p_e > 0$);
η	is the global efficiency of the pump calculated according to Annex A.

If the pump delivers a negative external static pressure ($\Delta p_e < 0$) due to a mismatch with the appliance, correction shall be calculated according to 6.6.4.

6.6.3 Capacity correction for integrated dry motor pumps

If the unit is equipped with a dry-motor pump, the capacity correction shall be calculated using Formula (21).

$$c_{th,pump} = q \times \Delta p_e \times \left[\left(lE - \eta \right) / \eta \right] / 1000 \quad (21)$$

where

$c_{th,pum}$	is the capacity correction, expressed in kW ($c_{th,pump} > 0$);
q	is the measured liquid flow rate, expressed in m^3/s;
Δp_e	is the measured available external static pressure difference, expressed in Pa ($\Delta p_e > 0$);
lE	is the motor efficiency level;
η	is the global efficiency of the pump calculated according to Annex A.

If the pump delivers a negative external static pressure ($\Delta p_e < 0$) due to a mismatch with the appliance, correction shall be calculated according to 6.6.4.

6.6.4 Capacity correction for non-integrated liquid pumps

If the measured hydraulic power according to Annex A is ≤ 300 W, the liquid pump is considered as a glandless circulator. The capacity correction is calculated using Formula (22).

$$c_{th,pump} = q \times \Delta p_i \times \left[\left(1 - \eta \right) / \eta \right] / 1000 \quad (22)$$

where

$c_{th,pum}$	is the capacity correction, expressed in kW ($c_{th,pump} < 0$);
q	is the measured liquid flow rate, expressed in m^3/s;
Δp_i	is the measured available internal static pressure difference, expressed in Pa ($\Delta p_i < 0$);
η	is the global efficiency of the pump calculated according to Annex A.

If the measured hydraulic power according to Annex A is > 300 W, the liquid pump is considered as a dry-motor pump. The capacity correction is calculated using Formula (23).

$$c_{th,pump} = q \times \Delta p_i \times \left[\left(lE - \eta \right) / \eta \right] / 1000 \qquad (23)$$

where

$c_{th,pum}$	is the capacity correction, expressed in kW ($c_{th,pump}$ < 0);
q	is the measured liquid flow rate, expressed in m^3/s;
Δp_i	is the measured available internal static pressure difference, expressed in Pa (Δp_i < 0);
lE	is the motor efficiency level;
η	is the global efficiency of the pump calculated according to Annex A.

7 Test methods

7.1 General

7.1.1 Introduction

The test procedures described below are valid for full capacity and reduced capacity tests and apply for continuous and alternating appliances which can operate in steady-state, transient and cyclical (ON-OFF) mode.

Transient operation is one of the operation modes of air-to-water(brine) appliances working in heating (as heat pumps). It occurs when the performances of the unit under test degradate over 2,5 % during the first 40 min of data collection period for a continuous appliance or during the first 4 calculation cycles for alternating appliance due to the frosting on the outdoor coil.

Continuous and alternating appliances include monovalent, bivalent and hybrid appliances.

In case of hybrid appliances, no ON/OFF cycles shall be generated by the laboratory itself.

In case of monovalent or bivalent appliances which operate in cycling (ON-OFF) mode, measurements shall be carried out either by using the control system of the appliance or in compliance with Annex F.

For the measurement of inputs and heating/cooling/heat recovery capacity, it is necessary to record all the data mentioned in 7.8 continuously. Except the following: gas density, Wobbe index and calorific value when the gas comes from a tank and this tank has not been changed during the tests. For heat recovery and inputs measurements, the sampling (intervals and frequencies) shall be the same as for corresponding heating or cooling capacity.

For any type of operation, the sequence shall be adjusted such that a complete recording is taken at least once every 10 s.

The laboratory can use the test protocol with any test bench on condition that it respects the required permissible deviations given in this standard and it lets the controls of the appliance operate.

7.1.2 All appliances

The test conditions for monovalent and bivalent appliances are reported in 5.2 from Table 4 to Table 10. The test conditions for hybrid appliances are reported in EN 12309-7:2014 in Clauses 4 and 6.

If liquid heat transfer medium other than water is used, the specific heat capacity and density of such heat transfer media shall be determined and taken into consideration in the evaluation (results and uncertainty).

7.1.3 Alternating appliances

For alternating appliances, capacities, gas and electrical power inputs shall be obtained from a number of complete stabilized “calculation cycles”.

A “calculation cycle” may consist of more than one “burner cycle”.

A “burner cycle” consists of a period from an ignition of the burner to the following ignition of the burner.

The data collection period shall be extended until the appliance completes four complete “calculation cycles”. The effective capacities shall be obtained from the measured capacities and the corrections from the heat of the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger. The effective power input shall be obtained from the measured electrical power input and the corrections from the heat of the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger and the pump(s) or the fan(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, if relevant.

Periodic fluctuations of measured quantities caused by the operation of regulation and control devices of the appliance are permissible on condition the value of such fluctuations do not exceed the permissible deviations listed in Table 12.

Fluctuations of the four different calculation cycles GUE (calculation results) is permissible on condition the standard deviation of them does not exceed 2,5 % and the deviations of individual GUE from mean value do not exceed 5,0 %.

7.1.4 Non ducted appliances

For non-ducted appliances, the adjustable settings such as louvers and fan speed shall be set for maximum steady-state operation air flow.

After that setting, the air flow rate is set under control of the appliance.

When the appliance is modulating, no disturbance of air flow should be perceived by the appliance as a consequence of the operation of test room apparatus.

7.1.5 Ducted appliances

The air flow rate and the pressure difference shall be related to standard air (1 013,25 mbar and 20 °C) for a dry heat exchanger.

If the air flow rate is stated with no atmospheric pressure, temperature and humidity conditions, it shall be considered as stated for test conditions. The air flow rate stated shall be converted into standard air conditions (1 013,25 mbar and 20 °C). The air flow rate setting shall be made when the fan only is operating.

The nominal air flow rate stated shall be set and the resulting external static pressure (ESP) measured. If the ESP is lower than 30 Pa, the air flow rate is adjusted to reach this minimum value.

The apparatus used for setting the ESP shall be maintained in the same position during all the tests.

If the installation instructions data state that the maximum allowable length of the discharge duct is less than 1 m, then the appliance can be tested as a non-ducted appliance with an ESP of 0 Pa.

After that setting, the air flow rate is set under control of the appliance.

7.1.6 Air to water(brine) and water(brine) to water(brine) appliances

The nominal water(brine) flow rate stated shall be set at corresponding test conditions and the resulting pressure drops measured. After that setting, the water flow rate is set under control of the appliance.

In the case of brine, if it is not mentioned in the technical instructions for installation and adjustment, the nature and the concentration of the product to use for the tests shall be stated. The minimum brine concentration shall be chosen to provide proper operation at minimum outlet temperature stated.

7.1.7 Sound measurements

The sound power level shall be measured with the corresponding test methods according to EN 12102-1:2022.

7.2 Measurement for water(brine) to water(brine) appliances

7.2.1 Steady-state operation conditions

Data collection shall take place when steady-state operating conditions are fulfilled. These conditions are considered obtained and maintained when all the measured quantities remain constant without having to alter the set values, for a minimum duration of:

— 30 min with the respect to the tolerances given in Tables 11 in case of continuous appliances

— 4 complete “calculation cycles” with respect to the tolerances given in Tables 12 in case of alternating appliances.

Periodic fluctuations of measured quantities caused by the operation of control devices are permissible on condition that the mean value of such fluctuations does not exceed the permissible deviations listed in Tables 11 for continuous appliances and in Table 12 for alternating appliances. The data collection period follows this period of 30 min in case of continuous appliances or 4 complete “calculation cycles” in case of alternating appliances.

All these requirements also apply for a test at reduced capacity when the burner operates at least at its minimal heat input.

7.2.2 Measurement of heating capacity, cooling capacity, heat recovery capacity, gas input and electrical power input

The heating capacity, cooling capacity, heat recovery capacity and inputs shall be measured in the steady-state operation conditions. The duration of the data collection is:

— 40 min in case of continuous appliances;

— 4 complete “calculation cycles” in case of alternating appliances.

All data shall be collected during the same period at the same frequency.

7.2.3 Measurement of GUE

The *GUE* shall be calculated with the measurements carried out during the same data collection period and shall respect the following requirements:

— In case of continuous appliances, the duration of the data collection is divided into four 10 min parts. A *GUE* is calculated for each part. The fluctuations of the GUE of the four different parts are permissible on condition the standard deviation of them does not exceed 1,5 % and the deviations of individual GUE from mean value does not exceed 3,0 %.

— In case of alternating appliances, fluctuations of the four different calculation cycles GUE (calculation results) are permissible on condition that the standard deviation of them does not exceed 2,5 % and the deviations of individual GUE from mean value do not exceed 5,0 %.

7.3 Measurement in cooling mode for air-to-water(brine) appliances

7.3.1 Steady-state operation conditions

Data collection shall take place when steady-state operating conditions are fulfilled. These conditions are considered obtained and maintained when all the measured quantities remain constant without having to alter the set values, for a minimum duration of:

— 30 min with the respect to the tolerances given in Table 11 in case of continuous appliances;

— 4 complete "calculation cycles" with respect to the tolerances given in Table 12 in case of alternating appliances.

Periodic fluctuations of measured quantities caused by the operation of control devices are permissible on condition that the mean value of such fluctuations does not exceed the permissible deviations listed in Table 11 for continuous appliances and in Table 12 for alternating appliances. The data collection period follows this period of 30 min in case of continuous appliances or 4 complete "calculation cycles" in case of alternating appliances.

All these requirements also apply for a test at reduced capacity when the burner operates at least at its minimal heat input.

7.3.2 Measurement of cooling capacity, heat recovery capacity, gas input and electrical power input

The cooling capacity, heat recovery capacity and inputs shall be measured in the steady-state operation conditions. The duration of the data collection is:

— 40 min in case of continuous appliances;

— 4 complete "calculation cycles" in case of alternating appliances.

All data shall be collected during the same period at the same frequency.

7.3.3 Measurement of GUE

The *GUE* shall be calculated with the measurements carried out during the same data collection period and shall respect the following requirements:

— In case of continuous appliances, the duration of the data collection is divided in to four 10 min parts. A *GUE* is calculated for each part. The fluctuations of the *GUE* of the four different parts are permissible on condition the standard deviation of them does not exceed 1,5 % and the deviations of individual GUE from mean value does not exceed 3,0 %.

— In case of alternating appliances, fluctuations of the four different calculation cycles GUE (calculation results) are permissible on condition that the standard deviation of them does not exceed 2,5 % and the deviations of individual GUE from mean value do not exceed 5,0 %.

7.4 Measurement in heating mode for air-to-water appliances

7.4.1 General

The test procedure consists of three periods: a preconditioning period, an equilibrium period, and a data collection period.

The duration of the data collection period differs depending upon whether the heat pump's operation is in steady-state operation or transient operation.

Annex D gives a flow chart of the procedure and pictorially represents the different test sequences that are possible when conducting a heating capacity test.

All the requirements also apply at reduced capacity when the burner operates at least at the minimal heat input.

7.4.2 Preconditioning period

The test room preconditioning apparatus and the appliance under test shall be operated until the appropriate test tolerances specified in Tables 11 and 12 are attained for at least:

— 10 min in case of continuous appliances;

— 2 calculation cycles in case of alternating appliances.

A defrost cycle may end a preconditioning period. If a defrost cycle does end a preconditioning period, the appliance shall operate in the heating mode for at least 10 min after defrost termination in case of continuous appliances or for at least 2 calculation cycles in case of alternating appliances prior to beginning the equilibrium period.

It is recommended that the preconditioning period ends with manually-induced defrost cycle for all the conditions for which an automatic defrost cycle is expected.

7.4.3 Equilibrium period

The equilibrium period immediately follows either the preconditioning period or a "recovery" period after the defrost cycle that ends the preconditioning period.

The recovery period, depending if the appliance is continuous or alternating will last 10 min or 2 calculation cycles respectively.

The duration of a complete equilibrium period is 30 min in case of continuous appliances or 4 calculation cycles in case of alternating appliances.

The appliance shall operate while meeting the appropriate test tolerances specified in Tables 11 and 12 except as specified in 7.4.6.5 (Test procedure for transient operation).

7.4.4 Data collection period

The data collection period immediately follows the equilibrium period.

The difference between the outlet and inlet temperatures of the heat transfer medium at the indoor heat exchanger shall be measured.

In case of continuous appliances, an average temperature difference ΔTi (τ) shall be calculated for each interval of 5 min during the data collection period and the average temperature difference for the first 5 min of this period, ΔTi ($\tau = 0$), shall be saved for the purpose of calculating the parameter in Formula (24).

In case of alternating appliances instead, an average temperature difference shall be calculated for each calculation cycle of the data collection period, ΔTi (τ), and the one calculated for the first calculation cycle, ΔTi ($\tau = 0$), shall be saved for the purpose of calculating the parameter in Formula (24).

$$\%\Delta T = \frac{\Delta T_{i(\tau=0)} - \Delta T_{i(\tau)}}{\Delta T_{i(\tau=0)}} \times 100 \quad (24)$$

where

$\%\Delta T$	is the coefficient of change, in %;
$\Delta T_{i(\tau = 0)}$	is the average difference between the outlet and inlet temperatures for the first 5 min period in case of continuous appliances or for the first calculation cycle in case of alternating appliances, in Kelvin;
$\Delta T_{i(\tau)}$	is the average difference between the outlet and inlet temperatures for other 5 min period than the first 5 min in case of continuous appliances or for other calculation cycles than the first one in case of alternating appliances, in Kelvin.

In case of continuous appliances, if the coefficient of change ($\%\Delta T$) remains within 2,5 % during the first 40 min of the data collection period and the appropriate test tolerances specified in Tables 11 are satisfied during both the equilibrium period and the first 40 min of the data collection period, then the test shall be designated a steady-state operation test. Steady-state operation tests shall be terminated after 40 min of data collection.

In case of alternating appliances, if the coefficient of change ($\%\Delta T$) remains within 2,5 % during the first 4 calculation cycles of the data collection period and the appropriate test tolerances specified in Tables 12 are satisfied during both the equilibrium period and the first 4 calculation cycles of the data collection period, then the test shall be designated a steady- state operation test. Steady-state operation tests shall be terminated after 4 calculation cycles of data collection.

7.4.5 Test procedure when a defrost cycle ends the preconditioning period

When a defrost cycle ends the preconditioning period, if the appliance initiates a defrost cycle during the equilibrium period or during the first 40 min of the data collection period in case of continuous appliances or during the first 4 calculation cycles in case of alternating appliances, the test shall be designated a transient operation test (see 7.4.6.5).

7.4.6 Test procedure when a defrost cycle does not end the preconditioning period

7.4.6.1 General

When a defrost does not end the preconditioning period either 7.4.6.2 or 7.4.6.3 applies.

7.4.6.2 Defrost during equilibrium or data collection period

If the appliance initiates a defrost cycle during the equilibrium period or during the first 70 min of the data collection period in case of continuous appliances or during the first 8 calculation cycles in case of alternating appliances, the test shall be restarted as specified 7.4.6.4.

7.4.6.3 Coefficient of change exceeds 2,5 % during data collection period

If the coefficient of change (%ΔT) exceeds 2,5 % any time during the first 70 min of the data collection period in case of continuous appliances or during the first 8 calculation cycles in case of alternating appliances, then the test procedure shall be restarted as specified in 7.4.6.4. Prior to the restart, defrost cycle shall occur. This defrost cycle may be manually initiated or delayed until the appliance initiates an automatic defrost.

7.4.6.4 Test restart procedure

If either 7.4.6.2 or 7.4.6.3 apply, then:

— In case of continuous appliances, the restart shall begin 10 min after the defrost cycle terminates with a new equilibrium period of 1 h. This second attempt shall follow the requirements of 7.4.2 and 7.4.3 and the test procedure of 7.4.5.

— In case of alternating appliances the restart shall begin 2 calculation cycle after the defrost cycle terminates with a new equilibrium period of 4 calculation cycles. This second attempt shall follow the requirements of 7.4.2 and 7.4.3 and the test procedure of 7.4.5.

7.4.6.5 Test procedure for transient operation tests

When, in accordance with 7.4.5, the test is designated a transient operation test, the following adjustments shall apply.

To constitute a valid transient operation test, the test tolerances specified in Table 13 for continuous appliances and in Table 14 for alternating appliances shall be achieved during both the equilibrium period and the data collection period. As noted in Table 13 and in Table 14 the test tolerances are specified for two sub-intervals. Interval H consists of data collected during each heating interval, with the exception of the first 10 min in case of continuous appliances or the first calculation cycle in case of alternating appliances after defrost termination. Interval D consists of data collected during each defrost cycle plus the first 10 min in case of continuous appliances or the first calculation cycle in case of alternating appliances of the subsequent heating interval.

The test tolerance parameters in Table 13 and in Table 14 shall be determined throughout the equilibrium and data collection periods. All data collected during each interval, H or D, shall be used to evaluate compliance with the Table 13 and Table 14 test tolerances. Data from two or more H intervals or two or more D intervals shall not be combined and then used in evaluating Table 13 and Table 14 compliance. Compliance is based on evaluating data from each interval separately.

The data collection period shall be extended until 3 h have elapsed or until the appliance completes three complete defrost cycles during the period, whichever occurs first.

In case of alternating appliances, a further condition shall be satisfied: after the 3 h have elapsed or the three defrost cycles have completed the data collection period shall be extended until the running calculation cycle is completed too.

If at an elapsed time of 3 h, the appliance is conducting a defrost cycle, the cycle shall be completed before terminating the collection of data.

In case of alternating appliances if at an elapsed time of 3 h, the appliance is conducting a defrost cycle, beside the defrost cycle, also the calculation cycle shall be completed before terminating the collection of data.

A complete defrost cycle consists of a heating period and a defrost period, from defrost termination to defrost termination.

7.4.6.6 Measurement of heating capacity, gas and electrical power inputs

During defrost cycles plus the first 10 min following defrost termination in case of continuous appliances or plus the first calculation cycle in case of alternating appliances, data used in evaluating the heating capacity, the gas input and the electrical power input of the appliance could be sampled more frequently than during the rest of the data collection period. All data shall be collected during the same period at the same frequency(ies).

7.4.6.7 Measurement of GUE

A GUE is calculated using heating capacity and gas heat input during the same data collection period.

7.5 Reduced capacity tests

7.5.1 General

For tests at reduced capacity, the appliance shall be set at the closest step or increment of the unit/appliance control to reach the required heating or cooling capacity (target value). Then:

— if this step or increment of the appliance control allows to reach the target value of the capacity within ± 10 %, the test is admitted and the measured capacity and GUE are used as capacity and GUE at this condition (the tolerances are those in Tables 11 and 12 for steady-state tests and in Tables 13 and 14 for transient tests);

— if this step or increment of the appliance control does not allow to reach the target value of the capacity within ±10 %, a second measurement shall be carried out to get a measurement above the target value and a measurement below the target value. In this case, the result is determined by linear interpolation. Any test with capacity which deviate more than ±10 % of the target value is rejected.

— if at the smallest control step of the unit the capacity compared to the target value is more than 10 %, the capacity and GUE are calculated through cycling interval tests.

7.5.2 Cycling interval (ON-OFF) tests

Cycling interval (ON-OFF) tests are tests where the appliance starts a cyclic shutdown of the burner to match the heating or cooling demand. This happens at reduced capacity tests, when although the burner operates at the minimal heat input stated in the operating instructions, the resulting heating or cooling capacities are higher than the heating or cooling demand.

NOTE Cycling interval (ON-OFF) tests can include or exclude a defrost period.

During the cycling interval (ON-OFF) test, the data collection period shall be extended until the appliance completes at least four complete “on-off cycles”.

In case of alternating appliances, the “ON period” shall be extended until the running calculation cycle is completed.

The effective capacities shall be obtained from the measured capacities and the corrections from the heat of the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger. The effective electrical power input shall be obtained from the measured electrical power input and the corrections from the heat of the pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger and the pump(s) or the fan(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, if relevant.

Periodic fluctuations of measured quantities caused by the operation of regulation and control devices of the appliance are permissible on condition the value of such fluctuations do not exceed the permissible deviations listed in Table 15.

Capacities, gas and electrical power inputs during this cycling interval (ON-OFF) tests are obtained as measured energies over at least four complete on/off cycles.

Cycling interval (ON-OFF) capacity for cooling P_{cycc} and cycling interval capacity for heating P_{cych} are the (time-weighted) average cooling capacity output and heating capacity output over the cycling interval test respectively. They are expressed in kW.

The cyclic interval gas utilization efficiency for heating (GUE_{cych}) or cooling (GUE_{cycc}) is obtained by dividing this cycling interval heating or cooling energy by the gas consumption of the unit over the same on/off cycles.

The cyclic interval auxiliary energy factor for heating (AEF_{cych}) or cooling (AEF_{cycc}) is obtained by dividing this cycling interval heating or cooling energy by the electrical power input of the unit over the same on/off cycles.

Fluctuations of the four different ON-OFF cycles GUE (calculation results) is permissible on condition the standard deviation of them does not exceed 2,5 % and the deviations of individual GUE from mean value do not exceed 5,0 %.

7.6 Permissible deviations

Table 11 — Permissible deviations on the set values during steady-state operation tests for continuous appliances (monovalent and bivalent appliances)

Measured quantity	Permissible deviations of the time average measured values from set values	Permissible deviations of individual measured values from time average measured values
Outdoor air		
- inlet temperature (dry bulb) [a]	±0,3 K	±1 K
- inlet temperature (wet bulb) [a]	±0,4 K	±1 K
- (dry bulb -wet bulb) temperature difference [b]	±0,3 K	/
- flow rate (volume)	5 %	±10 %
- static pressure drop	/	±10 %
Outdoor water or brine		
- inlet temperature	±0,2 K	±0,5 K
- outlet temperature	±0,3 K	±0,6 K
- flow rate	±1 %	±2,5 %
- static pressure difference	/	±10 %
Indoor water or brine		
- inlet temperature	±0,2 K	±0,5 K
- outlet temperature	±0,3 K	±0,6 K
- flow rate	±1 %	±2,5 %
- static pressure difference	/	±10 %
Electrical input		
- voltage	±4 %	±4 %

NOTE Permissible deviation includes the regulating capability of the test apparatus.

[a] For appliances with outdoor heat exchanger surfaces greater than 5 m^2, the deviation on the air inlet dry bulb temperature is doubled.

[b] This variation applies to the set temperature difference. If equal to 1 K, the temperature difference is thus allowed to vary between 0,7 K and 1,3 K.

Table 12 — Permissible deviations on the set values during steady-state operation tests for alternating appliances (hybrid appliances and alternating monovalent and bivalent appliances)

Measured quantity	Permissible deviations of the time average measured values from set values	Permissible deviations of individual measured values from time average measured values
Outdoor air [c]		
- inlet temperature (dry bulb) [a]	±1 K	±2 K
- inlet temperature (wet bulb) [a]	±1,5 K	±2,5 K
- (dry bulb -wet bulb) temperature difference [b]	±0,5 K	/
- flow rate (volume)	/	/
- static pressure drop	/	/
Outdoor water or brine [c]		
- inlet temperature load ≥ 70 % 40 % ≤ load < 70 % load < 40 %	 ±0,2 K ±0,2 K ±0,3 K	 ±0,5 K ±0,7 K ±0,9 K
- outlet temperature	/	/
- flow rate	±1 %	±2,5 %
- static pressure difference	±10 %	±10 %
Indoor water or brine [c]		
- inlet temperature load ≥ 70 % 40 % ≤ load < 70 % load < 40 %	 ±0,2 K ±0,2 K ±0,3 K	 ±0,5 K ±0,7 K ±0,9 K
- outlet temperature	±0,6 K	
- flow rate	±1 %	±2,5 %
- static pressure difference	±10 %	±10 %
Electrical input		
- voltage	±4 %	±4 %

NOTE Permissible deviation includes the regulating capability of the test apparatus.

[a] For appliances with outdoor heat exchanger surfaces greater than 5 m^2, the deviation on the air inlet dry bulb temperature is doubled.

[b] This variation applies to the set temperature difference. If equal to 1 K, the temperature difference is thus allowed to vary between 0,5 K and 1,5 K.

[c] For appliances with integrated fan(s) or liquid pump(s) or with external fan(s) or liquid pump(s) controlled by the appliance, the criteria on permissible deviations apply only when the fan(s) or liquid pump(s) work and only on the time average measured values compared to set values. (No restriction on individual measured values from time average measured values).

Table 13 — Permissible deviations on the set values in heating mode when using the transient test procedure for continuous appliances

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
	Interval H [a]	Interval D [b]	Interval H [a]	Interval D [b]
Outdoor air				
Temperature of air entering outdoor-side: - dry-bulb [c] - wet-bulb	 ±0,6 K ±0,3 K	 ±1,5 K ±1,0 K	 ±1,0 K ±0,6 K	 ±5,0 K /
Indoor water or brine				
Inlet water temperature	±0,2 K	/	±0,5 K	/
Outlet temperature	±0,5 K	/	/	/
Water flow rate	±2 %	/	±5 %	/
Electrical input				
- voltage	±4 %		±4 %	

NOTE Permissible deviation includes the regulating capability of the test apparatus during transient occurrences.

[a] Applies when the appliance is in the heating mode, except for the first 10 min after termination of a defrost cycle.

[b] Applies during the defrost cycle and during the first 10 min after the termination of a defrost cycle when the appliance is operating in the heating mode.

[c] For appliances with outdoor heat exchanger surfaces greater than 5 m^2, the deviation on the air inlet dry bulb temperature is doubled.

Table 14 — Permissible deviations on the set values in heating mode when using the transient test procedure for alternating appliances

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
	Interval H [a]	**Interval D [b]**	**Interval H [a]**	**Interval D [b]**
Outdoor air				
Temperature of air entering outdoor-side: - dry-bulb [c] - wet-bulb	±1K ±1K	±3 K ±3 K	±2 K ±2 K	/ /
Indoor water or brine				
Inlet water temperature	±0,3 K	/	±0,6 K	/
Outlet temperature	±0,8 K	/	/	/
Water flow rate	±2 %	/	±5 %	/
Electrical input				
- voltage	±4 %		±4 %	

NOTE Permissible deviation includes the regulating capability of the test apparatus during transient occurrences.

[a] Applies when the appliance is in the heating mode, except for the first calculation cycle after termination of a defrost cycle.

[b] Applies during the defrost cycle and during the first calculation cycle after the termination of a defrost cycle when the appliance is operating in the heating mode.

[c] For appliances with outdoor heat exchanger surfaces greater than 5 m^2, the deviation on the air inlet dry bulb temperature is doubled.

Table 15 — Permissible deviations on the set values for ON-OFF tests for continuous and alternating appliances

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor air				
	ON	OFF	ON	OFF
- inlet temperature (dry bulb) a	±1,5 K	/	±2,5 K	/
- inlet temperature (wet bulb) a	±2 K	/	/	/
- (dry bulb -wet bulb) temperature difference	/	/	/	/
- flow rate (volume)	5 %	/	/	/
- static pressure drop	/	/	/	/
Outdoor water or brine				
	ON	OFF	ON	OFF
- inlet temperature				
load ≥ 70 %	±0,2 K	/	±0,5 K	/
40 % ≤ load < 70 %	±0,2 K	/	±0,7 K	/
load < 40 %	±0,3 K	/	±0,9 K	/
- outlet temperature	/	/	/	/
- flow rate	±2 %	/	±5 %	/
- static pressure difference	±10 %	/	±10 %	/
Indoor water or brine				
	ON	OFF	ON	OFF
- inlet temperature				
load ≥ 70 %	±0,2 K	/	±0,5 K	/
40 % ≤ load < 70 %	±0,2 K	/	±0,7 K	/
load < 40 %	±0,3 K	/	±0,9 K	/
- outlet temperature	±0,6 K	/	/	/
- flow rate	±2 %	/	±5 %	/
- static pressure difference	±10 %	/	±10 %	/
Electrical input				
- voltage	±4 %		±4 %	

NOTE Permissible deviation includes the regulating capability of the test apparatus.

[a] For appliances with outdoor heat exchanger surfaces greater than 5 m^2, the deviation on the air inlet dry bulb temperature is doubled.

7.7 Test methods for electric power consumption during thermostat off mode, standby mode and off mode

7.7.1 Measurement of electrical power consumption during thermostat off mode

For cooling mode (for cooling only or reversible appliances), the thermostat set point is increased until the burner stops. After 15 min, the electrical power consumption is measured over a time period of not less than 30 min to determine the thermostat off power. The test shall be performed according to test conditions given in Table 4.

For heating mode (for heating only or reversible appliances), the same principle applies but the thermostat set point should be decreased until the burner stops. The test shall be performed according to test conditions given in Table 6 and Table 8.

7.7.2 Measurement of the electrical power consumption during standby mode

The appliance is stopped with the control device. After 15 min, the electrical power consumption is measured over a time period of not less than 30 min and assumed to be the standby mode electrical power consumption. The test shall be performed according to test conditions given in Table 4, Table 6 and Table 8.

7.7.3 Measurement of the electric power consumption during off mode

Following the standby mode electrical power consumption test, the appliance should be switched to off mode while remaining plugged in and supplied with power. After 15 min, the electrical power consumption is measured for a time period of not less than 30 min and assumed to be the off mode electrical power consumption. In case no off mode switch is available on the appliance, the standby mode electrical power is assumed to be equal to the off mode electrical power. The test shall be performed according to test conditions given in Table 4, Table 6 and Table 8.

7.8 Test results

The data to be recorded for capacities, inputs and rational use of energy measurements is given in Table 16. The table identifies the general information required but is not intended to limit the data to be obtained.

NOTE In this clause, the result of a calculation based on various data are considered as data.

The data will be the integrated values taken over the data collection period except time measurement during transient and cyclical operation tests, gas density, Wobbe index and gas calorific value when gas used is from a tank and this tank is not been changed all over the tests).

Table 16 — Data to be recorded

Measurement quantity	Unit
Ambient conditions:	
- air temperature, dry bulb - atmospheric pressure	°C mbar
Gas quantities: - gas flow rate - gas pressure (absolute or relative) - gas temperature - gas calorific value (net and gross) - gas density (absolute or relative) or Wobb index (net or gross)	 m^3/h or kg/h mbar °C MJ/m^3 or MJ/kg kg/m^3 or kg·m^3/kg·m^3 MJ/m^3 or MJ/kg
Electrical quantities:	
- voltage - total current - total power input, P_T - effective power input, P_E - power consumption during thermostat off mode - power consumption during standby mode - power consumption during off mode	V A W W W W W
Thermodynamic quantities Outdoor heat exchanger Air:	
- inlet temperature, dry bulb - inlet temperature, wet bulb - outlet temperature, dry bulb - outlet temperature, wet bulb - external/internal static pressure difference - volume flow rate	°C °C °C °C Pa m^3/s

Measurement quantity	Unit
Water or brine:	
- inlet temperature	°C
- outlet temperature	°C
- flow rate	m^3/s or kg/s
- pressure drop	kPa
- pump speed setting, if applicable	-
Indoor heat exchanger (water or brine):	
- inlet temperature	°C
- outlet temperature	°C
- flow rate	m^3/s or kg/s
- pressure drop	kPa
- pump speed setting, if applicable	-
Heat recovery heat exchanger	
- inlet temperature	°C
- outlet temperature	°C
- volume flow rate	m^3/s
- pressure drop	kPa
- pump speed setting, if applicable	-
Heat transfer medium (other than water)	
- density	kg/m^3
- specific heat	J/kg·K

Measurement quantity	Unit
Defrost	
- defrost period - operating cycle with defrost - data collection period	s s s
Capacities	
- effective heating capacity (Q_{Eh}) - effective cooling capacity (Q_{Ec}) - effective heat recovery capacity (QE_{hr})	W W W
Ratios	
- GUEh and $GUEh_{GCV}$ - GUEc and $GUEc_{GCV}$ - AEFh - AEFc	W/W W/W W/W W/W

7.9 Test apparatus

7.9.1 Arrangement of the test apparatus

7.9.1.1 General requirements

The test apparatus shall be designed in such a way that all requirements on adjustment of set values, stability criteria and uncertainties of measurement according to this document can be fulfilled.

7.9.1.2 Test room for the air side

The size of the test room shall be selected such that any resistance to air flow at the air inlet and air outlet orifices of the appliance is avoided. The air flow through the room shall not be capable of initiating any short circuit between these two orifices, and therefore the velocity of the air flow through the room at these two locations shall not exceed 1,5 m/s when the appliance is switched off. Unless otherwise stated in the appliance's instructions, the air inlet or air outlet orifices shall be at least 1 m from the surfaces of the test room.

Any direct heat radiation by heating device (appliance, equipment...) in the test room onto the appliance or onto the temperature measuring points shall be avoided.

7.9.1.3 Appliances with duct connection

The connections of a ducted air appliance to the test facility shall be sufficiently air tight to ensure that the measured results are not significantly influenced by exchange of air with the surroundings.

7.9.1.4 Appliances with integral pumps

For appliances with integral and adjustable water or brine pump(s), the pump(s) shall be set to obtain an external static pressure as close as possible to 0 Pa.

7.9.2 Installation and connection of the appliance

7.9.2.1 General

The appliance shall be installed and connected for the test as recommended by the appliance's installation manual. It shall be connected to a compensation system that allows setting of the required full or reduced capacity. Examples of such compensation systems in heating and cooling mode are given in Annex E.

For single duct appliances, in case the appliance's instructions do not specify how to install the discharge duct, the discharge duct shall be as short and straight as possible compatibly with minimum distance between the appliance and the wall for correct air inlet but not less than 0,5 m. Accessories shall not be connected to the discharge end of the duct.

For double duct appliances, the same requirements apply to both suction and discharge ducts, unless the appliance is designed to be installed directly on the wall.

7.9.2.2 Measuring points

Temperature and pressure measuring points shall be arranged in order to obtain mean significant values. For free air intake temperature measurements, it is required:

— either to have at least one sensor per square meter and not less than four measuring points and by restricting to 20 the number of sensor equally distributed on the air surface;

— or to use a sampling device. It shall be completed by four sensors for checking uniformity if the surface area is greater than 1 m^2.

Air temperature sensors shall be placed at a maximum distance of 0,25 m from the free air surface.

For water and brine, the density in formula of 6.3.2, 6.3.4.2 and 6.4.2 shall be determine in the temperature conditions measured near the flow measuring device.

7.10 Uncertainties of measurement

The uncertainties of individual measurement shall not exceed the values specified in Table 17.

Table 17 — Uncertainties of measurement for indicated individual values

Measured quantity	Unit	Uncertainty of measurement
Water or brine:		
- temperature inlet/outlet	°C	±0,15 K
- temperature difference	K	±0,21 K
- flow rate (volume or mass)	m^3/s or kg/s	±1 %
- static pressure difference	Pa	±5 Pa (P ≤ 100 Pa) or ± 5 % (P > 100 Pa)
Air:		
- dry bulb temperature	°C	±0,2 K
- wet bulb temperature	°C	±0,4 K
- flow rate (volume)	m^3/s	±5 %
- static pressure difference	Pa	±5 Pa (P ≤ 100 Pa) or ± 5 % (P > 100 Pa)
Concentration:		
- heat transfer medium	%	±2 %
Heat input:		
- atmospheric pressure	mbar	±5 mbar
- gas pressure	mbar	±2 % full scale (limit 0,5 mbar)
- gas flow rate	m^3/h or kg/h	±1 %
- gas temperature	°C	±0,5 K
- calorific value	MJ/m^3	±1 %
Electrical input:		
- electrical power	kW	±2 %
Time:	s	±0,2 s ≤ 1 h or ± 0,1 % > 1 h

The specification range of the measuring apparatus is chosen to be suitable between minimum part load and full load according to the uncertainties in Table 17.

The measurement uncertainties indicated concern individual measurements. For measurements requiring a combination of individual measurements (e.g. efficiency measurements), the lower uncertainties associated with individual measurements may be necessary to limit the overall uncertainty.

The heating, cooling or recovery capacities measured shall be determined within a maximum overall uncertainty of (20,5 × $\Delta T^{-0,89}$) %, independent of the individual uncertainties of measurement including the uncertainties on the properties of fluids.

The gas input shall be determined within a maximum overall uncertainty of 2 %, independent of the individual uncertainties of measurement including the uncertainties on the properties of the gas.

If the water (brine) flow stops during, for example, a transient test or during a cyclical operation test, no maximum overall uncertainty is required for the capacity.

The same principle applies for electrical power input and for gas input when relevant.

8 Marking and documentation

Marking and instructions to be included in technical documentation are dealt with in EN 12309-2:2015.

Annex A
(normative)

Determination of the liquid pump efficiency

A.1 General

The method for calculating the efficiency of the liquid pump, whether the pump is an integral part of the appliance or not, is based on the relationship between the efficiency of the pump and its hydraulic power.

A.2 Hydraulic power of the liquid pump

A.2.1 The pump is an integral part of the appliance

When the pump is an integral part of the appliance, the hydraulic power which shall be taken into account is defined as:

$$P_{hyd} = q \cdot \Delta p_e \qquad \text{(A.1)}$$

where

P_{hyd}	is the total hydraulic power of the pump, in watts;
q	is the water volume flow rate, in cubic meters per second;
Δp_e	is the measured available external static pressure difference, in pascals.

A.2.2 The pump is not an integral part of the appliance

When the pump is not an integral part of the appliance, the hydraulic power which shall be taken into account is defined as:

$$P_{hyd} = q \cdot \left(-\Delta p_i\right) \qquad \text{(A.2)}$$

where

P_{hyd}	is the total hydraulic power of the pump, in watts;
q	is the water volume flow rate, in cubic meters per second;
Δp_i	is the measured internal static pressure difference, in pascals.

A.3 Efficiency of integrated pumps

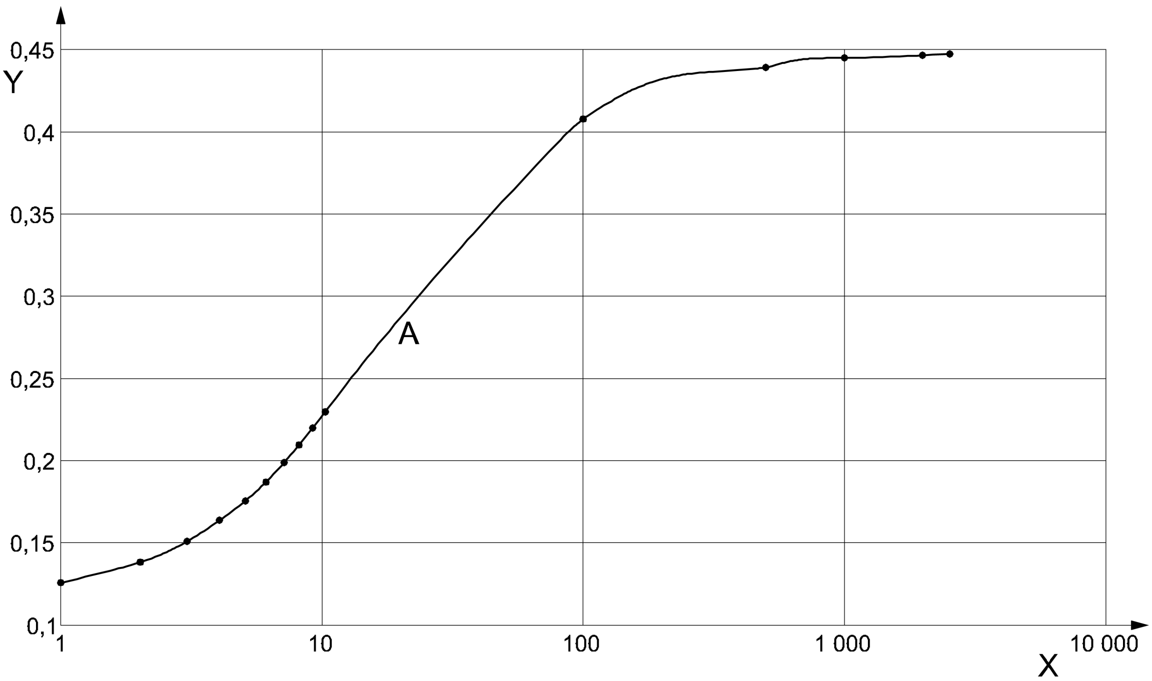
A.3.1 Glandless circulators

For glandless circulators, the calculation of the global efficiency η is based on the Energy Efficiency Index EEI using the following Formula (A.3):

$$\eta = \frac{0{,}35844 \times P_{hyd}}{1{,}7 \times P_{hyd} + 17 \times \left(1 - e^{-0{,}3 \times P_{hyd}}\right)} \times \left(\frac{C_{20}}{EEI}\right) \quad (A.3)$$

where

- P_{hyd} is the hydraulic power of the pump, expressed in W;
- C_{20} is a scaling factor equal to 0,49;
- EEI is the Energy Efficiency Index equal to 0,23.



Key

1 liquid pump

X hydraulic power P_{hyd} (W) [1 W ≤ 2 500 W]

Y efficiency η (-) [0,125 0 ≤ η ≤ 0,447 4]

Figure A.1 — Dependence of the efficiency of the glandless circulators on the hydraulic power

A.3.2 Dry motor pumps

For dry motor pumps, the global efficiency η shall be calculated using either Formula (A.4) or Formula (A.5) with respect of the hydraulic power of the pump:

a) When the hydraulic power of the liquid pump, calculated according to (A.1), is lower or equal to 500 W, then the efficiency of the pump is determined using the following formula:

$$\eta = 0{,}0721 \times P_{hyd}^{0{,}3183} \quad \text{(A.4)}$$

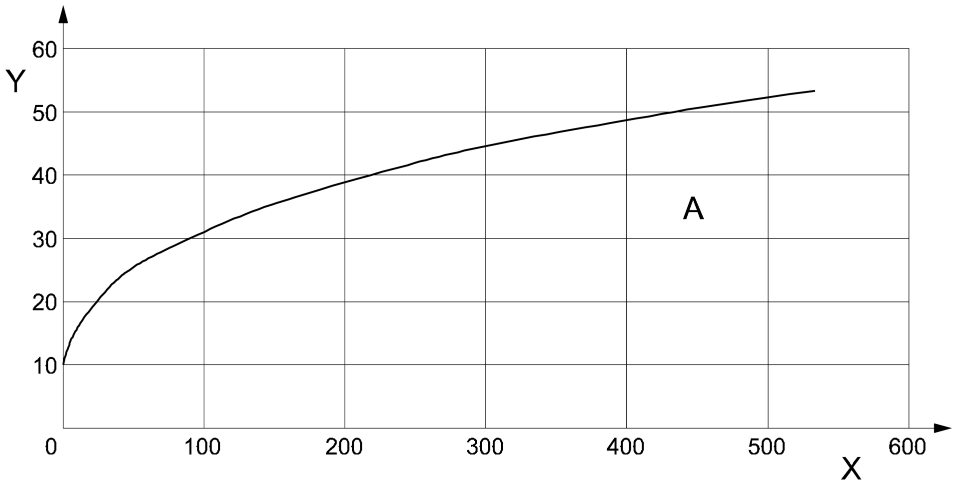
b) When the hydraulic power of the liquid pump, calculated according to (A.1), is greater than 500 W, then the global efficiency η of the pump is determined using the following formula:

$$\eta = 0{,}092 Ln\left(P_{hyd}\right) - 0{,}0403 \quad \text{(A.5)}$$

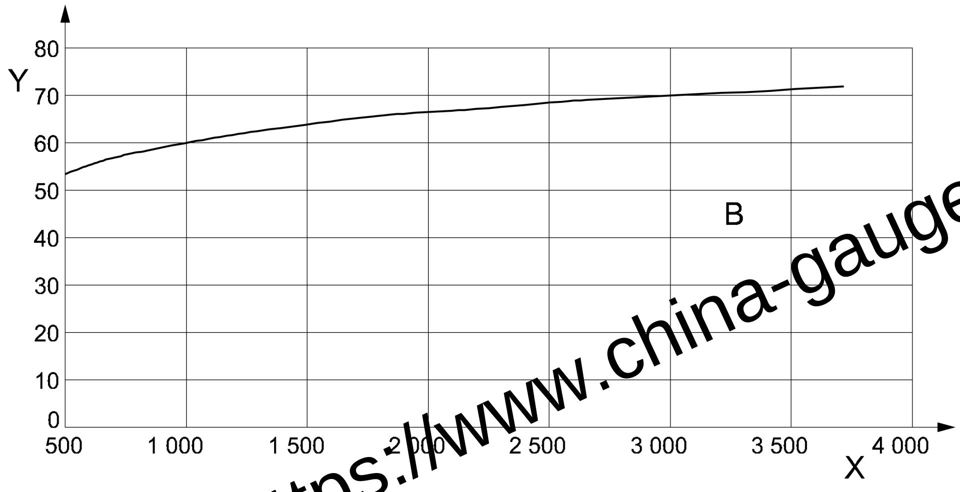
where

P_{hyd} is the measured hydraulic power of the pump, expressed in W.

For information, the graphs of the efficiency of the pump versus its hydraulic power are given below.



a) Efficiency of circulating pumps with a hydraulic power lower or equal to 500 W (source: COSTIC)



b) Efficiency of circulating pumps with a hydraulic power greater than 500 W (extrapolation of COSTIC curve above 1 kW)

Key

X P_{hyd} (W)

Y efficiency η (%)

A $y = 0{,}0721x^{0{,}318\,3}$

B y = 0,092Ln(x) – 0,040 3

Figure A.2 — Efficiency of the pump versus its hydraulic power graphs

A.4 Efficiency of non-integrated pumps

When the liquid pump is not an integral part of the unit, the calculation of the global efficiency to be taken into account in the pump correction is as follows:

a) when the hydraulic power, calculated according to (A.2), is lower or equal to 300 W then the efficiency of the pump is determined using Formula (A.3);

b) when the hydraulic power, calculated according to (A.2), is greater than 300 W but lower or equal to 500 W, then the efficiency of the pump is determined using Formula (A.4);

c) when the hydraulic power, calculated according to (A.2), is greater than 500 W the efficiency of the pump is determined using Formula (A.5).

Annex B
(normative)

Electrical and capacity corrections to include in the electrical power input and in the measured heating, cooling and heat recovery capacities

Table B.1 — "Individual" power input correction due to fan(s) and liquid pump(s) responsible for circulating the heat transfer medium through the outdoor and indoor heat exchangers

Appliance	Electrical auxiliary responsible for circulating the heat transfer medium through the outdoor heat exchanger	$c_{Elec,outdoor}$	Electrical auxiliary responsible for circulating the heat transfer medium through the indoor heat exchanger	$c_{Elec,pump}$
Air/water without duct connection	The fan is an integral part of the appliance	-	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$
			The pump is not an integral part of the appliance	$\frac{q \times \Delta p_i}{\eta \times 1000}$
Air/water with duct connection	The fan is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$
	The fan is not an integral part of the appliance	$\frac{q \times \Delta p_i}{\eta \times 1000}$	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$
	The fan is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$	The pump is not an integral part of the appliance	$\frac{q \times \Delta p_i}{\eta \times 1000}$
	The fan is not an integral part of the appliance	$\frac{q \times \Delta p_i}{\eta \times 1000}$	The pump is not an integral part of the appliance	$\frac{q \times \Delta p_i}{\eta \times 1000}$
Water/water or Brine/water	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$
	The pump is not an integral part of the appliance	$\frac{q \times \Delta p_i}{\eta \times 1000}$	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$
	The pump is an integral part of the appliance	$\frac{q \times \Delta p_e}{\eta \times 1000}$	The pump is not an integral part of the appliance	$\frac{q \times \Delta p_i}{\eta \times 1000}$
	The pump is not an integral part of the appliance	$\frac{q \times \Delta p_i}{\eta \times 1000}$	The pump is not an integral part of the appliance	$\frac{q \times \Delta p_i}{\eta \times 1000}$

Table B.2 — Capacity correction due to liquid pump responsible for circulating the heat transfer medium through the indoor heat exchanger

Appliance **Air/water, Water/water or Brine/water**	**Type of indoor liquid pump**	$c_{\mathrm{th,pump}}$	**Function**
The liquid pump is an integral part of the appliance	Glandless	$\left(q \times \Delta p_e\right) \times \left[\frac{\left(1-\eta\right)}{\eta}\right] / 1000$	Heating
			Cooling
			Heat recovery
	Dry motor	$\left(q \times \Delta p_e\right) \times \left[\frac{\left(IE-\eta\right)}{\eta}\right] / 1000$	Heating
			Cooling
			Heat recovery
The liquid pump is not an integral part of the appliance	$P_{hyd} \leq 300W$ (considered as Glandless)	$\left(q \times \Delta p_i\right) \times \left[\frac{\left(1-\eta\right)}{\eta}\right] / 1000$	Heating
			Cooling
			Heat recovery
	$P_{hyd} > 300W$ (considered as Dry motor)	$\left(q \times \Delta p_i\right) \times \left[\frac{\left(IE-\eta\right)}{\eta}\right] / 1000$	Heating
			Cooling
			Heat recovery

Annex C
(informative)

Primary energy efficiency - Calculation at a single operating point

C.1 Primary energy ratio in heating mode

The primary energy ratio in heating mode shall be determined using the following formula:

$$PER_h = \frac{1}{\frac{Prim_{gas}}{GUE_{h,GCV}} + \frac{Prim_{elec}}{AEF_h}} \qquad (C.1)$$

where:

PERh	is the heating primary energy ratio based on gross calorific value, in kilowatts per kilowatt;
$GUEh_{GCV}$	is the heating gas utilization efficiency based on gross calorific value, in kilowatts per kilowatt;
$Prim_{gas}$	is the primary energy factor for gas;
$Prim_{elec}$	is the primary energy factor for electricity;
AEF_h	is the heating auxiliary energy factor, in kilowatts per kilowatt.

C.2 Primary energy ratio in cooling mode

The primary energy ratio in cooling mode without heat recovery shall be determined using the following formula:

$$PER_c = \frac{1}{\frac{Prim_{gas}}{GUE_{c,GCV}} + \frac{Prim_{elec}}{AEF_c}} \qquad (C.2)$$

where

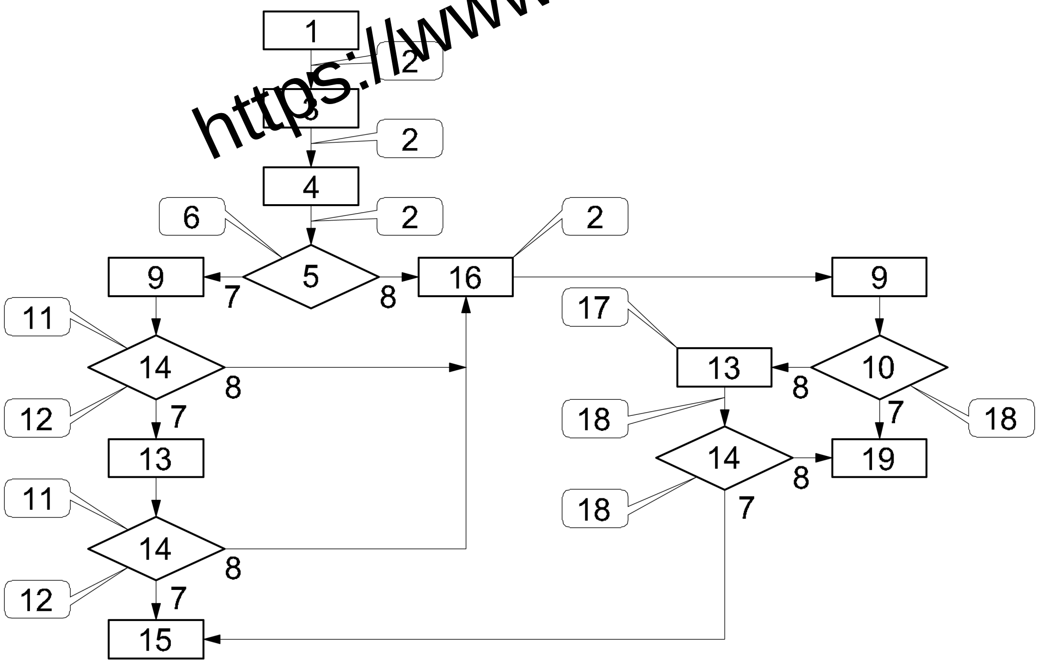
PERc	is the cooling primary energy ratio based on gross calorific value, in kilowatts per kilowatt;
$GUEc_{GCV}$	is the cooling gas utilization efficiency based on gross calorific value, in kilowatts per kilowatt:
$Prim_{gas}$	is the primary energy factor for gas;
$Prim_{elec}$	is the primary energy factor for electricity;
AEF_c	is the cooling auxiliary energy factor, in kilowatts per kilowatt.

Annex D
(informative)

Heating capacity tests - Flow chart and examples of different test sequences

D.1 Flow chart

Figure D.1 illustrates with a flow chart the test procedure described in 7.4.



Key

1 start of the test apparatus and start of the appliance

2 pre conditioning period (7.4.2)

3 operation until test tolerances are fulfilled

4 start of the pre-conditioning period

5 no defrost cycle at the end of pre-conditioning period

6 test procedure when a defrost cycle ends the preconditioning period (7.4.5)

7 yes

8 no

9 start of the equilibrium period according to 7.4.3

10 during the equilibrium period:
or %ΔT > 2,5 % or defrost operation

11 test procedure when a defrost cycle does not end the preconditioning period

12 test procedure when a defrost cycle does not end the preconditioning period

13 data collection period (40 min) according to 7.4.4

14 during the data collection period:
%Δ*T* < 2,5 % and no defrost operation

15 steady-state test procedure according to 7.4.4

16 at least 10 min operation after defrost cycle

17 test procedure when a defrost cycle does not end the preconditioning period

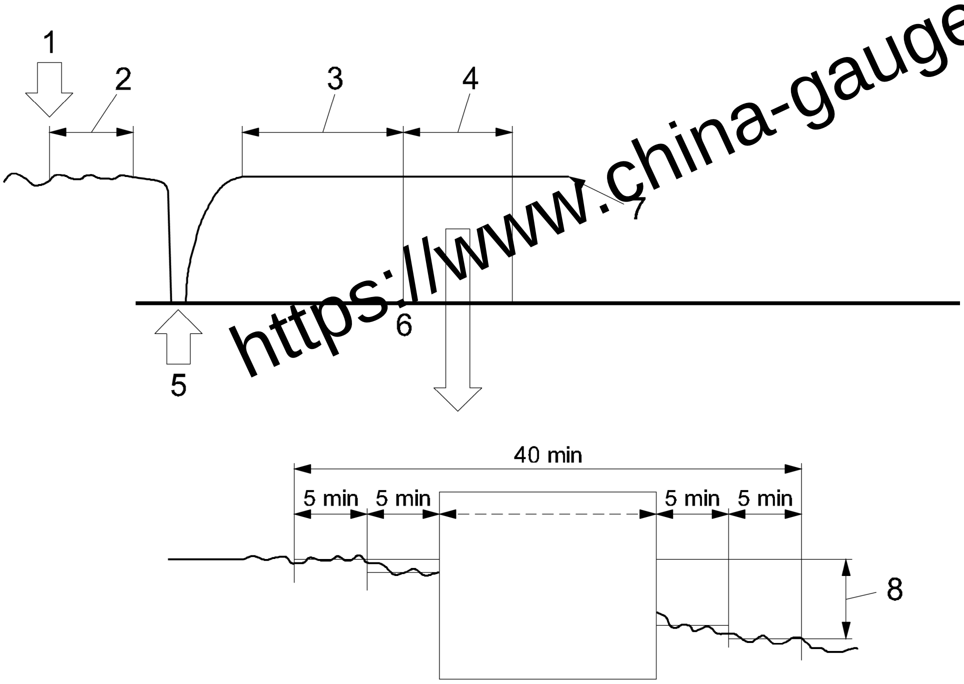
18 test procedure when a defrost cycle ends the preconditioning period

19 transient test procedure according to 7.4.6.5

Figure D.1 — Flow chart

D.2 Examples of test profiles

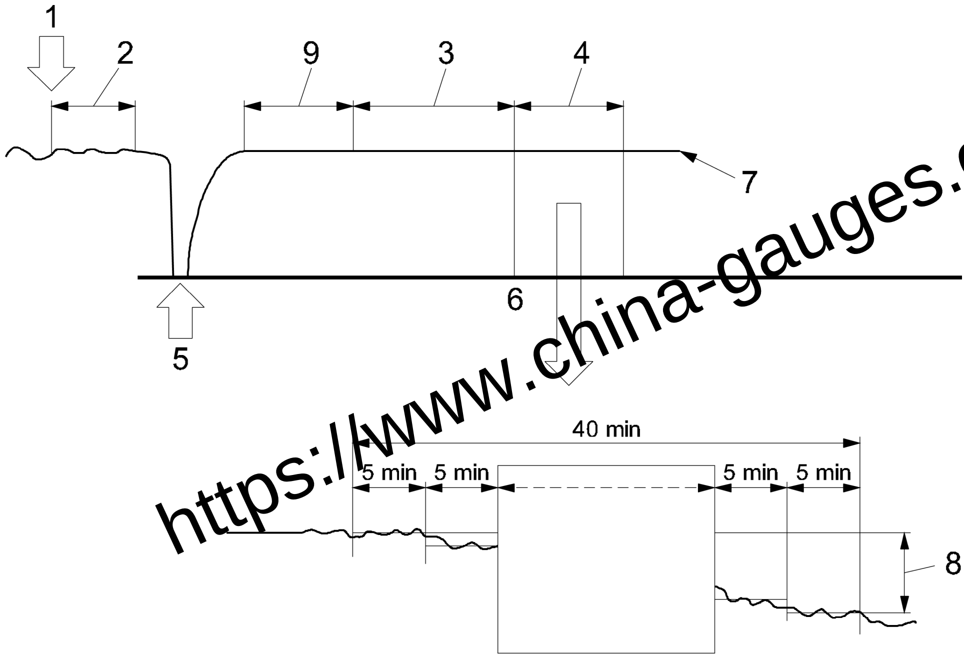
The Figure D.2, Figure D.3, Figure D.4, Figure D.5, Figure D.6, Figure D.7 and Figure D.8 given below show several of the cases that could occur while conducting a heating capacity test as specified in. All examples show cases where a defrost cycle ends the preconditioning period.



Key

1	compliance with test tolerances first achieved	5	defrost at end of preconditioning period
2	preconditioning period (10 min minimum)	6	point 4 expanded for detail
3	equilibrium period 30 min	7	ΔT_{water} *(indoor side)*
4	data for capacity calculation data collection period 40 min	8	ΔT decreases by 2,5 % or less during the first 40 min of the data collection period

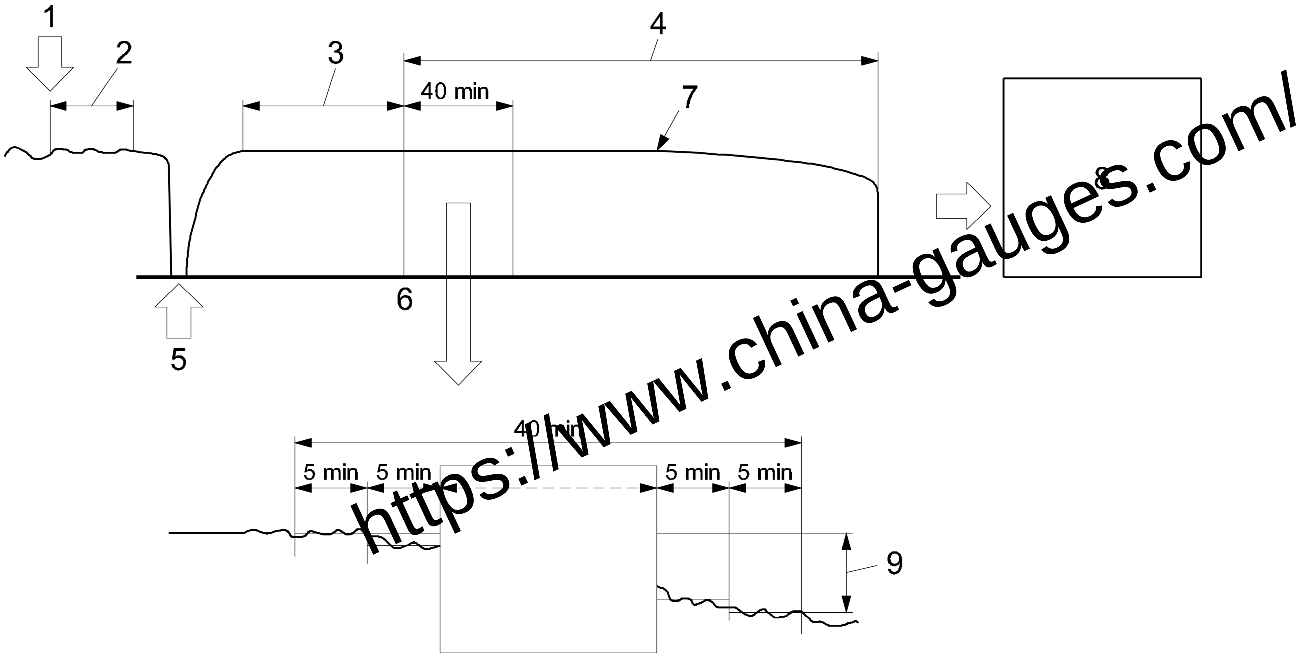
Figure D.2 — Steady-state heating capacity test with defrost at end of preconditioning period



Key

1 compliance with test tolerances first achieved
2 preconditioning period (10 min minimum)
3 equilibrium period 30 min
4 data for capacity calculation data collection period 40 min
5 defrost during preconditioning period
6 point 4 expanded for detail
7 ΔT_{water} *(indoor side)*
8 ΔT decreases by 2,5 % or less during the first 40 min of the data collection period
9 10 min after the defrost cycle that ends the preconditioning period

Figure D.3 — Steady-state heating capacity test with defrost during preconditioning period



Key

1 compliance with test tolerances first achieved

2 preconditioning period (10 min minimum)

3 equilibrium period 30 min

4 data for capacity calculation data collection period 3 h

5 defrost at end of preconditioning period

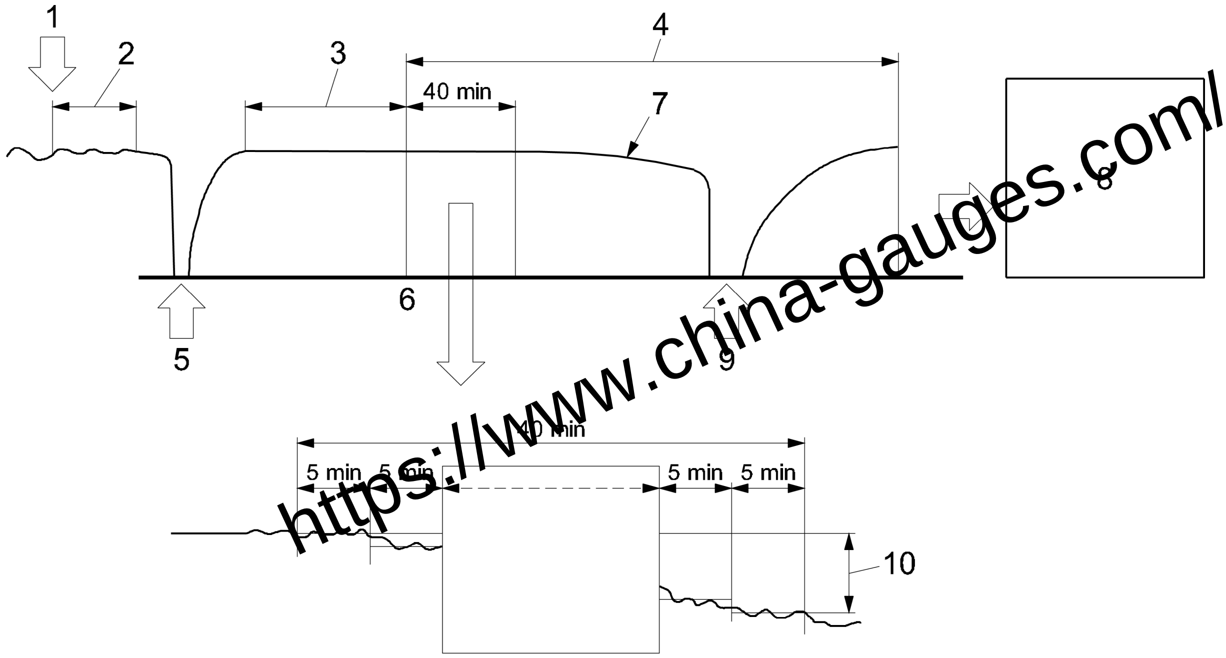
6 40 min of Point 4 expanded for detail

7 ΔT_{water} *(indoor side)*

8 transient test,
terminate test when data collection period equals 3 h

9 ΔT decreases by 2,5 % or less during the first 40 min of the data collection period

Figure D.4 — Transient heating capacity test with no defrost period



Key

1 compliance with test tolerances first achieved

2 preconditioning period (10 min minimum)

3 equilibrium period 30 min

4 data for capacity calculation data collection period 3 h

5 defrost at end of preconditioning period

6 40 min of Point 4 expanded for detail

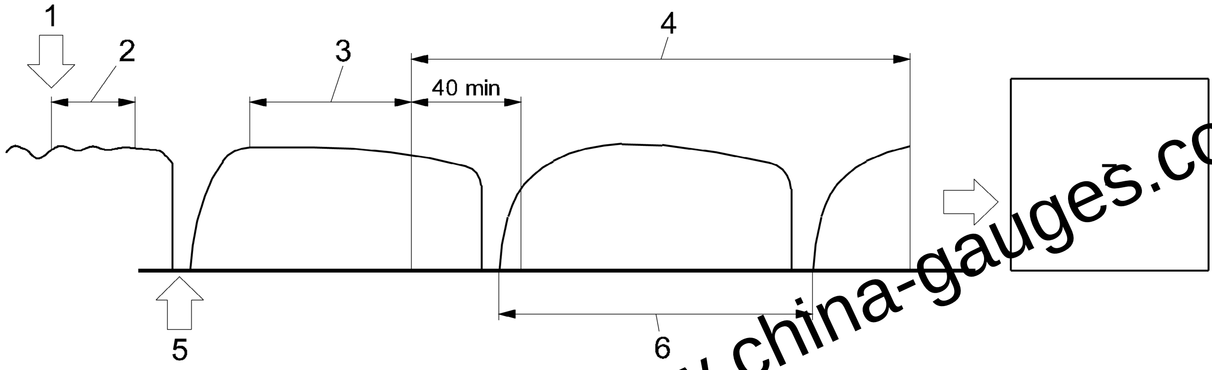
7 ΔT_{water} *(indoor side)*

8 transient test,
terminate test when data collection period equals 3 h

9 automatic defrost cycle occurs

10 ΔT decreases by 2,5 % or less during the first 40 min of the data collection period

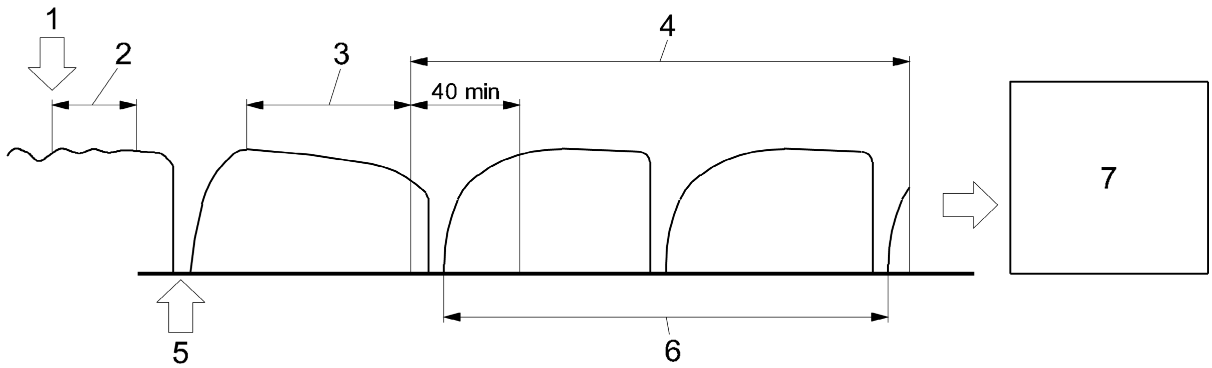
Figure D.5— Transient heating capacity test with one defrost period during the data collection period



Key

1 compliance with test tolerances first achieved
2 preconditioning period (10 min minimum)
3 equilibrium period 30 min
4 data collection period 3 h
5 defrost at end of preconditioning period
6 1 complete cycle
data for capacity calculation
7 transient test,
terminate test when data collection period equals 3 h

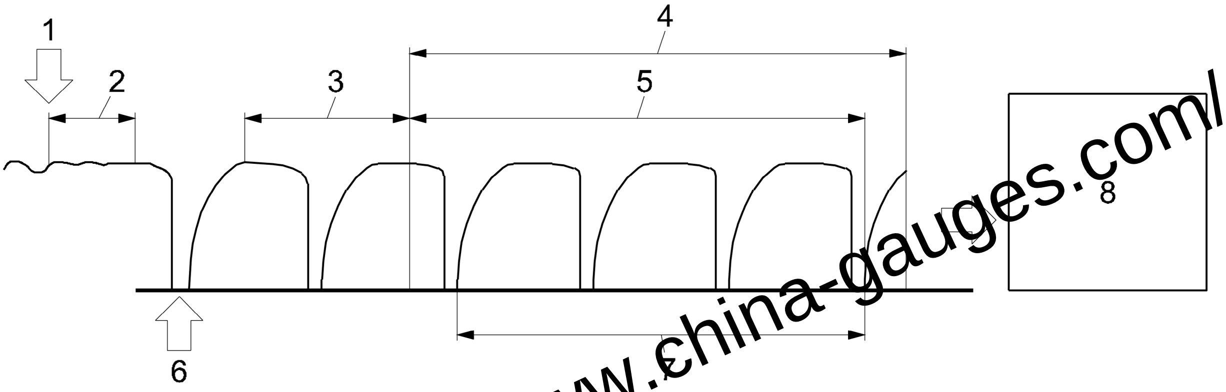
Figure D.6 — Transient heating capacity test with one complete cycle with defrost during the data collection period



Key

1 compliance with test tolerances first achieved
2 preconditioning period (10 min minimum)
3 equilibrium period 30 min
4 data collection period 3 h
5 defrost at end of preconditioning period
6 2 complete cycles
data for capacity calculation
7 transient test,
terminate test when data collection period equals 3 h

Figure D.7 — Transient heating capacity tests with two complete cycles with defrost during the data collection period



Key

1 compliance with test tolerances first achieved
2 preconditioning period (10 min minimum)
3 equilibrium period 30 min
4 3 h
5 data collection period
6 defrost at end of preconditioning period
7 3 complete cycles
data for capacity calculation
8 transient test,
terminate test when data collection period equals 3 h

Figure D.8 — Transient heating capacity test with three complete cycles with defrost during the data collection period

Annex E
(informative)

Direct method for air-to-water (brine) and water (brine) to water (brine) appliances

E.1 General

Annex E provides examples of compensation systems that can be used for the full and reduced capacity tests of air-to-water (see E.2) or water(brine) to water(brine) (see E.3) appliance in cooling and heating mode.

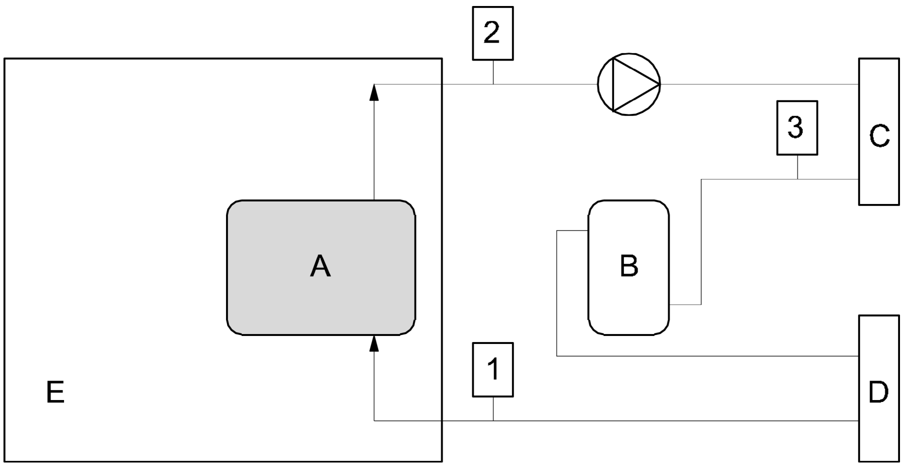
E.2 Compensation system air to water appliances

The outdoor heat exchanger of the air to water appliance recovers air energy from a closed climatic test room within the dry and wet bulb temperature are maintained within the ranges tolerated.

The indoor heat exchanger of the appliance is connected to a test rig that includes

— primary compensation and secondary compensation heat exchangers, to compensate for the cooling and the heating capacity of the appliance,

— one or more storage tanks, to avoid large inlet temperature deviations (10 l/kW to 30 l/kW), as described in Figure E.1.



Key

A	appliance under test	E	climatic test room
B	storage tank	1	inlet temperature of the indoor heat exchanger of the appliance
C	primary compensation heat exchanger	2	outlet temperature of the indoor heat exchanger of the appliance
D	secondary compensation heat exchanger	3	intermediate temperature for test rig control with 3 < 2 and 3 < 1

Figure E.1 — Test installation for air to water (brine) appliance at full or reduced capacity in heating mode

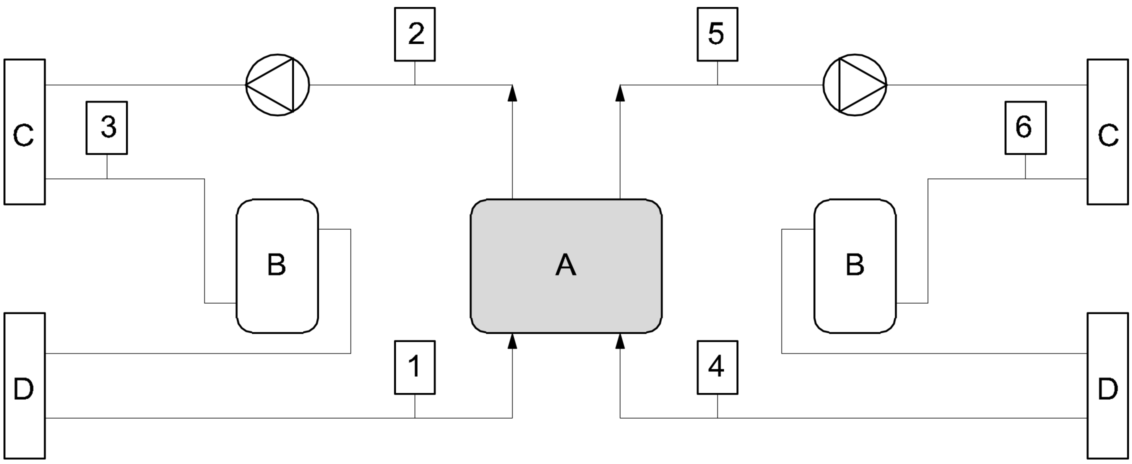
The outlet temperature (2) of the indoor heat exchanger is set from the system control of the appliance (A) under test. The quantity of heat flowing through the heat exchanger (C) varies depending on the desired intermediate temperature whose value is on the initiative of the test supervisor and determined by the control system of the test rig. This first control stage (supplemented by the addition of one or more storage tanks (B)) allows to attenuate the effect of the large variations in the output temperature of the heat exchanger of the appliance (2) (in particular when it operates cyclically). The second control stage of the test rig is located at the heat exchanger (D) where the quantity of heat flowing therein is adjusted according to the desired inlet temperature of the indoor heat exchanger of the appliance (A).

E.3 Compensation system for water/brine to water appliances

The appliance under test is installed in a test rig that includes:

— heating and cooling heat exchangers, to compensate for the cooling and the heating capacity of the appliance;

— one or more storage tanks, to avoid large inlet temperature deviations (10 l/kW to 30 l/kW), as described in Figure E.2.



Key

A	appliance under test	2	outlet temperature of the outdoor heat exchanger of the appliance
B	storage tank	3	intermediate temperature for test rig control with 3 < 1 and 3 < 2
C	primary compensation heat exchanger	4	inlet temperature of the indoor heat exchanger of the appliance
D	secondary compensation heat exchanger	5	outlet temperature of the indoor heat exchanger of the appliance
1	inlet temperature of the outdoor heat exchanger of the appliance	6	intermediate temperature for test rig control with 6 < 5 and 6 < 4

Figure E.2 — Test installation for water (brine) to water (brine) appliance at full or reduced capacity

Annex F
(normative)

Measurement in ON/OFF mode

F.1 General

This method for measurement of air/water, water/water and brine/water appliances operating in ON/OFF mode is based on:

— reaching equilibrium at reduced capacity when the burner operates at the minimum heat input stated in the operating instructions;

— imposing an “ON duration” and calculating the “OFF duration” on the basis of the required load.

F.2 Test procedure for measurement in ON/OFF mode

The test procedure for measurement in ON/OFF mode shall be conducted according to the basic principles described in 7.5.2 and with the respect of tolerances listed in Table 15.

The test sequence is:

— Step 0: Calculate the inlet temperature related to the fixed water flow rate determined at test conditions given in Tables 4 to 9 and related to the required partial load (target value);

— Step 1: Put appliance controller in manual mode, set temperatures and flow rate according to the part load test condition and operate appliance’s burner at the minimal heat input allowed in continuous operation mode;

— Step 2: Reach equilibrium period of 60 min or of eight calculation cycles in case of alternating appliances where appliance shall operate while meeting the appropriate test tolerances specified in Table 14;

— Step 3: Start cycle with an OFF period of 20 min or with an OFF period equivalent to four calculation cycles in case of alternating appliances;

— Step 4: Start with an ON period of 20 min or with an ON period of four calculation cycles in case of alternating appliances;

— Step 5: Complete the cycle with an OFF period of duration (in minutes) equals to:

$$\frac{20 \times P_E + P_{deg} \times t_{deg}}{P} - 20 \tag{F.1}$$

where

P_E	is the effective capacity during the ON period, in kW;
P_{deg}	is the effective capacity during the OFF period when the indoor circulation pump is still operating, in kW;
t_{deg}	is the period when the machine is still delivering capacity, in minutes;
P	is the required partial load (target value), in kW.

In case of alternating appliances the duration of the OFF period shall be equal to (in minutes):

$$\frac{t_{4cyc} \times P_E + P_{deg} \times t_{deg}}{P} - t_{4cyc} \qquad \text{(F.2)}$$

where

P_E	is the effective capacity during the ON period, in kW;
P_{deg}	is the effective capacity during the OFF period when the indoor circulation pump is still operating, in kW;
t_{deg}	is the period when the machine is still delivering capacity, in minutes;
T_{4cyc}	is the duration of 4 calculation cycles, in minutes;
P	is the required partial load (target value), in kW.

For alternating appliances, the OFF period shall be extended until the running calculation cycle is completed;

— Step 6: Repeat steps 4 and 5 for additional three times (for a total of four ON-OFF cycles);

— Step 7: If the cycling interval capacity (P_{cych}), calculated as the (time-weighted) average capacity over the four ON-OFF cycles (i.e. the cycling interval), exceeds the tolerance limit of ± 10 %, repeat steps 1 to 6 using an OFF period whose duration allows interpolation or extrapolation of results at targeted partial load.

An example on how to perform the ON-OFF tests: Case of a continuous air source appliance in heating mode:

— design heating load = 10 kW;

— PLR according to condition C of Table 6 of FprEN 12309-6:2023 (Part load conditions for reference seasonal performance calculation in heating mode of air-to-water units for medium temperature application for the reference heating season “A”, average) = 0,35;

— required partial load (target value) = 3,5 kW;

— flow rate at test conditions = 1,1 m^3/h;

— inlet temperature = 33,3 °C (related to Outlet temperature = 36 °C, flow rate and required partial load = 3,5 kW);

— effective heating capacity during ON period at minimum heat input P_E = 6 kW;

— effective heating capacity during the OFF period when the indoor circulation pump is still operating and at minimum heat input P_{deg} = 1,5 kW;

— ON duration = 20 min;

— t_{deg} duration = 5 min;

— OFF duration = [(20 × 6,0 + 5 × 1,5) / 3,5] – 20 = 16,4 min;

— if the measured cycling interval capacity P_{cych} is < 3,36 kW or > 3,64 kW, repeat test with different OFF cycle, else measurement is accepted.

Annex G
(informative)

Test report

G.1 General information

The test report may at least contain:

a) date;

b) test institute;

c) test location;

d) test method;

e) test supervisor;

f) appliance designation:

- type;
- serial / sample number;
- name of the manufacturer;
- flue type;
- gas family;

g) type of refrigerant;

h) mass of refrigerant;

i) type of absorbent or adsorbent;

j) mass of absorbent or adsorbent;

k) properties of heat transfer medium if different from water or air;

l) reference to this document.

G.2 Additional information

Additional information given on the data plate may be noted and any other information relevant for the test. Particularly, it may be stated whether the testing is performed on a new appliance or one that is in use. In the case of a test performed on an appliance in use, information relative to the year of installation, and on the cleaning of the heat exchange tubes may be given.

G.3 Test results

Effective capacities, gas and electrical power inputs, GUE, AEF, internal or external static pressure may be given together with the corresponding test conditions.

Annex ZA
(informative)

Relationship between this European Standard and the ecodesign requirements of Commission Regulation (EU) No 813/2013 L 239/136 aimed to be covered

This European Standard has been prepared under a Commission's standardization request M/535/ C(2015) 2626 final to provide one voluntary means of conforming to the ecodesign requirements of 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 L 239/136.

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.

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 L 239/136 and Commission's standardization request M/535/ C(2015) 2626 final

Ecodesign Requirements of Regulation (EU) No 813/2013	Clause(s)/sub-clause(s) of this EN	Remarks/Notes
Article 2 (7) Annex II, Table 2	Table 6 Table 9 6.4.3.2	$P_{rated,h}$
Annex II, Table 2	Table 7 Table 10 7.1.7	L_{WA}

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 L 239/1 aimed to be covered

This European Standard has been prepared under a Commission's standardization request M/535/ C(2015) 2626 final to provide one voluntary means of conforming to the energy labelling requirements of 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, combination heaters, packages of space heaters, temperature control and solar device and packages of combination heater, temperature control and solar device L 239/1.

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, combination heaters, packages of space heaters, temperature control and solar device and packages of combination heater, temperature control and solar device L 239/1 and Commission's standardization request M/535/ C(2015) 2626 final

Energy labelling requirements of Regulation (EU) No 811/2013	Clause(s)/sub-clause(s) of this EN	Remarks/Notes
Article 2 (6) Annex III, 1.1.3 (a) V Annex III, 1.1.4 (a) V Annex III, 1.2.3 (a) Annex III, 1.2.4 (a) Annex IV, 1.1 (d) Annex IV, 1.1 (j) Annex V, Table 8 Annex VI, 1.1 (b) Annex VI, 1.1 (g)	Table 6 Table 9 6.4.3.2	$P_{rated,h}$

Energy labelling requirements of Regulation (EU) No 811/2013	Clause(s)/sub-clause(s) of this EN	Remarks/Notes
Annex III, 1.1.3 (a) VII Annex III, 1.1.4 (a) VII Annex III, 1.2.3 (a) Annex III, 1.2.4 (a) Annex IV, 1.1 (m) Annex IV, 1.1 (g) Annex V, Table 8 Annex VI, 1.1 (j) Annex VII, 4 (a)	Table 7 Table 10 7.1.7	L_{WA}

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Annex ZC
(informative)

Relationship between this European Standard and the ecodesign requirements of Commission Regulation (EU) No 2016/2281 L 346/1 aimed to be covered

This European Standard has been prepared under a Commission's standardization request M/560/ C(2019) 1725 final to provide one voluntary means of conforming to the ecodesign requirements of Commission Regulation (EU) No 2016/2281 of 30 November 2016 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air heating products, cooling products, high temperature process chillers and fan coil units L 346/1.

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 ZC.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.

Table ZC.1 — Correspondence between this European Standard and Commission Regulation (EU) No 2016/2281 of 30 November 2016 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air heating products, cooling products, high temperature process chillers and fan coil units L 346/1 and Commission's standardization request M/560/ C(2019) 1725 final

Ecodesign Requirements of Regulation (EU) No 2016/2281	Clause(s)/sub-clause(s) of this EN	Remarks/Notes
Article 2 (7) Annex III - Table 18 Annex III - Table 24	Table 4	Standard rating conditions and reference design conditions for appliances in cooling mode

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Bibliography

[1] EN 15502-1:2021, *Gas-fired heating boilers — Part 1: General requirements and tests*

[2] EN 15502-2-1:2022, *Gas-fired central heating boilers — Part 2-1: Specific standard for type C appliances and type B2, B3 and B5 appliances of a nominal heat input not exceeding 1 000 kW*

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