
Toplotne črpalke z električnimi kompresorji - Preskušanje in zahteve za označevanje naprav/enot za gretje (gospodinjske) vode

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

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

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

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

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Contents

Page

Foreword.....	5
1 Scope	6
2 Normative references	6
3 Terms and definitions	6
4 Symbols and abbreviations	9
5 Installation requirements	11
5.1 Test apparatus and uncertainties of measurement	11
5.2 Test room for the outdoor heat exchanger of air source heat pumps	12
5.3 Installation and connection of the heat pump	12
5.4 Installation of heat pumps consisting of several parts	12
6 Settings and test conditions.....	13
6.1 General.....	13
6.2 Settings for non-ducted air source units	13
6.3 Setting the external static pressure difference for ducted air source units.....	13
6.4 Setting the difference of temperature for heat pumps using a liquid as heat source	13
6.5 Test conditions	13
6.5.1 General test conditions.....	13
6.5.2 Additional test conditions.....	14
7 Performance tests.....	16
7.1 General.....	16
7.2 Basic principles	16
7.3 Off-peak products	17
7.4 Power input corrections.....	18
7.4.1 Power input of fans for heat pumps with duct connection	18
7.4.2 Power input of liquid pumps	18
7.5 Stabilization [stage A]	19
7.6 Filling and storage [stage B]	19
7.7 Filling and heating up period [stage C]	20
7.8 Standby power input [stage D].....	20
7.9 Water draw-offs and COP calculation [stage E]	21
7.9.1 Determination of the useful energy	21
7.9.2 Determination of the energy consumption	23
7.9.3 Coefficient of performance (COP_{DHW})	24
7.10 Reference hot water temperature and volume of mixed water at 40°C [stage F].....	24
7.11 Calculation of the smart control factor SCF	25
7.11.1 General.....	25
7.11.2 Smart Control Test procedure	25
7.12 Determination of the ambient correction term Q_{cor}	30
7.13 Water heating energy efficiency η_{wh}	31
7.13.1 Determination of Q_{elec}	31
7.13.2 Calculation of η_{wh} for heat pump water heaters and heat pump combination water heaters	31
7.13.3 Calculation of the Annual Consumption of electric energy	31
8 Other tests	31
8.1 Temperature operating range.....	31
8.2 Outside the operating range.....	33
8.3 Safety devices checking test.....	33
8.3.1 General.....	33

8.3.2	Shutting off the heat transfer medium flows	33
8.3.3	Complete power supply failure	33
8.4	Condensate draining	33
9	Test results and test report	33
9.1	Data to be recorded	33
9.2	Test report	35
9.2.1	General Information.....	35
9.2.2	Main results.....	36
10	Marking	37
11	Documentation.....	37
11.1	Technical data sheet	37
11.1.1	General description	37
11.1.2	Performance characteristics	37
11.2	Instructions	38
11.2.1	General.....	38
11.2.2	Physical description.....	38
11.2.3	Additional heating devices, if integrated in unit	38
11.2.4	Control and safety	38
11.2.5	Instructions for installation	38
11.2.6	Instructions for maintenance	39
Annex A	(normative) Load profiles	40
Annex ZA	(informative) Relationship between this European Standard and the requirements of Commission Regulation (EU) No 814/2013	45
Annex ZB	(informative) Relationship between this European Standard and the requirements of Commission Regulation (EU) No 812/2013	46
Annex ZC	(informative) Relationship between this European Standard and the requirements of Commission Regulation (EU) No 813/2013	47
Annex ZD	(informative) Relationship between this European Standard and the requirements of Commission Regulation (EU) No 811/2013	48
Bibliography		49

Figures

Figure 1	— Stages and order of the tests.....	17
Figure 2	— Illustration of a test for one possible load profile	22
Figure 3	— Test procedure for “SMART CYCLE”	26

Tables

Table 1	— Uncertainties of measurement for indicated values.....	11
Table 2	— Variations allowed for the test conditions when the heat pump is running	14
Table 3	— Test conditions applicable to all systems.....	15
Table 4	— Test conditions for particular types of systems.....	15
Table 5	— Maximum ventilation exhaust air available dependent on declared load profile	16
Table 6	— Example of a series of load profiles	28

prEN 16147:2015 (E)

Table 7 — k-values	30
Table 8 — Operating conditions	32
Table 9 — Determination of wet bulb temperature related to dry bulb temperature	32
Table 10 — Data to be recorded	34
Table 11 — Additional data to be recorded for smart cycle test.....	35
Table 12 — Presentation of main results.....	36
Table A.1 — Load profiles 3 XS to S	40
Table A.2 — Load profiles M to XL.....	41
Table A.3 — Load profiles XXL to 4 XL	43
Table ZA.1 — Correspondence between this European Standard and Commission Regulation (EU) No 814/2013	45
Table ZB.1 — Correspondence between this European Standard and Commission Regulation (EU) No 812/2013	46
Table ZC.1 — Correspondence between this European Standard and Commission Regulation (EU) No 813/2013	47
Table ZD.1 — Correspondence between this European Standard and Commission Regulation (EU) No 811/2013	48

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Foreword

This document (prEN 16147:2015) has been prepared by Technical Committee CEN/TC 113 "Heat pumps and air conditioning units", the secretariat of which is held by AENOR.

This document is currently submitted to the CEN Enquiry.

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 integral parts of this document.

This document will supersede EN 16147:2011.

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 Clauses 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 draft Standard prEN 50440:2014;
- 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) 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;
- h) 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.

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.

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.

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

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 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 reference load profiles and which includes the heat losses of the storage tank

3.8**reference hot water temperature**

θ'_{WH}

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

3.9**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

prEN 16147:2015 (E)

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 electricity consumption

Q_{elec}

consumption of electricity 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 power 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}

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 electricity consumption	kWh/a
CC	conversion coefficient, equal to 2,5	—
SCF	smart control factor	—
COP_{DHW}	coefficient of performance for a given reference load profile	—
c_p	specific heat capacity of water	kJ/(kgK)
Δ_{pe}	measured external static pressure difference	Pa
Δ_{pi}	measured internal static pressure difference	Pa
f	minimum flow rate for which hot water is contributing to the reference energy	l/min
f_{max}	maximum flow rate of considered load profile	l/min
$f_{\text{max}}(t)$	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 which value is given in Table 7	—
m_{act}	difference of the two weights (filled / empty) of the storage water heater	kg
η	efficiency of the fan according to EN 14511-3	-
η_{wh}	water heating energy efficiency	%
n_{tap}	number of draw-offs during the load profile	—
P_{es}	standby power input	kW
P_{s}	measured average power consumption for off-peak products	kW
P_{stby}	primary standby power loss	kW
Q_{cor}	ambient correction term	kWh
Q_{elec}	daily electricity consumption	kWh
$Q_{\text{EL-LP}}$	calculated heat energy produced by electrical resistance heater during the whole load profile	kWh
$Q_{\text{EL-tap}}$	Calculated heat energy produced by electrical resistance heater to reach the required tapping temperature	kWh

prEN 16147:2015 (E)

Symbol	Description	Units
$Q_{\text{HP-tap}}$	useful energy during one single draw-off	kWh
Q_{LP}	total useful energy content during the whole load profile	kWh
$Q_{\text{elec}}^{\text{smart}}$	total useful energy consumption during the smart period of the smart cycle	kWh
$Q_{\text{LP}}^{\text{smart}}$	total useful energy content during the smart period of the smart cycle	kWh
$Q_{\text{elec}}^{\text{ref}}$	Total electricity 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
$Q_{\text{elec}}^{\text{WHL,C}}$	Total electricity consumption of the WHL control cycle	kWh
Q_{ref}	reference energy of the considered 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
$\rho(T)$	density of water at temperature T	kg/m ³
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 / duration	h
T_{DB}	Dry bulb temperature	°C
T_{m}	water temperature at which hot water starts contributing to the reference energy	°C
T_{p}	minimum water temperature to be achieved during water draw-off	°C
T_{WB}	Wet bulb temperature	°C
θ_{WC}	incoming cold water temperature	°C
$\theta_{\text{WC}}(t)$	incoming cold water temperature during draw-off	°C
θ_{WH}	outgoing hot water temperature	°C
$\theta_{\text{WH}}(t)$	hot water temperature during draw-off	°C
θ'_{WH}	reference hot water temperature	°C
V_{air}	nominal air volume flow rate	m ³ /s
V_{Fluid}	measured liquid volume flow rate	m ³ /s
V_{m}	rated volume of a hot water storage tank	l
V_{40}	maximum volume of mixed water at 40 °C	l
$W_{\text{eh-HP}}$	total electricity consumption during the test duration t_{h}	kWh
$W_{\text{eh-M}}$	measured electricity consumption during the test duration t_{h}	kWh

Symbol	Description	Units
$W_{EL-Corr}$	correction due to electricity consumption of fan/liquid pump	kWh
W_{EL-LP}	total electrical energy consumption during the whole load profile	kWh
$W_{EL-M-LP}$	total measured electrical energy input	kWh
W_{EL-OFF}	calculated energy consumption for off-peak products	kWh
W_{es-HP}	total energy input during the last on-off-cycle	kWh
W_{es-M}	measured energy consumption during the last on-off cycle	kWh

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	%	± 2 %
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	± 1 %
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:

- 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;
- the lines shall be installed so that the difference in elevation does not exceed 2,5 m;
- thermal insulation shall be applied to the lines in accordance with the manufacturer's instructions;
- 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 of 5m whichever is shorter. Piping shall be well insulated and made as short as possible and with as few possible bends as possible.