

BS EN 16147:2011

Incorporating corrigendum October 2011



BSI Standards Publication

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

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Full document details: BS EN 16147:2011

National foreword

This British Standard is the UK implementation of EN 16147:2011, incorporating corrigendum October 2011. It supersedes BS EN 255-3:1997, which is withdrawn.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.

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Published by BSI Standards Limited 2012

ISBN 978 0 580 77021 0

ICS 27.080; 27.200

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 29 February 2011.

Amendments/corrigenda issued since publication

Date	Text affected
29 February 2012	Implementation of CEN corrigendum October 2011: Correction to EN foreword, 10th paragraph, 1st indent

English Version

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

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

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

This European Standard was approved by CEN on 3 December 2010.

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Foreword

This document (EN 16147:2011) 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of an identical text or by endorsement, at the latest by July 2011, and conflicting national standards shall be withdrawn at the latest by July 2011.

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

This document supersedes EN 255-3:1997.

This European Standard has been prepared under a mandate M/324 given to CEN by the European Commission and the European Free Trade Association.

This document has been prepared by the working group CEN/TC 113/WG 10 "Heat pumps and air conditioners".

This standard was submitted to enquiry under the reference prEN 255-3 which has been changed before Formal Vote to FprEN 16147.

This European Standard references the document TREN D1 D(2002) M/324 for information on "Water-Heaters, Hot Water Storage Appliances and Water Heating Systems".

Testing procedures for simultaneous operation for domestic hot water production and space heating are not treated in this standard. In this standard the basis of the measurements are the daily EU-Reference-Tapping-Cycles defined in the mandate M/324. Presently there is no standard fixed for daily cycles for the space heating mode.

The following technical and general modifications have been introduced during the revision:

- The new COP_{DHW} is smaller than the former COP_t of EN 255-3, since heat losses of the hot water storage tank are considered in the calculation of the COP_{DHW} , whereas the former standard EN 255-3 did not account these losses.
- In EN 16147, five different daily tapping profiles (S, M, L, XL, and XXL) for different storage tank sizes can be selected in order to determine the coefficient of performance.

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

1 Scope

This European Standard specifies methods for testing and reporting of the rating and it specifies requirements for marking of air/water, brine/water, water/water and direct exchange/water heat pumps with electrically driven compressors connected to or including a domestic hot water storage tank. When these units are used for space heating, then EN 14511 (all parts) applies.

In case of air-to-water heat pumps, this European Standard comprises only factory-made units which can be ducted on the airside.

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

NOTE 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.

In the case of units consisting of several parts, the standard applies only to those designed and supplied as a complete package.

This European Standard does not include any requirement about the quality of water.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including amendments) applies.

EN 14511-1:2007, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling — Part 1: Terms and definitions*

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 14511-4, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling — Part 4: Requirements*

EN 60204-1, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005, modified)*

EN 60335-2-40, *Household and similar electrical appliances — Safety — Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers (IEC 60335-2-40:2002, modified)*

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 61000-3-11:2000)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14511-1:2007 and the following apply.

3.1

heat pump for heating domestic water

heat pump as defined in EN 14511-1 connected to or including a domestic hot water storage tank

3.2

domestic hot water

water heated for household or similar purposes

3.3

nominal volume (V_n)

volume of water that is assigned to the storage tank by the manufacturer and marked on it

3.4

indoor air

heat source for a heat pump which absorbs heat by an air heat exchanger in direct contact with the air inside a building

3.5

coefficient of performance for tapping domestic hot water (COP_{DHW})

coefficient of Performance which is determined by the use of EU reference tapping cycles and which includes the heat losses of the storage tank

NOTE See Foreword, 10th paragraph, 1st indent.

3.6

reference hot water temperature (θ_{WH})

temperature determined as the mean value of the average temperatures during one tapping which ends when the hot water temperature is below 40 °C

3.7

maximum volume of usable hot water (V_{max})

total volume of hot water with a temperature of 40 °C produced from water at a temperature of not less than 40 °C and cold water at temperature of 10 °C

NOTE See 6.6.

3.8

off-peak product

product that is designed to fulfill the requirements of the tapping pattern between 7:00 and 22:00 without external energy supply, e.g. to enable operation at off-peak / low-tariff periods

3.9

operating range

working range for the heat pump as specified by the manufacturer and covered by full manufacturer warranty

4 Symbols and abbreviations

Symbol	Description	Units
c_p	Specific heat capacity of water	kJ/(kg*K)
n_{TAP}	Number of tappings during a tapping cycle	-
P_{es}	Standby power input	kW
Q_{EL-Tap}	Calculated heat energy produced by electricity (resistance heater) to reach the required tapping temperature	kWh
Q_{EL-TC}	Calculated heat energy produced by electricity (resistance heater) during the whole tapping cycle	kWh

$Q_{\text{HP-Tap}}$	Useful heat energy produced by heat pump during one tapping	kWh
$Q_{\text{HP-TC}}$	Useful heat energy produced by heat pump during the whole tapping cycle	kWh
Q_{Tap}	Total useful heat energy during one tapping	kWh
Q_{TC}	Total useful heat energy during the whole tapping cycle	kWh
T	Temperature	K
t	Time	s
t_{h}	Heating up time	s
t_{es}	Duration of one on-off-cycle (period between the last and second-last switch-off of compressor) of the heat pump to determine the standby power input	s
t_{TAP}	Time length of one tapping	s
t_{TTC}	Time period of test cycle in hours	h
$\dot{V}_{\text{Air}}$	Nominal air volume flow rate	m ³ /s
$\dot{V}_{\text{Fluid}}$	Measured liquid volume flow rate	m ³ /s
$\dot{V}_{\text{Tap}}$	Volume flow rate of hot water during tapping	m ³ /s
V_{max}	Maximum volume of usable hot water	m ³
W_{eh}	Heating up energy input	kWh
$W_{\text{EL-Corr}}$	Electrical energy consumption of fans or liquid pumps	kWh
$W_{\text{EL-HP-TC}}$	Total electrical energy consumption of the heat pump during the whole tapping cycle	kWh
$W_{\text{EL-M-TC}}$	Measured electrical energy consumption during the whole tapping cycle	kWh
$W_{\text{EL-TC}}$	Total electrical energy consumption during a tapping cycle	kWh
W_{es}	Energy input during the last on-off-cycle (period between the last and second-last switch-off of compressor) to determine the standby power input	kWh
Δp_{ext}	Difference of external static pressure	Pa
Δp_{int}	Difference of internal static pressure	Pa
$\Delta T_{\text{desired}}$	Set temperature difference between hot water temperature and cold water temperature	K
$\theta_{\text{Q, Boundary}}$	Temperature at operating range limit	°C
θ_{WC}	Cold water temperature	°C
θ_{WH}	Hot water temperature	°C

θ_{WH}	Reference hot water temperature	°C
$\rho(T)$	Density of the hot water depending on the temperature at the flow meter	kg/m ³

5 General test requirements

5.1 Test apparatus and uncertainties

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, the permissible deviations shall not exceed the values specified in Table 2. In addition the maximal permissible deviation of thermal energy for the complete tapping cycle shall be less than 5 %.

Table 1 — Uncertainties of measurement for indicated values

Measured quantity	Unit	Uncertainty of measurement
Domestic hot water - temperature - temperature difference - volume - volume flow - thermal energy (complete tapping cycle)	°C - K - dm³ - dm³/s - kWh	± 0,2 K ± 0,2 K ± 2 % ± 2 % ± 5 %
Liquid (heat transfer medium) - temperature inlet / outlet - volume flow - static pressure difference - brine concentration	°C - m³/s - Pa %	± 0,15 K ± 1 % ± 5 Pa ($\Delta p \leq 100$ Pa) ± 5 % ($\Delta p > 100$ Pa) ± 2 %
Air (heat source) - dry bulb temperature - wet bulb temperature - volume flow - static pressure difference	°C °C - dm³/s - Pa	± 0,2 K ± 0,3 K ± 5 % ± 5 Pa ($\Delta p \leq 100$ Pa) ± 5 % ($\Delta p > 100$ Pa)
Electrical quantities - electric power - electrical energy - voltage - current	- W - kWh - V - A	± 1 % ± 1 % ± 0,5 % ± 0,5 %

Table 2 — Permissible deviations from set values

Measured quantity	Permissible deviation of the arithmetic mean values from set values	Permissible deviations of individual measured values from set values
Domestic hot water - inlet temperature - volume flow	$\pm 1 \text{ K}$ $\pm 5 \%$	$\pm 1 \text{ K}$ $\pm 10 \%$
Liquid (heat transfer medium) - inlet temperature - outlet temperature - volume flow ^a - static pressure difference ^a	$\pm 0,2 \text{ K}$ $\pm 0,3 \text{ K}$ $\pm 2 \%$ -	$\pm 0,5 \text{ K}$ $\pm 0,6 \text{ K}$ $\pm 5 \%$ $\pm 10 \%$
Air - inlet temperature (dry bulb/wet bulb) - ambient temperature (if not used as heat source) - volume flow - static pressure difference	$\pm 0,3 \text{ K}$ $\pm 1 \text{ K}$ $\pm 5 \%$ -	$\pm 1 \text{ K}$ $\pm 2 \text{ K}$ $\pm 10 \%$ $\pm 10 \%$
Voltage	$\pm 4 \%$	$\pm 4 \%$

^a Frosting period excluded.

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. The air velocity in the room shall also not be higher than the mean velocity through the unit inlet. 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 Setting the external static pressure difference on the air side for heat pumps with duct connection

5.3.1 All units

The test conditions are given in Table 4 and Table 5.

If liquid heat transfer media other than water are used, the specific heat capacity and density of such heat transfer media shall be determined and taken into consideration in the evaluation.

Table 2 states permissible deviations of the measured values from the test conditions.

5.3.2 Non ducted units

For non ducted units, the adjustable settings such as louvers and fan speed shall be set according to the manufacturer instruction.