BS EN 16147:2017

BSI Standards Publication

Heat pumps with electrically driven compressors — Testing, performance rating and requirements for marking of domestic hot water units

bsi.

National foreword

This British Standard is the UK implementation of EN 16147:2017. It supersedes BS EN 16147:2011 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RHE/17, Testing of air conditioning units.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2017

ISBN 978 0 580 90365 6

ICS 27.080

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 January 2017.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16147

January 2017

ICS 27.080

Supersedes EN 16147:2011

English Version

Heat pumps with electrically driven compressors - Testing, performance rating and requirements for marking of domestic hot water units

Pompes à chaleur avec compresseur entraîné par moteur électrique - Essais, détermination des performances et exigences pour le marquage des appareils pour eau chaude sanitaire

Wärmepumpen mit elektrisch angetriebenen Verdichtern - Prüfungen, Leistungsbemessung und Anforderungen an die Kennzeichnung von Geräten zum Erwärmen von Brauchwarmwasser

This European Standard was approved by CEN on 8 October 2016.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

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.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 16147:2017 E

Contents

Page

European foreword

This document (EN 16147:2017) has been prepared by Technical Committee CEN/TC 113 “Heat pumps and air conditioning units”, the secretariat of which is held by AENOR.

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 July 2017, and conflicting national standards shall be withdrawn at the latest by July 2017.

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

This document supersedes EN 16147:2011.

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

For relationship with EU Directive(s), see informative Annexes ZA, ZB, ZC and ZD, which are an integral part of this document.

Note that the following provides details of significant technical changes between this document and the previous edition:

a) re-structuring of the standard into the Clause 5 "Installation requirements", Clause 6 "Settings and test conditions", Clause 7 "Performance tests", Clause 8 „Other tests“ and Clause 9 „Test results and test report“;

b) update of Table 1 "Uncertainties of measurement for indicated values" in terms of units;

c) update of the performance test regarding the stages (i.e. A. to F.) and the order of the tests (see 7.2);

d) introduction of 7.11 "Calculation of the smart control factor SCF" and 7.12 „Determination of the ambient correction term Q_{cor} “ on the basis of the European Standard EN 50440:2015;

e) introduction of 7.13.3 "Calculation of the Annual Consumption of electric energy";

f) re-allocation and revision of the former "tapping cycles“ into the new annex "Load profiles" (see Tables A.1 to A.3);

g) introduction of 7.14 "Other performances" regarding rated heat output and seasonal coefficient of performance;

h) addition of the Annex ZA and Annex ZB for the relationship between this European Standard and the requirements of Commission Regulation (EU) No 814/2013 and (EU) No 812/2013;

i) addition of the Annex ZC and Annex ZD for the relationship between this European Standard and the requirements of Commission Regulation (EU) No 813/2013 and (EU) No 811/2013.

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

1 Scope

This European Standard specifies methods for testing, rating of performance and calculation of water heating energy efficiency of air/water, brine/water, water/water and direct exchange/water heat pump water heaters and heat pump combination heaters with electrically driven compressors and connected to or including a domestic hot water storage tank for domestic hot water production.

This European Standard comprises only the testing procedure for the domestic hot water production of the heat pump system.

NOTE 1 Testing procedures for simultaneous operation for domestic hot water production and space heating are not treated in this standard. Simultaneous means that domestic hot water production and space heating generation occur at the same time and may interact.

NOTE 2 For heat pump combination heaters the seasonal efficiency of space heating is determined according to EN 14825.

This European Standard only applies to water heaters which are supplied in a package of heat pump and storage tank. In the case of water heaters consisting of several parts with refrigerant connections, this European Standard applies only to those designed and supplied as a complete package.

This European Standard does not specify requirements of the quality of the used water.

2 Normative references

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

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

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

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

EN 60204-1, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements (IEC 60204-1)*

EN 60335-2-40, *Household and similar electrical appliances - Safety - Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers (IEC 60335-2-40)*

EN 61000-3-11, *Electromagnetic compatibility (EMC) - Part 3-11: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems - Equipment with rated current <= 75 A and subject to conditional connection (IEC 61000-3-11)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14511-1 and the following apply.

3.1
heat pump water heater
water heater that uses ambient heat from air source, water source or ground source, and/or waste heat for heat generation

3.2
heat pump combination heater
heat pump space heater that is designed to also provide heat to deliver hot drinking or sanitary water at given temperature levels, quantities and flow rates during given intervals, and is connected to an external supply of drinking or sanitary water

3.3
domestic hot water
water heated for household or similar purposes

3.4
storage volume
V_{m}
measured volume of the tank

3.5
non heated space air
heat source for a heat pump which absorbs heat by an air heat exchanger in direct contact with the air inside a non-heated space within a building

3.6
indoor air
heat source for a heat pump which absorbs heat by an air heat exchanger in direct contact with the air inside a heated space within a building

3.7
coefficient of performance for domestic hot water
COP_{DHW}
coefficient of performance which is determined by the use of a reference load profile and which includes the heat losses of the storage tank

3.8
reference hot water temperature
θ'_{WH}
temperature determined as the mean temperature value of the average temperatures during one single draw-off which ends when the hot water temperature is below 40 °C

3.9
mixed water at 40 °C
V_{40}
quantity of water at 40 °C, which has the same heat content (enthalpy) as the hot water which is delivered above 40 °C at the output of the water heater

3.10
off-peak product
water heater that is energised for a maximum period of 8 consecutive hours between 22:00 and 07:00 of the 24 hour tapping pattern

3.11
water heating energy efficiency
η_{wh}
ratio between the useful energy (in domestic hot water) provided by a water heater and the energy required for its generation

3.12
load profile
given sequence of water draw-offs

3.13
water draw-off
given combination of useful water flow rate, useful water temperature, useful energy content and peak temperature

3.14
useful water flow rate
f
minimum flow rate for which hot water is contributing to the reference energy

3.15
useful water temperature
T_m
water temperature at which hot water starts contributing to the reference energy

3.16
useful energy content
Q_{tap}
energy content of hot water provided at a temperature equal to, or above, the useful water temperature, and at water flow rates equal to, or above, the useful water flow rate

3.17
peak temperature
T_p
minimum water temperature to be achieved during water draw-off calculated as the mean value over the water draw-off

3.18
reference energy of the load profile
Q_{ref}
sum of the useful energy content of water draw-offs in a particular load profile

3.19
daily electrical energy consumption
Q_{elec}
consumption of electrical energy for water heating over 24 consecutive hours under a specific load profile

3.20
smart control
device that automatically adapts the water heating process to individual usage conditions with the aim of reducing energy consumption

3.21
smart control factor
SCF
water heating energy efficiency gain due to smart control

3.22
primary standby heat loss
P_{stby}
primary power input of a heat pump water heater in operating modes without heat demand

3.23
standby power input
P_{es}
total power input of the unit during the standby test, including the power input of the unit to overcome heat losses of the tank and the power input of any auxiliary device

3.24
ambient correction term
Q_{cor}
energy correction term which takes into account the fact that the place where the water heater is installed is not an isothermal place

3.25
conversion coefficient
CC
coefficient reflecting the power generation efficiency

Note 1 to entry: According to Directive 2012/27/EU the *CC* value is equal to 2,5.

4 Symbols and abbreviations

Symbol	Description	Units
AEC	Annual electrical energy consumption	kWh/a
CC	conversion coefficient, equal to 2,5	—
SCF	smart control factor	—
COP_{DHW}	coefficient of performance for domestic hot water	—
c_p	specific heat capacity of water	kJ/(kgK)
ESP	external static pressure	Pa
f	useful water flow rate	l/min
f_{max}	maximum flow rate of considered load profile	l/min
$f_{max}(t)$	maximum flow rate of hot water during draw-off	l/min
$f(t)$	useful water flow rate	l/min
i	index for the draw-off	—
k	coefficient for the determination of ambient correction term, which value is given in Table 7	—
m_{act}	difference of the two weights (filled/empty) of the storage water heater	kg
P_{es}	standby power input	kW
P_{rated}	rated heat output	kW
P_S	measured average power input for off-peak products	kW
P_{stby}	primary standby heat loss	kW
Q_{cor}	ambient correction term	kWh
Q_{elec}	daily electrical energy consumption	kWh
$Q_{EL\text{-}LP}$	calculated heat energy produced by electrical resistance heater during the whole load profile	kWh
$Q_{EL\text{-}tap}$	Calculated heat energy produced by electrical resistance heater to reach the required tapping temperature	kWh
$Q_{HP\text{-}tap}$	useful energy during one single draw-off	kWh
Q_{LP}	total useful energy content during the whole load profile	kWh
Q_{elec}^{smart}	total electrical energy consumption during the smart period of the smart cycle	kWh
Q_{LP}^{smart}	total useful energy content during the smart period of the smart cycle	kWh

Symbol	Description	Units
$Q_{\text{elec}}^{\text{ref}}$	Total electrical energy consumption during the reference period of the smart cycle	kWh
$Q_{\text{LP}}^{\text{ref}}$	total useful energy content during the reference period of the smart cycle	kWh
Q_{ref}	reference energy of the load profile	kWh
Q_{tap}	energy content of hot water provided at a temperature equal to, or above, the useful water temperature, and at water flow rates equal to, or above, the useful water flow rate	kWh
smart	indicator of the smart control compliance of the product	
$SCOP_{\text{DHW}}$	Seasonal Coefficient of Performance for domestic hot water	
t_{d}	test phase duration	s
t_{es}	duration of the last on-off-cycle of the heat pump	s
t_{h}	heating up time	s
t_{40}	time from starting the draw-off until θ_{WH} is less than 40 °C	s
t_{tap}	duration of a draw-off of useful water	s
t_{TTC}	load profile time	h
T_{DB}	dry bulb temperature	°C
T_{m}	useful water temperature	°C
T_{p}	peak temperature	°C
T_{WB}	wet bulb temperature	°C
$\dot{V}_{\text{air}}$	nominal air volume flow rate	m^3/s
$\dot{V}_{\text{fluid}}$	measured liquid volume flow rate	m^3/s
V_{m}	storage volume	l
V_{40}	mixed water at 40 °C	l
$W_{\text{eh-HP}}$	total electrical energy consumption during the test duration t_h	kWh
$W_{\text{eh-M}}$	measured electrical energy consumption during the test duration t_h	kWh
$W_{\text{EL-Corr}}$	correction due to electrical energy consumption of fan/liquid pump	kWh
$W_{\text{EL-LP}}$	total electrical energy consumption during the whole load profile	kWh
$W_{\text{EL-M-LP}}$	total measured electrical energy consumption	kWh
$W_{\text{EL-OFF}}$	calculated electrical energy consumption for off-peak products	kWh
$W_{\text{es-HP}}$	total electrical energy consumption during the last on-off-cycle	kWh

Symbol	Description	Units
$W_{es\text{-}M}$	measured electrical energy consumption during the last on-off cycle	kWh
Δp_e	measured external static pressure difference	Pa
Δp_i	measured internal static pressure difference	Pa
η	efficiency of the fan or the pump according to EN 14511–3	—
η_{wh}	water heating energy efficiency	%
n_{tap}	number of draw-offs during the load profile	—
θ_{WC}	incoming cold water temperature	°C
$\theta_{WC}(t)$	incoming cold water temperature during draw-off	°C
θ_{WH}	outgoing hot water temperature	°C
$\theta_{WH}(t)$	hot water temperature during draw-off	°C
θ'_{WH}	reference hot water temperature	°C
$\rho(T)$	density of water at temperature T	kg/m^3

5 Installation requirements

5.1 Test apparatus and uncertainties of measurement

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

Water systems or other heat transfer liquid systems shall be sufficiently free of entrained gas as to ensure that the measured results are not significantly influenced.

The inlet and outlet temperatures of the domestic water are measured in the centre of the flow and as close as possible to the appliance. The response time of the temperature sensor and the sampling interval have to be chosen to maintain the uncertainties in Table 1.

Ducted air systems shall be sufficiently airtight to ensure that the measured results are not significantly influenced by exchange of air with the surroundings.

The uncertainties of measurement shall not exceed the values specified in Table 1.

Table 1 — Uncertainties of measurement for indicated values

Measured quantity	Unit	Uncertainty
Domestic Hot Water		
Temperature	°C	±0,2 K
Temperature difference	K	±0,2 K
Volume	L	±2 %
Volume flow	l/min	±2 %
Thermal energy	kWh	±5 %
Liquid (heat source)		
Temperature inlet/outlet	°C	±0,15 K
Volume flow	m^3/s	±1 %
Static pressure difference	Pa	±1 kPa ($\Delta P \leq 20$ kPa) ± 5 % ($\Delta P \geq 20$ kPa)
Brine concentration	% vol.	±2 % vol.
Air (heat source)		
Dry bulb temperature	°C	±0,2 K
Wet bulb temperature	°C	±0,4 K
Volume flow	m^3/h	±5 %
Static pressure difference	Pa	±5 Pa ($\Delta P \leq 100$ Pa) ±5 % ($\Delta P \geq 100$ Pa)
Electrical quantities		
Electric power	W	±0,1 W (≤10 W) ±1 % (≥10 W)
Electrical energy	kWh	±1 %
Voltage	V	±0,5 %
current	A	±0,5 %
Ambient		
Ambient temperature indoors	°C	±0,5 K

5.2 Test room for the outdoor heat exchanger of air source heat pumps

The size of the test room shall be selected to avoid any resistance to air flow at the air inlet and air outlet orifices of the test object. The air flow through the room shall not be capable of initiating any short circuit between the two orifices, and therefore the velocity of air flow at these two locations shall not exceed 1,5 m/s when the test object is switched off.

Unless otherwise stated by the manufacturer, the air inlet and air outlet orifices shall not be less than 1 m from the surfaces of the test room; this also applies to any measuring ducts.

Any direct heat radiation (e.g. solar radiation) onto heating units in the test room onto the heat pump or onto the temperature measuring points shall be avoided.

5.3 Installation and connection of the heat pump

The heat pump shall be installed and connected for the test as recommended by the manufacturer in his installation and operation manual. The accessories provided by option (for example heating element) are not included in the test.

Temperature and pressure measuring points shall be arranged in order to obtain significant mean values.

5.4 Installation of heat pumps consisting of several parts

In the case of heat pumps consisting of several refrigeration parts (split heat pumps) the following installation conditions shall be complied with for the tests:

a) each refrigerant line shall be installed in accordance with the manufacturer's instructions; the length of each line shall be between 5 m and 7,5 m;

b) the lines shall be installed so that the difference in elevation does not exceed 2,5 m;

c) thermal insulation shall be applied to the lines in accordance with the manufacturer's instructions;

d) unless constrained by the design at least half of the interconnecting lines shall be exposed to the outdoor conditions with the rest of the lines exposed to the indoor conditions.

For the test of direct exchange ground coupled heat pumps requirement d) is not valid.

For indirect systems where the heat pump is separated from the tank, water or brine connections to the tank shall be installed in accordance with the manufacturer’s instructions to the maximum stated length or 5 m, whichever is shorter. Piping shall be installed according to d) and with as few bends as possible and insulated according to c).

6 Settings and test conditions

6.1 General

Set points for internal control equipment of the unit such as thermostats, pressure switches or mixing valves shall be set to the values as stated in the installation and operating instructions.

If several set points or a range are stated, the manufacturer shall indicate the one to be used for the tests.

Thermostat settings and settings for auxiliary electrical heaters shall be done according to the installations and operating instructions and shall remain in the same position for the duration of the test.

If the water heater is equipped with a mixing valve for the hot water, this valve shall be set at the manufacturer's recommended setting throughout the test.

6.2 Settings for non-ducted air source units

For non-ducted units, the adjustable settings such as louvers and fan speed shall be set according to the installations and operating instructions.

Without information from the manufacturer, louvers and fan speed shall be set for maximum air flow rate.

6.3 Setting the external static pressure difference for ducted air source units

The volume flow and the pressure difference shall be related to standard air and with dry heat exchanger. If the air flow rate is given by the manufacturer with no atmospheric pressure, temperature and humidity conditions, it shall be considered as given for standard air conditions.

The air flow rate as stated in the installation and operating instructions shall be converted into standard air conditions. The air flow rate setting shall be made when the fan only is operating.

The resulting standard air flow rate shall be set and the resulting external static pressure (ESP) measured.

If the ESP is lower than 30 Pa, the air flow rate is decreased 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 and operating instructions state that the maximum allowable duct length is for inlet and outlet together less than 2 m, then the unit shall be tested with its duct length but as a non-ducted unit; therefore the ESP is considered equal to 0 Pa

6.4 Setting the difference of temperature for heat pumps using a liquid as heat source

For heat pump water heater using liquid (water or brine) as heat source, the nominal liquid flow rate as specified in the operation and installation instructions shall be set with the inlet liquid temperature as given in Table 4.

For heat pump combination heater, the liquid flow rate as specified for space heating operation at standard rating conditions at medium temperature application (47 °C/55 °C) according to EN 14511-2 and EN 14511-3 shall be set with the inlet liquid temperature as given in Table 4.

6.5 Test conditions

6.5.1 General test conditions

The tests shall be carried out at the relevant test conditions specified in Table 3 and Table 4.

For heat pumps using ventilation exhaust air as heat source, the air flow rate shall be set as specified by the manufacturer but shall not exceed the maximum values given in Table 5.

Permissible deviations shall not exceed the values specified in Table 2. In addition the maximal permissible deviation of thermal energy for the complete load profile shall be 5 %.

6.5.2 Additional test conditions

For heat pumps using ventilation exhaust air as heat source, additional air flow rates can be tested.

Table 2 — Variations allowed for the test conditions when the heat pump is running

Readings	**Variations of arithmetical mean values from specified test conditions**			**Variation of individual readings from specified test conditions**		
	Interval H [a]	Interval D [b]	Interval S [c]	Interval H [a]	Interval D [b]	Interval S [c]
Air temperature						
dry-bulb [d]	±0,6 K	±1,5 K		±1,0 K	±5,0 K	±2,5 K
- wet-bulb	±0,4 K	±1,0 K		±0,6 K	—	
- volume flow	±5 %			±10 %		
- static pressure difference	—			±10 %		

Readings	Variations of arithmetical mean values from specified test conditions			Variation of individual readings from specified test conditions		
	Interval H [a]	Interval D [b]	Interval S [c]	Interval H [a]	Interval D [b]	Interval S [c]
- ambient temperature of the tank (if not used as heat source)	±1 K			±2 K		
Domestic hot water						
- inlet temperature	±1 K			±1 K		
- volume flow	≥10 l/min (±5 %) ±0,5 l/min (≤10 l/min)			≥10 l/min (±10 %) ±1,0 l/min (≤10 l/min)		
Liquid						
- Liquid source Inlet temperature	±0,2 K	—	±0,5 K	±0,5 K	—	—
- Volume flow	±1 %			±2,5 %		
- Static pressure difference	–			±10 %		
Others						
Voltage	±4 %			±4 %		

[a] Interval H applies when the heat pump is operating, except for the first 10 min after termination of a defrost cycle, and the first 10 min after a restart of the heat pump.

[b] Interval D applies during a defrost cycle and during the first 10 min after the termination of a defrost cycle when the heat pump is operating in the heating mode.

[c] Interval S applies when the compressor is stopped and during the first 10 min after the hot water thermostat has started again the heat pump.

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

Table 3 — Test conditions applicable to all systems

Measured variable	Set value
Power supply voltage	Rated voltage
Power supply frequency	Rated frequency
Air flow rate on the heat source side	Nominal, as indicated by the manufacturer. When only a range is given, tests are to be carried out at the maximum value.
Temperature of the incoming cold water	10 °C
Pressure of incoming cold water	max. 0,6 MPa (6 bar)
Hot water flow rate	(see load profiles in Annex A)

Table 4 — Test conditions for particular types of systems

Type of heat source	Heat source Air Dry (wet) bulb temperature in °C	Heat source inlet/outlet or bath [a] temperature in °C	Range of ambient temperature of heat pump in °C	Ambient temperature of storage tank in °C
Outdoor air heat pump (placed indoor side)			from 15 to 30	20
average	7 (6)			
colder	2 (1)			
warmer	14 (13)			
Outdoor air heat pump (outdoor side)		–	heat source temperature	20
average	7 (6)			
colder	2 (1)			
warmer	14 (13)			
Non heated space air	15 (12)	–	heat source temperature	15
Indoor air	20 (15)	–	heat source temperature	20
Exhaust air	20 (12)	–	from 15 to 30	20
Water	–	10 / 7 [b]	from 15 to 30	20
Brine	–	0 / −3 [b]	from 15 to 30	20
Direct evaporation	–	4 [a]	from 15 to 30	20

[a] Brine bath mean temperature for direct evaporation testing.

[b] The outlet temperature shall be used by the manufacturer for setting the flow rate that is to be maintained during the test in accordance with 6.4.

Table 5 — Maximum ventilation exhaust air available dependent on declared load profile

Declared load profile	XXS	XS	S	M	L	XL	XXL	3XL	4XL
Maximum ventilation exhaust air available, m^3/h	109	128	128	159	190	870	1 021	2 943	8 830

The flow rates in Table 5 are expressed in m^3/h at a humidity of 5,5 g/m^3.

NOTE Measurement of the air flow rate according to EN ISO 5801.

7 Performance tests

7.1 General

The test methods specified in this clause are designed to determine the water heating energy efficiency and the performance of heat pump when providing heat for domestic hot water.

The appliance shall be installed and adjusted in the initial state conditions and in the initial adjustment conditions as given in Clauses 5 and 6.

7.2 Basic principles

The test consists of the following six principal stages:

[Stage A] Stabilization (see 7.5);

[Stage B] Filling and storage volume (see 7.6);

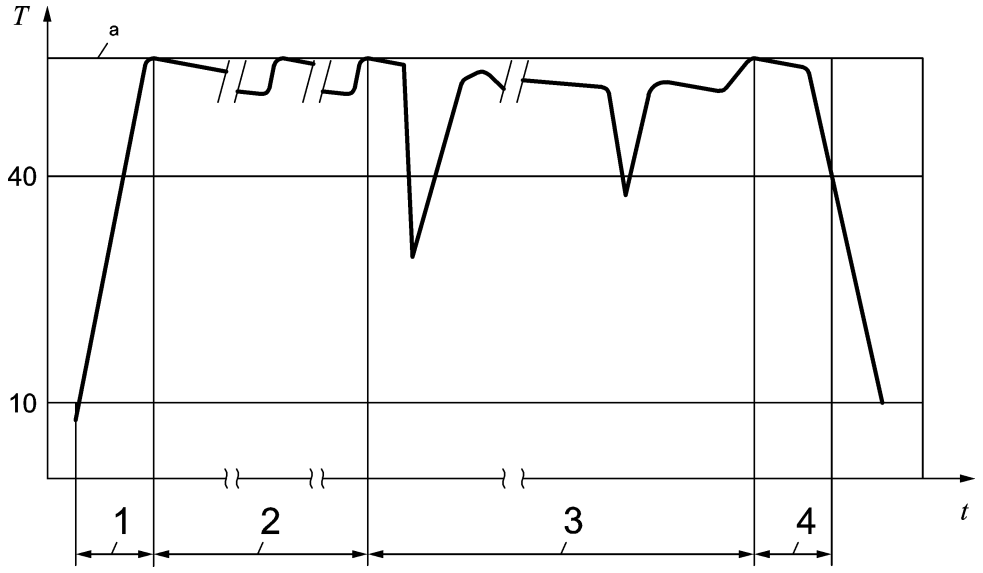
[Stage C] Filling and heating up period (see 7.7);

[Stage D] Standby power input (see 7.8);

[Stage E] Water draw-offs (see 7.9);

[Stage F] Mixed water at 40 °C and reference hot water temperature (see 7.10).

After the preparation of the test (stages A and B) the tests C to F are performed as shown in Figure 1. Provided that the starting conditions are the ending conditions of the previous stage, each individual stage can be carried out independently.



Key

1	[Stage C] Filling and heating up period (see 7.7)	*T*	temperature
2	[Stage D] Standby power input (see 7.8)	*t*	time
3	[Stage E] Water draw-offs (see 7.9)	a	set point temperature
4	[Stage F] Mixed water at 40 °C and reference hot water temperature (see 7.10)		

Figure 1 — Stages and order of the tests

All tests are performed with power supplied at the rated voltage and rated frequency as stated in the installation and operation instructions. After the initial start of the heat pump the power supply is left for the duration of the test.

Any supplementary heat supply which can be switched off by the user shall be switched off during the entire test, unless otherwise stated by the manufacturer.

7.3 Off-peak products

For off-peak products, the product shall be installed and connected as stated in the installation and operation instructions. All appropriate information to set the time period for which the unit is not allowed to be energized whereas the unit is under power supply shall be stated in the installation and operation instructions, for conducting Stage E of the performance test.

For off-peak products, the power supply to the unit is shut down at the beginning of Stage E (load profiles) and is reactivated 16 h later.

After that, the next switch off of the compressor by the thermostat sensing the water temperature in the tank shall be obtained within 8 h, otherwise the product is not considered to be an off-peak product.

For off peak products the power input due to auxiliaries shall be included in the total power input in Stage E.

If this measurement is not made during Stage E, then the average electrical power input (P_s) is determined from the first 20 min of the standby period and shall be added to the measured power input during Stage E.

The corresponding energy consumption is to be added to Stage E and shall be calculated according to Formula (1).

$$W_{\text{EL-OFF}} = 16 \times P_S \tag{1}$$

where

$W_{\text{EL-OFF}}$ is the calculated electrical energy consumption for off-peak products in kWh;

16 is the off-peak time in h;

P_s is the measured average power input in kW.

7.4 Power input corrections

7.4.1 Power input of fans for heat pumps with duct connection

In the case of heat pumps, which allow an external static pressure difference, only a fraction of the power input to the fan motor shall be included in the effective power absorbed by the heat pump.

If no fan is provided with the heat pump, the proportional power input which is to be included in the effective power absorbed by the heat pump, shall be calculated using Formula (2):

$$W_{\text{EL-Corr}} = \frac{1}{3600 \times 1000} \times \int_0^{t_d} \frac{\dot{V}_{\text{air}}(t) \times \Delta p_i}{\eta} dt \tag{2}$$

where

$W_{\text{EL-Corr}}$ is the correction due to electrical energy consumption of fan in kWh;

η is the efficiency of the fan according to EN 14511–3;

Δp_i is the measured internal static pressure difference in Pa;

$\dot{V}_{\text{air}}$ is the nominal air volume flow rate in m^3/s;

t_d is the test phase duration in s.

If a fan is an integral part of the heat pump, only a fraction of the input to the fan motor shall be included in the effective power absorbed by the heat pump. The fraction which is to be excluded from the total power absorbed by the heat pump shall be calculated using Formula (3):

$$W_{\text{EL-Corr}} = \frac{1}{3600 \times 1000} \times \int_0^{t_d} \frac{\dot{V}_{\text{air}}(t) \times \Delta p_e}{\eta} dt \quad (3)$$

where

$W_{\text{EL-Corr}}$ is the correction due to electrical energy consumption of fans in kWh;

η is the efficiency of the fan according to EN 14511–3;

$\dot{V}_{\text{air}}$ is the nominal air volume flow rate in m^3/s;

Δp_e is the measured external static pressure difference in Pa;

t_d is the test phase duration in s.

7.4.2 Power input of liquid pumps

The power input of pumps in any intermediate circuit or e.g. for loading a separate storage connected to the heat pump shall be fully included in the effective power absorbed by the heat pump.

At the evaporator side, the fraction of the power absorbed by a liquid pump which is required to overcome the internal static pressure difference of the evaporator shall be included in the effective power input absorbed by the heat pump.

If no pump is provided with the heat pump the proportional power input which is to be included in the effective power absorbed by the heat pump, shall be calculated using Formula (4):

$$W_{\text{EL-Corr}} = \frac{1}{3600 \times 1000} \times \int_0^{t_d} \frac{\dot{V}_{\text{fluid}}(t) \times \Delta p_i}{\eta} dt \quad (4)$$

where

η is the efficiency of circulating pump according to EN 14511–3;

Δp_i is the measured internal static pressure difference in Pa;

$\dot{V}_{\text{fluid}}$ is the measured liquid volume flow rate in m^3/s;

t_d is the test phase duration in s.

If a pump is an integral part of the heat pump, only a fraction of the input to the pump motor shall be included in the effective power absorbed by the heat pump. The fraction which is to be excluded from the total power absorbed by the heat pump shall be calculated using Formula (5):

$$W_{\text{EL-Corr}} = \frac{1}{3600 \times 1000} \times \int_0^{t_d} \frac{\dot{V}_{\text{fluid}}(t) \times \Delta p_e}{\eta} dt \quad (5)$$

where

η is the efficiency of circulating pump according to EN 14511–3;

Δp_e is the measured external static pressure difference in Pa;

$\dot{V}_{\text{fluid}}$ is the measured liquid volume flow rate in m^3/s;

t_d is the test phase duration in s.

7.5 Stabilization [stage A]

The product is kept at ambient conditions until all parts of the product have reached ambient conditions ± 2 K (at least 24 h for storage heat pump water heater).

7.6 Filling and storage [stage B]

The empty water heater is to be weighed; the weight of taps on inlet and/or outlet pipes shall be included.

Then the storage water heater is filled with water as stated in the installation and operation instructions at the pressure of incoming cold water (see Table 3). The water supply is then cut off.

The filled water heater is to be weighed, including the taps.

The difference of the two weights (m_{act}) is to be converted into volume in litres in accordance with Formula (6).

$$V_m = 1000 \times \frac{m_{act}}{\rho(T)} \quad (6)$$

where

V_m is the rated volume of the hot water storage tank in l;

m_{act} is the difference of the two weights in kg;

$\rho(T)$ is the density of water in kg/m^3.

This volume is to be reported in litres to the nearest one-tenth litres.

Filling and storage is not applicable to heat pump combination heaters.

7.7 Filling and heating up period [stage C]

The product shall be fully filled with cold water. Cold water shall circulate in the tank until the outlet temperature is equal to the inlet temperature within the allowed variation given in Table 2. The test consists in determining the heating up time t_h necessary to heat the storage quantity of water from an initial state until the first time the compressor is switched off by the thermostat sensing the water temperature in the tank.

This initial state is at the temperature of the incoming cold water specified in Table 3. The heat pump is switched on.

The heating up time, t_h, and the corresponding electrical energy consumption, $W_{eh\text{-}HP}$, are measured from the time the heat pump is switched on until it is shut off by the hot water thermostat situated in the tank, with the correction calculated according to 7.4, with test duration $t_d = t_h$.

The electrical energy consumption is calculated according to Formula (7).

$$W_{eh\text{-}HP} = W_{eh\text{-}M} - W_{EL\text{-}Corr} \quad (7)$$

where

$W_{eh\text{-}M}$ is the measured electrical energy consumption during the test duration t_h in kWh;

$W_{EL\text{-}Corr}$ is the correction due to electrical energy consumption of fan/liquid pump in kWh;

$W_{eh\text{-}HP}$ is the total electrical energy consumption during the test duration t_h in kWh.

7.8 Standby power input [stage D]

The standby power input is determined by measuring the electrical power input over an integral number of on-off cycles of the heat pump, initiated by the thermostat situated in the tank, when no hot water draw-offs are done.

After the thermostat shuts off the heat pump following the heating up period, the system is left to operate with no hot water draw-offs for a number of full cycles.

The test shall be performed over a period of minimum 48 h or less, if 6 on-off cycles have been occurred. Then the duration t_{es}, and the electrical energy consumption $W_{es\text{-}HP}$ of the last on-off cycle are determined using Formula (8).

$$W_{es\text{-}HP} = W_{es\text{-}M} - W_{EL\text{-}Corr} \quad (8)$$

where

$W_{es\text{-}M}$ is the measured electrical energy consumption during the last on-off cycle, in kWh;

$W_{EL\text{-}Corr}$ is the correction due to electrical energy consumption of fan/liquid pump, in kWh according to 7.4 with test duration $t_d = t_{es}$;

$W_{es\text{-}HP}$ is the total electrical energy consumption during the last on-off cycle, in kWh.

The standby power input is determined by Formula (9):

$$P_{es} = \frac{W_{es\text{-}HP}}{t_{es}} \times 3\,600 \quad (9)$$

where

P_{es} is the standby power input in kW;

$W_{es\text{-}HP}$ is the total electrical energy consumption during the last on-off cycle in kWh;

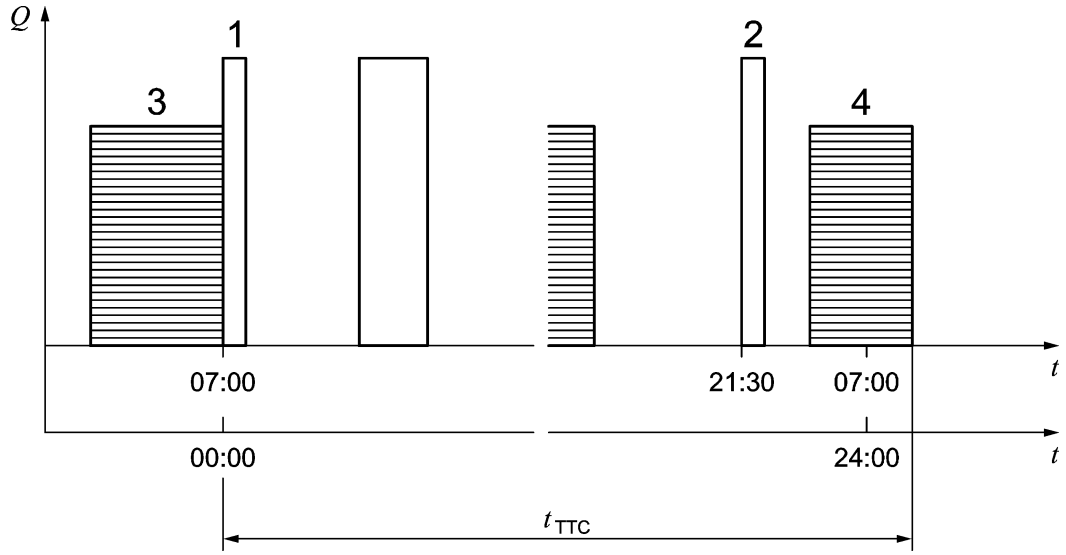
t_{es} is the duration of the last on-off cycle of the heat pump in s.

7.9 Water draw-offs and COP calculation [stage E]

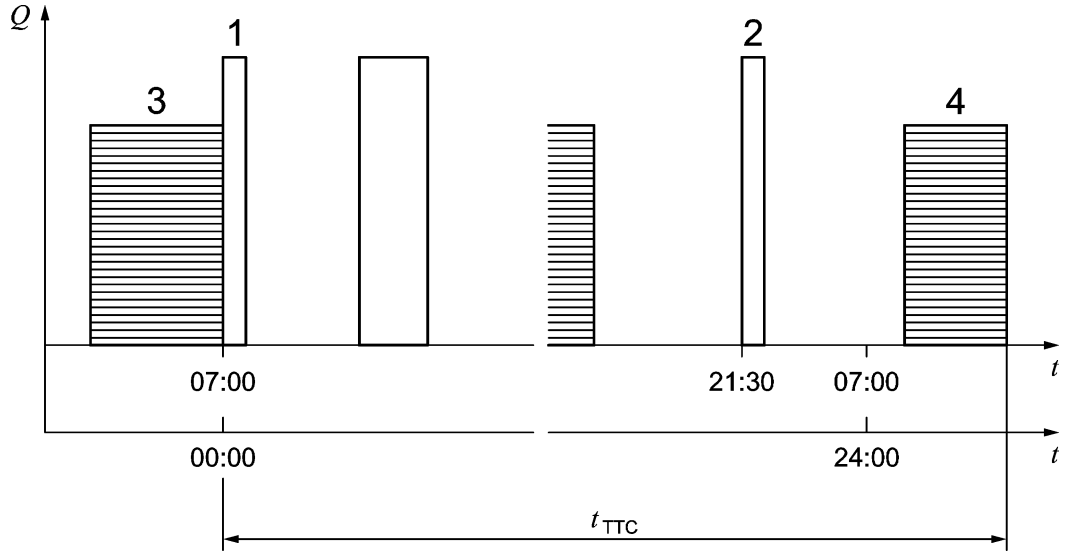
7.9.1 Determination of the useful energy

There are different load profiles for different energy contents according to Annex A. For the test a specific load profile shall be selected from Table A.1 to Table A.3. Each individual draw-off of the load profile shall be completed; this means the valve shall be closed, and a delay of at least one minute is required, before starting the following draw-off.

The test cycle starts directly after the last shut off of the heat pump by the hot water thermostat situated in the tank. The test cycle ends with the last shut off of the heat pump, if load profile time t_{TTC} is at least 24 h or more (see Figure 2 a)). If the heat pump is not running when 24 h have passed from the start of the test cycle, the test cycle has to be extended until the heat pump restarts and stops again (see Figure 2 b)).



a) Illustration of a test where the heat pump is still running at the end of the 24-h period



b) Illustration of a test where the heat pump is not running at the end of the 24-h period

Key

1	first draw-off of the load profile
2	last draw-off of the load profile
3	running period of the heat pump directly before the start of the test cycle
4	running period of heat pump after last draw-off (2)
Q	energy in kWh
t	time in h:min
t_{TTC}	load profile time in h:min

Figure 2 — Illustration of a test for one possible load profile

The useful energy $Q_{\text{HP-tap}}$ (kWh) during one single draw-off is given by Formula (10):

$$Q_{\text{HP-tap}} = \frac{1}{60 \times 1000 \times 3600} \int_0^{t_{\text{tap}}} c_{\text{p}} \times \rho(T) \times f(t) \times \left(\theta_{\text{WH}}(t) - \theta_{\text{WC}}(t)\right) dt \quad (10)$$

where

$\theta_{\text{WH}}(t) - \theta_{\text{WC}}(t)$ is the temperature difference between hot water temperature at outlet and cold water at inlet of domestic hot water storage in K;

$f(t)$ is the useful water flow rate, expressed in l/min;

t_{tap} is the time duration of a draw-off of useful water in s;

c_{p} is the specific heat capacity of water in kJ/(kgK);

$\rho(T)$ is the density of the hot water at the flow meter in kg/m³.

For draw-offs with a peak temperature T_{p} of 55 °C, this temperature cannot always be achieved by the heat pump alone. During the draw-off it is then assumed that the missing temperature difference to the required T_{p} is produced by an additional electrical resistance heater.

For that case, Formulae (11), (12) and (13) are used:

$$Q_{\text{EL-tap}} = \frac{1}{60 \times 1000 \times 3600} \int_0^{t_{\text{tap}}} c_{\text{p}} \times \rho(T) \times f(t) \times \left(\theta_{\text{WC}}(t) + \left(T_p - 10\right) - \theta_{\text{WH}}(t)\right) dt \quad (11)$$

$Q_{\text{EL-tap}}$ is set to zero, in case (11) results in a negative value.

The draw-off will be stopped when $Q_{\text{HP-tap}} + Q_{\text{EL-tap}}$ is equal to the required energy for this draw-off.

The overall tapping energy Q_{LP} of the load profile is:

$$Q_{\text{EL-LP}} = \sum_{i=1}^{n_{\text{tap}}} Q_{\text{EL-tap}_i} \quad (12)$$

$$Q_{\text{LP}} = \sum_{i=1}^{n_{\text{tap}}} Q_{\text{HP-tap}_i} + Q_{\text{EL-LP}} \quad (13)$$

where

$Q_{\text{EL-LP}}$ is the calculated heat energy produced by electrical resistance heater during the whole load profile in kWh;

Q_{LP} Is the total useful energy content during the whole load profile in kWh;

n_{tap} is the number of draw-offs during the load profile;

i is the index for the draw-off.

7.9.2 Determination of the electrical energy consumption ($W_{\text{EL-LP}}$)

The total measured electrical energy consumption $W_{\text{EL-M-LP}}$ (kWh) of the appliance during the measurement period of the load profile t_{TTC} is corrected by the following electrical energy consumptions to obtain the total electrical energy consumption $W_{\text{EL-LP}}$, using Formula (14):

— correction for fans or liquid pumps, $W_{\text{EL-Corr}}$ (kWh);

— heat loss of the tank to a duration of 24 h;

— additional electrical input, $Q_{\text{EL-LP}}$ (kWh);

— electrical energy consumption for off-peak product where applicable, $W_{\text{EL-OFF}}$ (kWh).

$$W_{\text{EL-LP}} = W_{\text{EL-M-LP}} - W_{\text{EL-Corr}} + \left(24 - t_{\text{TTC}}\right) \times P_{\text{es}} + Q_{\text{EL-LP}} + W_{\text{EL-OFF}} \quad (14)$$

where

$W_{\text{EL-LP}}$ is the total electrical energy consumption during the whole load profile in kWh;

t_{TTC} is the load profile time in h;

P_{es} is the standby power input in kW.

7.9.3 Coefficient of performance (COP_{DHW})

The coefficient of performance COP_{DHW} for the whole load profile is calculated using Formula (15):

$$COP_{\text{DHW}} = \frac{Q_{\text{LP}}}{W_{\text{EL-LP}}} \quad (15)$$

where

Q_{LP} is the total useful energy content during the whole load profile in kWh;

$W_{\text{EL-LP}}$ is the total electrical energy consumption during the whole load profile in kWh.

7.10 Reference hot water temperature and volume of mixed water at 40 °C [stage F]

This test is started when the compressor switches off at the end of the last measurement period for the load profile. A continuous hot water draw-off is started and continues until the hot water temperature $\theta_{\text{WH}}(t)$ falls below 40 °C. The hot water flow rate, f_{max}, shall be set to maximum flow rate of the considered load profile.

A reference value for the hot water temperature inside the tank is determined by measuring the outlet water temperature. The average temperature during this draw-off is the reference hot water temperature θ'_{WH} according to Formula (16):

$$\theta'_{\text{WH}} = \frac{1}{t_{40}} \int_0^{t_{40}} \theta_{\text{WH}}\left(t\right) dt \quad (16)$$

where

θ'_{WH} is the reference hot water temperature in °C;

$\theta_{\text{WH}}(t)$ is the outgoing hot water temperature in °C;

t_{40} is the time from starting the draw-off until θ_{WH} is less than 40 °C in s.

The maximum amount of mixed water at 40 °C in one single draw-off shall be determined. This is done by calculating the hot water energy during the draw-off.

The hot water flow rate f_{max} together with the temperatures of the incoming cold water θ_{WC} and the outgoing hot water θ_{WH} are measured during the draw-off at least each 10 s. The maximum hot water volume V_{40} is calculated using Formula (17):

$$V_{40} = \frac{1}{(40-10)\times 60}\int_0^{t_{40}} f_{max}(t)\times\left[\theta_{WH}(t)-\theta_{WC}(t)\right]dt \quad (17)$$

where

V_{40} is the maximum volume of mixed water at 40 °C in l;

$\theta_{WH}(t)$- $\theta_{WC}(t)$ is the temperature difference between hot water temperature at outlet and cold water at inlet of domestic hot water storage in K;

t_{40} is the time from starting the draw-off until $\theta_{WH}(t)$ is less than 40 °C in s;

$f_{max}(t)$ is the flow rate of hot water during draw-off in l/min.

7.11 Calculation of the smart control factor SCF

7.11.1 General

In case a smart control is declared the smart control can be tested according to 7.1 and 7.11.2.

7.11.2 Smart Control Test procedure

7.11.2.1 Measurement procedure

The Smart Control test procedure is based on two periods of test; they are named “reference period” and “smart period”. During the first period, “reference period”, the smart control does not influence the heating procedure and the appliance uses the settings for the temperature according to 7.1; in the second period, “smart period”, which will be reached automatically, the appliance works to reduce any electrical energy consumption to achieve a minimum performance goal (i.e. smart control factor: SCF) compared with the first period of test.

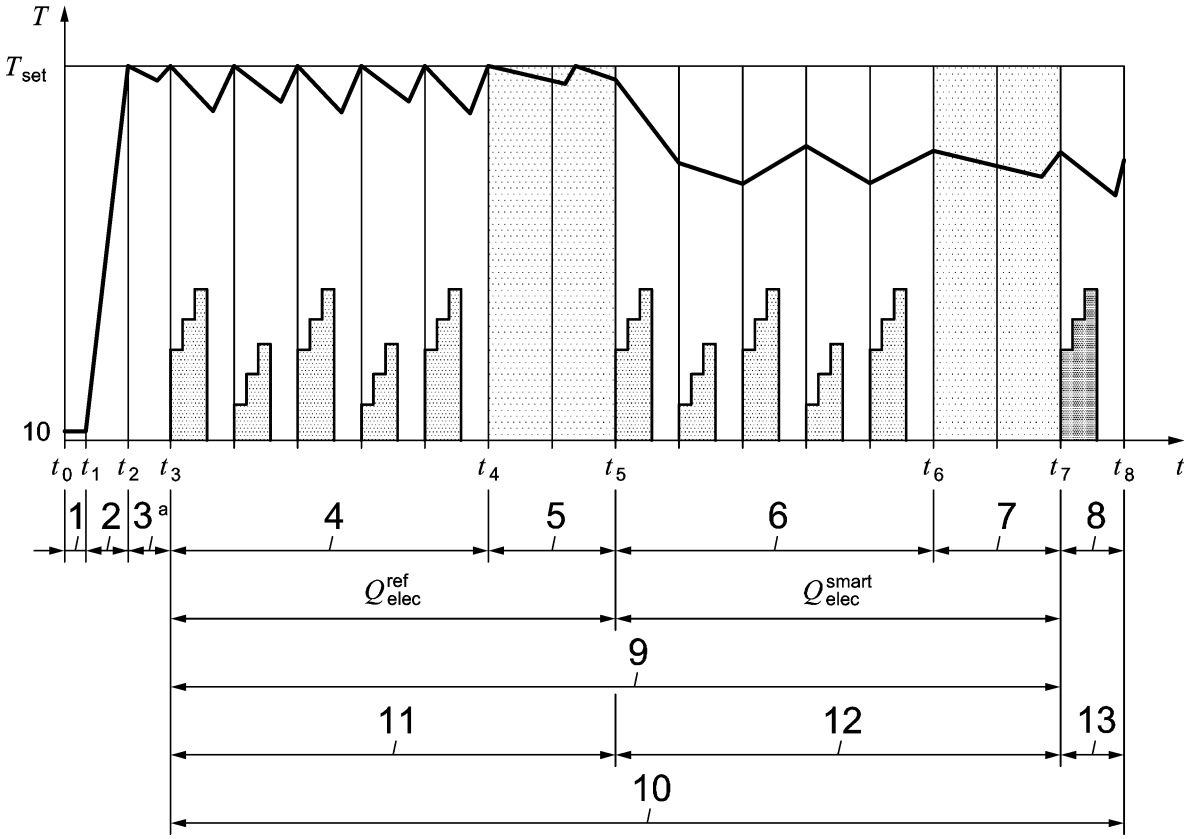
During the reference period the smart control is activated for learning but disabled for operation.

During the smart period the smart control is activated and enabled for optimized operations, i.e. energy savings.

During both periods the chosen load profiles have to be fulfilled.

The total test period is called SMART CYCLE.

The whole test is made using the product thermostat.



Key

1	step 0/1	8	step 8
2	step 2	9	measured energy
3	step 3	10	smart cycle
4	step 4	11	reference period
5	step 5	12	SMART period
6	step 6	13	WHL check cycle
7	step 7		
T	temperature	T_{set}	set temperature
t	time		
Q_{elec}^{ref}	total electrical energy consumption during the reference period of the smart cycle in kWh	Q_{elec}^{smart}	total electrical energy consumption during the smart period of the smart cycle in kWh
a	$t \geq 12$ h		
	hot water temperature		tapping day
	no tapping day		

Figure 3 — Test procedure for "SMART CYCLE"

7.11.2.2 Installation

STEP 0 of Figure 3: The appliance is installed following the same methodology showed in Clause 5.

7.11.2.3 Stabilization

STEP 1 of Figure 3: The appliance is stabilized following the same methodology showed in 7.5.

7.11.2.4 Filling and heat-up

STEP 2 of Figure 3: The product shall be fully filled with cold water. The step consists in heating up the storage quantity of water from this initial state until the first time the compressor is switched off by the thermostat sensing the water temperature in the tank.

7.11.2.5 Stabilization before reference period

STEP 3 of Figure 3: keep the product operating without draw-offs during at least 12 h. This stage ends - and next stage starts - at the first thermostat cut-out after 12 h.

7.11.2.6 Reference period

STEP 4/5 of Figure 3: This test period allows consumer behaviour learning and measuring energy consumption with smart control activation.

STEP 4/5 can last 7 or 14 days (1 or 2 weeks); the manufacturer will decide to use one or two weeks procedure and the product will be tested accordingly.

The load profiles for the first 5 days of test will be chosen randomly by the lab between the Load Profile, declared by the manufacturer for the product (WHL, Water Heater Load), and the immediately lower Load Profile (WHL-1). It means five water heater loads shall be defined (e.g. three "WHL" and two "WHL-1") and the lab can decide to use them randomly (e.g. WHL = M → MMMSS, SSMMM, MSMSM, …). In the case that WHL is the smallest Load Profile 3XS, the product shall be tested using only the Load Profile WHL (i.e. 3XS) for all five days.

The 6th and 7th days of test there will be no tapping. An example is given in Table 6.

Table 6 — Example of a series of load profiles

Reference period	Smart period
Day 1: WHL	Repetition in the same order
Day 2: WHL-1	
Day 3: WHL	
Day 4: WHL-1	
Day 5: WHL	
Day 6: no tapping	
Day 7: no tapping	

If a second week in the reference period is used, it shall have the same load profiles sequence and order compared with the first week

SMART CONTROL is manually/automatically activated, according to the manufacturer's instructions, at time t_3 (Figure 3), and it stays on from t_3 to t_8.

For the selected Load Profiles, draw-offs are made in accordance with the specifications of the appropriate 24 h tapping pattern from tables of Annex A. Tapping patterns start at t_3 (7:00h) according to tables of Annex A. The tapping period ends 24 h later for each day.

During the tapping step, technical parameters (power, temperature, etc.) are established in accordance with specifications in Tables 3, 4, 5. During draw-offs the recommended sample rate is 3 s or less. Recorded values shall be part of the technical test report.

Electrical energy consumption over each 24h test, $Q_{\text{elec}}^{\text{ref}}[i]$ [kWh], will be measured and a total electrical energy consumption will be defined for the "Reference period" according to Formula (18).

$$Q_{\text{elec}}^{\text{ref}} = \sum_{i=1}^{7n} Q_{\text{elec}}^{\text{ref}}[i] \quad (18)$$

where

$n = 1$ is the "reference period" based on one week;

$n = 2$ is the "reference period" based on two weeks.

i is the day of the reference period

The useful energy content of each load profile of the reference period $Q_{\text{LP}}^{\text{ref}}[i]$ [kWh] shall be determined as specified in 7.9.1. The total useful energy content of the reference period $Q_{\text{LP}}^{\text{ref}}$ shall be calculated using Formula (19):

$$Q_{\text{LP}}^{\text{ref}} = \int_{i=1}^{7n} Q_{\text{LP}}^{\text{ref}}[i] \quad (19)$$

where

$n = 1$ is the "reference period" based on one week;

$n = 2$ is the "reference period" based on two weeks.

i is the day of the reference period

Products classified as "Off-peak" appliances shall be energized for a maximum period of 8 consecutive hours during 22:00h and 7:00h of the 24 h tapping pattern as specified in tables of Annex A.

The load profile period of 24 h shall be respected, that's to say that each 24 h, at 07:00 begins the draw-offs specified in tables of Annex A without waiting a shut-off of the heat pump by the thermostat.

7.11.2.7 Smart period

STEP 6/7 of Figure 3: Immediately after the "Reference period", the test of "Smart period" is performed during one week, using the same repetition of load profile sequence defined during the "reference period"; **smart control** function is enabled. The electrical energy consumption is measured during this step as well and it will be compared to the electrical energy consumption of the "reference period". This percentage of saving is named "Smart control factor: SCF".

The main results of the test are the electrical energy consumption over each 24 h test, $Q_{\text{elec}}^{\text{smart}}[i]$ and the total electrical energy consumption for the 'smart period', $Q_{\text{elec}}^{\text{smart}}$ according to Formula (20).

$$Q_{\text{elec}}^{\text{smart}} = \sum_{i=1}^{7n} Q_{\text{elec}}^{\text{smart}}[i] \quad (20)$$

where

$n = 1$ is the "reference period" based on one week;

$n = 2$ is the "reference period" based on two weeks.

i is the day of the reference period

The useful energy content of each load profile of the reference period $Q_{\text{LP}}^{\text{smart}}[i]$ [kWh] shall be determined as specified in 7.9.1. The total useful energy content of the reference period $Q_{\text{LP}}^{\text{smart}}$ shall be calculated using Formula (21).

$$Q_{\mathrm{LP}}^{\mathrm{smart}} = \sum_{i=1}^{7n} Q_{\mathrm{LP}}^{\mathrm{smart}}[i] \quad (21)$$

where

$n = 1$ is the "reference period" based on one week;

$n = 2$ is the "reference period" based on two weeks.

i is the day of the reference period

Products to be classified as "Off-peak" appliances shall be energized for a maximum period of 8 consecutive hours during 22:00h and 7:00h of the 24 h tapping pattern as specified in tables of Annex A.

The load profile period of 24h shall be respected, that's to say that each 24 h, at 07:00 begins the draw-offs specified in tables of Annex A without waiting a shut-off of the heat pump by the thermostat.

7.11.2.8 Reporting of "Smart Control Factor" (*SCF*)

The difference between $Q_{\mathrm{LP}}^{\mathrm{ref}}$ and $Q_{\mathrm{LP}}^{\mathrm{smart}}$ measurement results shall be lower than 2 %. The *SCF* shall be calculated using Formula (22).

$$SCF = \left(1 - \frac{Q_{\mathrm{elec}}^{\mathrm{smart}}}{Q_{\mathrm{elec}}^{\mathrm{ref}}}\right) \quad (22)$$

7.11.2.9 Check cycle

STEP 8 of Figure 3: Immediately after the "Smart period" an additional 24 h load profile (named "WHL check cycle") is performed and requirements shall be fulfilled. If the requirement is not fulfilled, the smart control benefit cannot be taken into account in the calculation of the water heating energy efficiency (see 7.13.2) and the value of smart is equal to 0 in Formula (26). In this step the product is tested in accordance to the water heater load profile of the first day (Day 1) of the "reference period". The unit shall be able to fulfil the requirements of this load profile.

7.12 Determination of the ambient correction term Q_{cor}

The ambient correction term Q_{cor} takes into account the fact that the heat pump is installed in a non-isothermal place. Q_{cor} is expressed in kWh and calculated using Formula (23).

$$Q_{\mathrm{cor}} = -k \times 24 \times P_{\mathrm{stby}} \quad (23)$$

where

k is a coefficient which value is given in Table 7;

P_{stby} is the primary standby heat loss as determined by Formula (24), in kWh.

$$P_{\mathrm{stby}} = CC \times P_{\mathrm{es}} \quad (24)$$

Table 7 — *k*-values

	3XS	XXS	XS	S	M	L	XL	XXL	3XL	4XL
k	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0	0	0

7.13 Water heating energy efficiency η_{wh}

7.13.1 Determination of Q_{elec}

For the determination of the daily electrical energy consumption use Formula (25).

$$Q_{elec} = \frac{Q_{ref}}{Q_{LP}} \times W_{EL\text{-}LP} \quad (25)$$

where

Q_{elec} is the daily electrical energy consumption in kWh;

Q_{ref} is the reference energy content of the considered load profile in kWh;

Q_{LP} is the total useful energy content energy during the whole load profile in kWh;

$W_{EL\text{-}LP}$ is the total electrical energy consumption during the load profile in kWh.

7.13.2 Calculation of η_{wh} for heat pump water heaters and heat pump combination water heaters

The water heating energy efficiency is defined in Formula (26) and shall be expressed in %:

$$\eta_{wh} = \frac{Q_{ref}}{\left(CC \times Q_{elec}\right) \times \left(1 - SCF \times smart\right) + Q_{cor}} \quad (26)$$

where

η_{wh} is the water heating energy efficiency expressed in %;

Q_{ref} is the reference energy content of the considered load profile in kWh;

Q_{elec} is the daily electrical energy consumption in kWh;

CC is the conversion coefficient, equal to 2,5;

SCF is the smart control factor as determined according to 7.11.2;

Q_{cor} is the ambient correction term as determined according to 7.12 in kWh.

smart is an indicator of the smart control compliance of the product.

If the value of *SCF* is greater or equal to 0,07 and the requirement under 7.11.2.9 is fulfilled then the value of *smart* shall be 1. In all other cases, the value of *smart* shall be 0.

7.13.3 Calculation of the Annual Consumption of electric energy

The annual electrical energy consumption (*AEC*) in kWh/a and rounded to the nearest integer shall be calculated using Formula (27):

$$AEC = 0,6 \times 366 \times \left(Q_{elec} \times \left(1 - SCF \times smart\right) + \frac{Q_{cor}}{CC} \right) \quad (27)$$

7.14 Other performance

7.14.1 Rated heat output

The rated heat output P_{rated} is defined according Formula (28) when determined in the test conditions as specified in Table 4 and average climate for outdoor air units, and with the maximum load profile declared by the manufacturer.

$$P_{\text{rated}} = \frac{1{,}163 \times 3600 \times V_{40}\left(40 - 10\right)}{t_{\text{h}} \times 1000} \tag{28}$$

where

P_{rated} is the rated heat output in kW;

V_{40} is the maximum volume of mixed water at 40 °C in l;

t_h is the heating up time in s;

7.14.2 Seasonal coefficient of performance ($SCOP_{\text{DHW}}$)

The Seasonal Coefficient of Performance $SCOP_{\text{DHW}}$ is to be considered equal to the COP_{DHW} when determined in the test conditions as specified in Table 4 and average climate for outdoor air units, and with the maximum load profile declared by the manufacturer.

8 Other tests

8.1 Temperature operating range

The unit shall be capable of operating within the limit of use indicated by the manufacturer according to Table 8. The procedure includes two heating up periods; the first one proceeded at the minimal heat source temperature, the second one at maximal heat source temperature.

Table 8 — Operating conditions

Test No.	Heat source temperature at the evaporator [a] °C	Temperature domestic water or intermediate fluid in the tank °C
Test 1	minimal heat source temperature	start temperature according to Table 3 maximal hot water temperature (thermostat setting) hot water mean temperature (draw-off)
Test 2	maximal heat source temperature	
[a] For units using air as heat source, the wet bulb temperature is specified according to Table 9.		

The minimal heat source temperature (lower limit of use) at the outdoor heat exchanger is set at the beginning of the test and maintained constant during the test. The maximal hot water temperature (higher limit of use) is set at the thermostat during the beginning of the test and maintained constant during the test. Permissible deviations from set values are specified Table 2. The tank is filled with water at the temperature of the incoming cold water specified in Table 3. Then the unit shall start up and heat up the tank to the maximum possible hot water temperature defined by the manufacturer, without being stopped by the safety devices.

The maximum set point of the hot water temperature values are stated in the operation and installation instructions. The deviation between individual values and set values shall be between:

— zero and minus twice the permissible deviation according to Table 2, for maximal temperatures;

— zero and plus twice the permissible deviation according to Table 2, for minimal temperatures.

Uncertainty of measurement shall be as specified in Table 1. The test is performed with the same source volume flow as used for the measurement of the load profile.

Table 9 — Determination of wet bulb temperature related to dry bulb temperature

Dry bulb temperature T_{DB} in °C	**Wet bulb temperature T_{WB}** in °C
$T_{DB} < -10$	Not defined
$-10 \leq T_{DB} \leq 12$	$T_{WB} = T_{DB} - 1$
$12 < T_{DB} \leq 20$	$T_{WB} = 0{,}34 * T_{DB} + 6{,}95$
$T_{DB} > 20$	$T_{WB} = 0{,}86 * T_{DB} - 3{,}50$

Immediately after the heat pump stops the first time, 50 % of the nominal tank volume is tapped and the hot water temperature is measured. The hot water flow rate has to be set to maximum flow rate of the declared load profile. The mean value of the hot water temperature during the draw-off is the upper limit for the domestic hot water production.

Then the procedure is repeated with the maximal heat source temperature (upper limit of use).

The environmental conditions during the test shall be as specified in Table 4 and Table 5.

The test is fulfilled when under the specified conditions during the whole test procedure the heat pump is not shut off by a security device.

8.2 Outside the operating range

If operating outside the temperature range can cause damage to the unit, it shall be provided with safety devices which ensure that the unit suffers no damage when the operating limits of use indicated by the manufacturer are exceeded and remains capable of operating when coming back within these limits. A safety device that does not automatically reset may trip provided that a warning device is fitted.

The manufacturer shall indicate any safety devices provided and their operating conditions according to 11.2.4.

8.3 Safety devices checking test

8.3.1 General

To check the correct operating of the safety devices on the unit, the following faults shall be simulated consecutively. The unit shall have attained steady-state in the test conditions during the heating up of the tank according to Table 4 and Table 5.

8.3.2 Shutting off the heat transfer medium flows

In case the unit is not equipped with a flow switch, the unit shall be tested with an additional flow switch, as follows:

a) blocking of the heat source system (e.g. switch the fan off on the source side);

b) blocking the heat transfer medium flow of the heat sink system (e.g. switch the circulating pump off on the sink side).

Shutting off the heat transfer medium flow shall be maintained for at least 1 h.

The unit is checked for any damage sustained during the test and if any safety devices have operated during the test. The unit shall suffer no damage and shall remain capable of operating after restoration of the flow rates. A safety device that does not automatically reset may trip provided that a warning device is available.

8.3.3 Complete power supply failure

Complete power supply failure lasting 5 s to 10 s shall be simulated. After restoration of power the unit shall restart automatically not more than 20 min after the compressor has been allowed to restart by the control devices of the unit.

The unit is checked for any damage sustained during the test and if any safety devices have operated during the test.

The test does not apply when the manufacturer states that the machine does not automatically restart after power supply failure.

8.4 Condensate draining

The draining of condensate shall be observed, when operating at the standard conditions given in Table 4 and Table 5. During the tests no condensed water shall drip, run or blow off the unit except through the drain.

9 Test results and test report

9.1 Data to be recorded

The data to be recorded during the tests of stage C to F are given in Table 10. The table identifies the general information required but is not intended to limit the data to be obtained.

For units with smart control, the additional data to be recorded from the smart cycle test are given in Table 11. For each day of the smart cycle, data of stage E shall also be recorded.

Table 10 — Data to be recorded

Measured or calculated quantity	Unit	All tests	Heating up period (stage C)	Standby power input (stage D)	Water draw-offs and COP_{DHW} (stage E)	Mixed water and reference temperature (stage F)
Heat source: water or brine						
Liquid inlet temperature	°C	x				
Liquid outlet temperature	°C	x				
Brine concentration	% vol.	x				
Liquid density	kg/m³	x				
Liquid specific heat	kJ/kg/K	x				
Liquid flow rate	kg/h	x				
Internal / external static pressure	kPa	x				
Heat source: air						
Air dry bulb temperature	°C	x				
Air wet bulb temperature	°C	x				
Ducted units						
Air volume flow rate	m³/h	x				

Measured or calculated quantity	Unit	All tests	Heating up period (stage C)	Standby power input (stage D)	Water draw-offs and COP_{DHW} (stage E)	Mixed water and reference temperature (stage F)
Internal / external static pressure	Pa	x				
Domestic hot water						
Cold water Inlet temperature	°C	θwc				
Hot water temperature(s)	°C				T_m	θ_{WH}
Peak temperature	°C				T_p	
Hot water flow rate(s)	l/min				f	f_{max}
Time / duration	s		t_h	t_{es}	t_{TTC}	t_{40}
Number of on/off cycles	-			x		
Load profile	-				x	
Reference energy	kWh				Q_{ref}	
Useful heat energy of each draw-off	kWh				$Q_{HP\text{-}tap}$	
Total useful energy content of the load profile	kWh				Q_{LP}	
Coefficient of performance	-				COP_{DHW}	
Ambient correction term	-				Q_{cor}	
Water heating energy efficiency	%				η_{wh}	
Volume of tapped water	l					V_{40}
Reference temperature	°C					θ'_{WH}
Defrost cycles						
Defrost period	s	x				
Operating cycle with defrost period	s	x				
Others						
Atmospheric pressure	Pa	x				
Ambient temperature	°C	x				
Electrical quantities						
Voltage	V	x				
Frequency	Hz	x				
Power input	kW			P_{es}		
Measured Electrical energy	kWh		$W_{eh\text{-}M,}$	$W_{es\text{-}M}$	$Q_{EL\text{-}tap,}$ $Q_{EL\text{-}}$	

Measured or calculated quantity	Unit	All tests	Heating up period (stage C)	Standby power input (stage D)	Water draw-offs and COP_{DHW} (stage E)	Mixed water and reference temperature (stage F)
consumption					LP, $W_{EL\text{-}M\text{-}LP}$	
Correction for fans and pumps	kWh		$W_{EL\text{-}corr}$	$W_{EL\text{-}corr}$	$W_{EL\text{-}corr}$	
Off-peak product electrical energy consumption, where applicable	kWh				$W_{EL\text{-}OFF}$	
Electrical energy consumption	kWh		$W_{eh\text{-}HP}$	$W_{es\text{-}HP}$	$W_{EL\text{-}LP}$	
Daily electrical energy consumption	kWh				Q_{elec}	
Annual electrical energy consumption	kWh/a				*AEC*	

Table 11 — Additional data to be recorded for smart cycle test

Measured or calculated quantity	Unit	Smart cycle	Reference period	Smart period
Domestic hot water				
Order of load profiles for Day 1 to Day 5			x	x
Total useful energy content	kWh		Q_{LP}^{ref}	Q_{LP}^{smart}
Electrical quantities				
Total electrical energy consumption	kWh		Q_{elec}^{ref}	Q_{elec}^{smart}
Smart control factor	-	*SCF*		

9.2 Test report

9.2.1 General information

The test report shall at least contain:

a) date;

b) test institute;

c) test place;

d) test supervisor;

e) test object denomination;

f) manufacturer's serial numbers of the heat pump and the storage tank, as applicable;

g) descriptions of the heat pump and the storage tank including thermostat setting, pump and fan speed;

h) off-peak product (yes/no);

i) type of refrigerant;

j) mass of refrigerant;

k) properties of fluids (other than water);

l) reference to this European Standard;

m) any deviations from the test method;

n) data recorded (see 9.1);

o) main results (see 9.2.2);

p) date and signature of the test supervisor.

9.2.2 Main results

Main results shall be reported according to Table 12.

Table 12 — Presentation of main results

No.	Result	Symbol	Unit
1)	Load profile	–	–
2)	Settings of the control, e.g. thermostat set point temperature, mode	–	–
3)	Heating up time	t_h	h:min
4)	Heating up electrical energy consumption	$W_{\text{eh-HP}}$	kWh
5)	Stand-by power input	P_{es}	W
6)	Total useful energy content during the load profile	Q_{LP}	kWh
7)	Total electrical energy consumption during load profile	$W_{\text{EL-LP}}$	kWh
8)	Daily electrical energy consumption	Q_{elec}	kWh
9)	Coefficient of Performance	COP_{DHW}	–
10)	Water heating energy efficiency	η_{wh}	%
11)	Annual electrical energy consumption	AEC	kWh/a
12)	Reference hot water temperature	θ'_{WH}	°C
13)	Maximum volume of mixed water at 40 °C	V_{40}	l
14)	Smart control settings, e.g. thermostat set point temperature, mode	–	–
15)	For products with smart control, Smart Control Factor	SCF	–

16)	For products with smart control, order of the load profiles of Day 1 to Day 5	–	–
17)	Temperature operating range: Minimal and maximal heat source temperature, minimal start and maximal mean temperature domestic hot water	–	°C
18)	Rated volume of the tank, where applicable	V_{m}	l
19)	Rated heat output	P_{rated}	kW
20)	Seasonal coefficient of performance	$SCOP_{\mathrm{DHW}}$	–

10 Marking

Each heat pump shall have a durable, permanently fixed marking that is easily readable when the unit is in position for use, bearing at least the information required by safety standards. If the heat pump consists of several parts the information shall be marked on each of these parts together with the model designation of the complementary parts.

Further information can be provided; if performance details are provided, only the test conditions of Table 3, Table 4 and Annex A are permitted.

11 Documentation

11.1 Technical data sheet

11.1.1 General description

The technical documentation shall contain the following information:

a) trade mark, model designation;

b) power supply (voltage, frequency);

c) denomination of the unit (e.g.: air-to-water);

d) number of separate component units;

e) name of refrigerant and mass of charge;

f) overall dimensions and weight of each separate component unit.

11.1.2 Performance characteristics

The technical documentation shall contain in a table all the performance and rating characteristics according to Table 12.

The technical documentation shall state the characteristics apply to a new unit with clean heat exchangers.

In addition, the technical documentation shall state the nominal flow rates and maximal possible external static pressure differences for air and water.

The technical documentation shall state the electrical characteristics in accordance with EN 60335-2-40 or EN 60204-1 as applicable and:

a) maximum starting current of the unit, as defined in EN 61000-3-11;

b) maximum power input and maximum operating current, excluding the starting period;

c) reactive power or power factor at the rated point, for units with a total power input higher than 10 kW;

d) power input of fan and pump if included in the units.

11.2 Instructions

11.2.1 General

If not already required by other standards, the technical documentation shall contain the information as specified.

11.2.2 Physical description

The technical documentation shall state:

a) the refrigerant, air and liquid circuits preferably providing circuit diagrams, showing every functional unit, control and safety device and specifying their type;

b) if the unit uses water in the heat exchangers, the water capacity contained in the unit, and either the constructional materials of the heat exchangers or the water quality;

c) if used, the type of brine and the concentration into any other liquid;

d) the type of oil to be used in the compressor.

11.2.3 Additional heating devices, if integrated in unit

The technical documentation shall state the type and location of additional heating devices and their control and safety devices.

11.2.4 Control and safety

The technical documentation shall:

a) state the functions achieved by the control and safety devices provided with the unit and specify when applicable their provision for adjustment and the method by which the safety devices are reset;

b) provide specifications for any control or safety devices necessary to ensure correct operation of the unit but which are not provided with the unit;

c) specify any limitation to the use of the rest of the installation.

11.2.5 Instructions for installation

The technical documentation shall state in particular:

a) the required location conditions (whether units are to be installed outside or in a weather proof enclosure, or in a heated space);

b) requirements of physical layout, access and clearance;

c) requirements for the electrical, liquid, air and refrigerant connections, to be made on site;

d) the location of warning and tripping devices;

e) the installation precautions to be taken to ensure, in particular:

   1) correct circulation of the heat transfer media;

   2) water draining;

   3) cleanliness of heat exchange surfaces;

   4) to minimize noise, vibration or other adverse effects.

Special indications for units using soil, sea water, ground water or surface water: specify any materials which are in contact with the water or with the brine.

11.2.6 Instructions for maintenance

The technical documentation shall state:

a) content and frequency of routine maintenance operations which shall be performed by the user;

b) content and frequency of maintenance and inspection operations which shall be performed by a specialist.

Annex A
(normative)

Load profiles

Tables A.1 to A.3 provide the load profiles for the determination according to 7.2 stage E. “Water draw-offs”.

Table A.1 — Load profiles 3 XS to S

h		3 XS			XXS			XS			S			
		Q_{tap}	f	T_m	Q_{tap}	f	T_m	Q_{tap}	f	T_m	Q_{tap}	f	T_m	T_p
		kWh	l/min	°C	kWh	l/min	°C	kWh	l/min	°C	kWh	l/min	°C	°C
1	07:00	**0,015**	2	25	**0,105**	2	25				**0,105**	3	25	
2	07:05	**0,015**	2	25										
3	07:15	**0,015**	2	25										
4	07:26	**0,015**	2	25										
5	07:30	**0,015**	2	25	**0,105**	2	25	**0,525**	3	35	**0,105**	3	25	
6	07:45													
7	08:01													
8	08:05													
9	08:15													
10	08:25													
11	08:30				**0,105**	2	25				**0,105**	3	25	
12	08:45													
13	09:00	**0,015**	2	25										
14	09:30	**0,015**	2	25	**0,105**	2	25				**0,105**	3	25	
15	10:00													
16	10:30													
17	11:00													
18	11:30	**0,015**	2	25	**0,105**	2	25				**0,105**	3	25	
19	11:45	**0,015**	2	25	**0,105**	2	25				**0,105**	3	25	
20	12:00	**0,015**	2	25	**0,105**	2	25							
21	12:30	**0,015**	2	25	**0,105**	2	25							
22	12:45	**0,015**	2	25	**0,105**	2	25	0,525	3	35	**0,315**	4	10	55
23	14:30	**0,015**	2	25										
24	15:00	**0,015**	2	25										

		3 XS			**XXS**			**XS**			**S**			
		Q_{tap}	f	T_m	Q_{tap}	f	T_m	Q_{tap}	f	T_m	Q_{tap}	f	T_m	T_p
h		kWh	l/min	°C	kWh	l/min	°C	kWh	l/min	°C	kWh	l/min	°C	°C
25	15:30	**0,015**	2	25										
26	16:00	**0,015**	2	25										
27	16:30													
28	17:00													
29	18:00				**0,105**	2	25				**0,105**	3	25	
30	18:15				**0,105**	2	25				**0,105**	3	40	
31	18:30	**0,015**	2	25	**0,105**	2	25							
32	19:00	**0,015**	2	25	**0,105**	2	25							
33	19:30	**0,015**	2	25	**0,105**	2	25							
34	20:00				**0,105**	2	25							
35	20:30							**1,05**	3	35	**0,42**	4	10	55
36	20:45				**0,105**	2	25							
37	20:46													
38	21:00				**0,105**	2	25							
39	21:15	**0,015**	2	25	**0,105**	2	25							
40	21:30	**0,015**	2	25							**0,525**	5	45	
41	21:35	**0,015**	2	25	**0,105**	2	25							
42	21:45	**0,015**	2	25	**0,105**	2	25							
43	Q_{ref}	**0,345**			**2,100**			**2,100**			**2,100**			

Table A.2 — Load profiles M to XL

		M				L				XL			
		Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p
h		**kWh**	l/min	°C	°C	**kWh**	l/min	°C	°C	**kWh**	l/min	°C	°C
1	07:00	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
2	07:05	**1,4**	6	40		**1,4**	6	40					
3	07:15									**1,82**	6	40	
4	07:26									**0,105**	3	25	
5	07:30	**0,105**	3	25		**0,105**	3	25					
6	07:45					**0,105**	3	25		**4,42**	10	10	40
7	08:01	**0,105**	3	25						**0,105**	3	25	
8	08:05					**3,605**	10	10	40				

h		M				L				XL			
		Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p
		kWh	l/min	°C	°C	**kWh**	l/min	°C	°C	**kWh**	l/min	°C	°C
9	08:15	**0,105**	3	25						**0,105**	3	25	
10	08:25					**0,105**	3	25					
11	08:30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
12	08:45	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
13	09:00	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
14	09:30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
15	10:00									**0,105**	3	25	
16	10:30	**0,105**	3	10	40	**0,105**	3	10	40	**0,105**	3	10	40
17	11:00									**0,105**	3	25	
18	11:30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
19	11:45	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
20	12:00												
21	12:30												
22	12:45	**0,315**	4	10	55	**0,315**	4	10	55	0,735	4	10	55
23	14:30	**0,105**	3	25		**0,105**	3	25		0,105	3	25	
24	15:00									**0,105**	3	25	
25	15:30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
26	16:00									**0,105**	3	25	
27	16:30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
28	17:00									**0,105**	3	25	
29	18:00	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
30	18:15	**0,105**	3	40		**0,105**	3	40		**0,105**	3	40	
31	18:30	**0,105**	3	40		**0,105**	3	40		**0,105**	3	40	
32	19:00	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
33	19:30												
34	20:00												
35	20:30	**0,735**	4	10	55	**0,735**	4	10	55	**0,735**	4	10	55
36	20:45												
37	20:46									**4,42**	10	10	40
38	21:00					**3,605**	10	10	40				
39	21:15	**0,105**	3	25						**0,105**	3	25	
40	21:30	**1,4**	6	40		**0,105**	3	25		**4,42**	10	10	40

h		M				L				XL			
		Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p
		kWh	l/min	°C	°C	**kWh**	l/min	°C	°C	**kWh**	l/min	°C	°C
41	21:35												
42	21:45												
43	Q_{ref}	**5,845**				**11,655**				**19,07**			

Table A.3 — Load profiles XXL to 4 XL

h		XXL				3XL				4XL			
		Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p
		kWh	l/min	°C	°C	**kWh**	l/min	°C	°C	**kWh**	l/min	°C	°C
1	07:00	**0,105**	3	25		**11,2**	48	40		**22,4**	96	40	
2	07:05												
3	07:15	**1,82**	6	40									
4	07:26	**0,105**	3	25									
5	07:30												
6	07:45	**6,24**	16	10	40								
7	08:01	**0,105**	3	25		**5,04**	24	25		**10,08**	48	25	
8	08:05												
9	08:15	**0,105**	3	25									
10	08:25												
11	08:30	**0,105**	3	25									
12	08:45	**0,105**	3	25									
13	09:00	**0,105**	3	25		**1,68**	24	25		**3,36**	48	25	
14	09:30	**0,105**	3	25									
15	10:00	**0,105**	3	25									
16	10:30	**0,105**	3	10	40	**0,84**	24	10	40	**1,68**	48	10	40
17	11:00	**0,105**	3	25									
18	11:30	**0,105**	3	25									
19	11:45	**0,105**	3	25		**1,68**	24	25		**3,36**	48	25	
20	12:00												
21	12:30												
22	12:45	**0,735**	4	10	55	**2,52**	32	10	55	**5,04**	64	10	55
23	14:30	**0,105**	3	25									
24	15:00	**0,105**	3	25									
25	15:30	**0,105**	3	25		**2,52**	24	25		**5,04**	48	25	
26	16:00	**0,105**	3	25									

h		XXL				3XL				4XL			
		Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p
		kWh	l/min	°C	°C	**kWh**	l/min	°C	°C	**kWh**	l/min	°C	°C
27	16:30	**0,105**	3	25									
28	17:00	**0,105**	3	25									
29	18:00	**0,105**	3	25									
30	18:15	**0,105**	3	40									
31	18:30	**0,105**	3	40		**3,36**	24	25		**6,72**	48	25	
32	19:00	**0,105**	3	25									
33	19:30												
34	20:00												
35	20:30	**0,735**	4	10	55	**5,88**	32	10	55	**11,76**	64	10	55
36	20:45												
37	20:46	**6,24**	16	10	40								
38	21:00												
39	21:15	**0,105**	3	25									
40	21:30	**6,24**	16	10	40	**12,04**	48	40		**24,08**	96	40	
41	21:35												
42	21:45												
43	Q_{ref}	**24,53**				**46,76**				**93,52**			

Annex ZA
(informative)

Relationship between this European Standard and the ecodesign requirements of Commission Regulation (EU) No 814/2013 aimed to be covered

This European standard has been prepared under a Commission's standardization request M/534 (Ecodesign Water Heaters) to provide one voluntary means of conforming to the ecodesign requirements of Commission Regulation (EU) No 814/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for water heaters and hot water storage tanks.

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 — Correspondance between this European Standard and Commission Regulation (EU) No 814/2013Correspondence between this European Standard and Commission Regulation (EU) No 814/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for water heaters and hot water storage tanks and Commission's standardization request M/534 (Ecodesign Water Heaters)

Ecodesign requirements of Regulation No 814/2013	Clause(s) / subclause(s) of this EN	Remarks / Notes
Annex II, 1.3	7.10	
Annex II, 1.1	7.13	
Annex II, 1.2	7.6	
Annex II, 1.4	7.14.1	"For rated heat output" definition and calculation
Annex II, 1.6	9	In particular refer to Table 10 and Table 12.
Annex III, 2	7.3	
Annex III, 2	7.9	
Annex III, 3 and 6	7.11	
Annex III, 5	6.5.1	
Annex III, 6	7.6	
Annex III, 6	7.10	
Annex III, 6	7.13	
Annex IV, 2 and 3	7.13	
Annex IV, 4	7.11	

Ecodesign requirements of Regulation No 814/2013	Clause(s) / subclause(s) of this EN	Remarks / Notes
Annex IV, 5	7.12	

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 and the ecodesign requirements of Commission Regulation (EU) No 812/2013 aimed to be covered

This European standard has been prepared under a Commission's standardization request M/534 (Ecodesign Water Heaters) to provide one voluntary means of conforming to the ecodesign requirements of Commission Regulation (EU) No 812/2013 of 18 February 2013 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to the energy labelling of water heaters, hot water storage tanks and packages of water heater and solar device.

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 ecodesign requirements of that Regulation and associated EFTA Regulations.

Table ZB.1 — Correspondence between this European Standard and Commission Regulation (EU) No 812/2013 of 18 February 2013 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to the energy labelling of water heaters, hot water storage tanks and packages of water heater and solar device and Commission's standardization request Full reference to the request 'M/534 (Ecodesign Water Heaters)

Ecodesign requirements of Regulation No 812/2013	Clause(s) / subclause(s) of this EN	Remarks / Notes
Annex VII 2	7.9	
Annex VII 2, 7; Annex VIII 2, 4	7.13	
Annex VII , 3, 7	7.11	
Annex VII, 5	6.5.1	
Annex VIII 6	7.12	

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 ZC
(informative)

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

This European standard has been prepared under a Commission's standardization request M/535 (Ecodesign Space Heaters) 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.

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 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters and Commission's standardization request M/535 (Ecodesign Space Heaters)

Ecodesign requirements of Regulation No 813/2013	Clause(s) / subclause(s) of this EN	Remarks / Notes
Annex II, 2	7.13.2	
Annex II, 5	7.13.1	
Annex II, 5	7.13.2	
Annex III, 5	7.1 to 7.9	
Annex III, 5	7.13	

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 ZD
(informative)

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

This European standard has been prepared under a Commission's standardization request M/535 (Ecodesign Space Heaters) to provide one voluntary means of conforming to the ecodesign requirements of Commission 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 the energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device.

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 ZD.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 ZD.1 — Correspondence between this European Standard and Commission 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 the energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device and Commission's standardization request Full reference to the request M/535 (Ecodesign Space Heaters)

Ecodesign requirements of Regulation No 811/2013	Clause(s) / subclause(s) of this EN	Remarks / Notes
Annex III, 2	7.13.2	
Annex IV, 2.1 f)	7.13.1	
Annex IV, 2.1 g)	7.13.2	
Annex IV, 2.1 l)	7.13.1	
Annex IV, 2.1 m)	7.13.2	
Annex V, 2	7.13	
Annex V, 6	7.13	
Annex VI, 2.1	7.13	
Annex VI, 4.1	7.1 to 7.9	
Annex VII, 5	7.13	

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.

Bibliography

[1] EN ISO 5801, *Industrial fans - Performance testing using standardized airways (ISO 5801:2007 including Cor 1)*

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Copyright in BSI publications

All the content in BSI publications, including British Standards, is the property of and copyrighted by BSI or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use.

Save for the provisions below, you may not transfer, share or disseminate any portion of the standard to any other person. You may not adapt, distribute, commercially exploit, or publicly display the standard or any portion thereof in any manner whatsoever without BSI's prior written consent.

Storing and using standards

Standards purchased in soft copy format:

- A British Standard purchased in soft copy format is licensed to a sole named user for personal or internal company use only.
- The standard may be stored on more than 1 device provided that it is accessible by the sole named user only and that only 1 copy is accessed at any one time.
- A single paper copy may be printed for personal or internal company use only.

Standards purchased in hard copy format:

- A British Standard purchased in hard copy format is for personal or internal company use only.
- It may not be further reproduced – in any format – to create an additional copy. This includes scanning of the document.

If you need more than 1 copy of the document, or if you wish to share the document on an internal network, you can save money by choosing a subscription product (see 'Subscriptions').

Reproducing extracts

For permission to reproduce content from BSI publications contact the BSI Copyright & Licensing team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email subscriptions@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Useful Contacts

Customer Services
Tel: +44 345 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 345 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.