



BSI Standards Publication

**Air conditioners, liquid chilling packages
and heat pumps, with electrically driven
compressors, for space heating and cooling -
Testing and rating at part load conditions
and calculation of seasonal performance**

National foreword

This British Standard is the UK implementation of EN 14825:2018. It supersedes BS EN 14825:2016, which is withdrawn.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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Date	Text affected
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English Version

**Air conditioners, liquid chilling packages and heat pumps,
with electrically driven compressors, for space heating and
cooling - Testing and rating at part load conditions and
calculation of seasonal performance**

Climatiseurs, groupes refroidisseurs de liquide et
pompes à chaleur avec compresseur entraîné par
moteur électrique pour le chauffage et la réfrigération
des locaux - Essais et détermination des
caractéristiques à charge partielle et calcul de
performance saisonnière

Luftkonditionierer, Flüssigkeitskühlsätze und
Wärmepumpen mit elektrisch angetriebenen
Verdichtern zur Raumbeheizung und -kühlung -
Prüfung und Leistungsbemessung unter
Teillastbedingungen und Berechnung der
jahreszeitbedingten Leistungszahl

This European Standard was approved by CEN on 25 June 2018.

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.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (EN 14825:2018) has been prepared by Technical Committee CEN/TC 113 “Heat pumps and air conditioning units”, the secretariat of which is held by UNE.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2019, and conflicting national standards shall be withdrawn at the latest by June 2019.

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 14825:2016.

The revision was necessary in order to harmonize this European standard with Commission Regulation (EU) 2015/1095 of 5 May 2015 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for professional refrigerated storage cabinets, blast cabinets, condensing units and process chillers.

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 Regulation(s), see informative Annex ZA, Annex ZB, Annex ZC and Annex ZD, which are integral parts of this document.

The technical content of the previous edition remains unchanged with the exceptions of technical modification that were deferred to the next revision at UAP stage of EN 14825:2016. The main changes with respect to requirements for *forthcoming regulations* are:

- a) modification of the scope to include hybrid heat pumps; DX-to-water(brine) units and process chillers;
- b) modification of Clause 3 in order to be harmonized with Commission Regulation (EU) 2015/1095 of 5 May 2015;
- c) modification of Table 1 to include references to European regulations which use different terms and symbols;
- d) new numbering of Clause 5 and Clause 6;

EN 14825:2016	EN 14825:2018
Clause 5	Clause 6
Clause 6	Clause 5

- e) modification of Clause 5 to include new requirement for seasonal space cooling efficiency;
- f) modification of Clause 6 to include requirements for hybrid heat pumps and DX-to-water(brine) units;
- g) new Clause 7 with test methods for hybrid heat pumps with fossil fuel boilers;
- h) modification of Clause 8 to include air-to-air units above 12 kW and hybrid heat pumps;
- i) new Clause 9 to cover process cooling;

- j) new Clause 10 to cover calculation of SEPR;
- k) renumbering of Clause 8 to Clause 11

EN 14825:2016	EN 14825:2018
Clause 8	Clause 11
Clause 9	Clause 12
Clause 10	Clause 13
Clause 11	Clause 14

- l) modification of Clause 11, Clause 12, Clause 13 and Clause 14 to include units below 12 kW and ground coupled units;
- m) new Annex C for process chillers;
- n) new Annex D for air conditioners and air-to-air heat pumps above 12 kW, water(brine)-to-air units and liquid chilling packages;
- o) renumbering of Annex C to Annex H

EN 14825:2016	EN 14825:2018
Annex C	Annex E
Annex D	Annex F
Annex E	Annex G
Annex F	Annex H
Annex G	Annex J
Annex H	Annex L

- p) new E.3 for hybrid heat pumps, new E.4 for process chillers, new E.5 for comfort chillers and air/water(brine)-to-air and air-conditioners below or equal to 2 MW and E.6 for Air-to-air and water(brine)-to-air heat pumps below or equal to 2 MW;
- q) new Annex K for Calculation example for $SCOP_{on}$ for variable speed hybrid heat pump based on heat pump and boiler separated test;
- r) new Annex N for rating of outdoor units of multi-split air conditioners and heat pumps;
- s) modification Annex ZA to reflect the new numbering;
- t) modification split of Annex ZB into Annex ZB and Annex ZC to reflect the new numbering and the different scheme of annexes for ecodesign and ecolabelling;
- u) new informative Annex ZD, Relationship between this European Standard and the requirements of Commission Regulation (EU) 2015/1095 of 5 May 2015.

NOTE Some modifications listed above were drafted in anticipation of Commission Regulation 2016/2281.

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.

Introduction

Heat pumps, air conditioners and liquid chilling packages can be selected and compared at standard rating conditions. These conditions do not represent the usual operating conditions of the equipment over a season. Better comparison for equipment can be assessed by determining Seasonal Energy Efficiency Ratio and Seasonal Coefficient of Performance that enable to take into account more representative operating conditions and performance at rated capacities.

Fixed capacity heat pumps, air conditioners and liquid chilling packages deal with varying loads by varying the operation time. The efficiency of the system is dependent on the effectiveness of the controlling thermostats. Variable capacity air conditioners, liquid chilling packages and heat pumps, by continuous or step control of the compressor, can more closely match the varying load improving system efficiency.

This document provides part load conditions and calculation methods for calculating the Seasonal Energy Efficiency Ratio ($SEER_{on}$) and Seasonal Coefficient of Performance ($SCOP_{on}$ and $SCOP_{net}$) of such units when they are used to fulfil the cooling and heating demands.

Other electric energy consumptions can occur when the unit is not used to fulfil the cooling and heating demands such as those from a crankcase heater or when the unit is on standby. These consumptions are considered in the calculation methods for $SEER$ and $SCOP$.

This document also considers Seasonal Energy Performance Ratio of process chillers ($SEPR$) which is representative of variations in loads throughout a complete year. Test conditions and test method are described to calculate this $SEPR$.

$SEER/SEER_{on}$, $SCOP/SCOP_{on}$, $SCOP_{net}$ and $SEPR$ calculations may be based on calculated or measured values. In case of measured values, this document gives the methods for testing heat pumps, air conditioners and liquid chilling packages at part load conditions.

The standard rating conditions and test methods are given in EN 14511-2 and EN 14511-3.

Although this document was prepared in the frame of the Commission Regulation (EU) No 206/2012 implementing Directive 2009/125/EC with regard to ecodesign requirements for air conditioners and comfort fans, it may also be used to show compliance with the requirements of the European Directive 2010/30/EU and Commission Delegated Regulation (EU) No 626/2011.

This document was prepared in the frame of the Commission Regulation (EU) No 813/2013 implementing Directive 2009/125/EC with regard to ecodesign requirements for space heaters and combination heaters. This European standard also aims at showing compliance with the requirements of the European Directive 2010/30/EU and Commission Delegated Regulation (EU) No 811/2013.

This document was prepared in the frame of the Commission Regulation (EU) 2015/1095 of 5 May 2015 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for professional refrigerated storage cabinets, blast cabinets, condensing units and process chillers.

1 Scope

This document covers air conditioners, heat pumps and liquid chilling packages, including comfort and process chillers. It applies to factory made units defined in EN 14511-1, except single duct, double duct, control cabinet and close control units. It also covers direct exchange-to-water(brine) heat pumps (DX-to-water(brine)) as defined in EN 15879-1.

This document also covers hybrid heat pumps as defined in this standard.

This document gives the temperatures and part load conditions and the calculation methods for the determination of seasonal energy efficiency $SEER$ and $SEER_{on}$, seasonal space cooling energy efficiency $\eta_{s,c}$ seasonal coefficient of performance $SCOP$, $SCOP_{on}$ and $SCOP_{net}$, and seasonal space heating energy efficiency $\eta_{s,h}$ and seasonal energy performance ratio $SEPR$.

Such calculation methods can be based on calculated or measured values.

In case of measured values, this document covers the test methods for determination of capacities, EER and COP values during active mode at part load conditions. It also covers test methods for power input during thermostat-off mode, standby mode, off-mode and crankcase heater mode.

NOTE 1 The word “unit” is used instead of the full terms of the products.

NOTE 2 The word “cooling” is used to refer to both space cooling and process cooling.

NOTE 3 The word “heating” is used to refer to space heating.

2 Normative references

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

EN 267, *Automatic forced draught burners for liquid fuels*

EN 303-2, *Heating boilers - Part 2: Heating boilers with forced draught burners - Special requirements for boilers with atomizing oil burners*

EN 304, *Heating boilers - Test code for heating boilers for atomizing oil burners*

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

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

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

EN 15879-1, *Testing and rating of direct exchange ground coupled heat pumps with electrically driven compressors for space heating and/or cooling - Part 1: Direct exchange-to-water heat pumps*

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

3 Terms, definitions, symbols, abbreviated terms and units

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14511-1 and EN 15879-1 and the following apply.

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1.1

active mode

mode corresponding to the hours with a cooling or heating load of the building and whereby the cooling or heating function of the unit is activated

Note 1 to entry: This condition may involve on/off-cycling of the unit in order to reach or maintain a required indoor air temperature.

3.1.2

active mode seasonal coefficient of performance

$SCOP_{on}$

average coefficient of performance of the unit in active mode for the designated heating season, determined from the part load, supplementary heating capacity (where required) and bin-specific coefficients of performance ($COP_{bin}(T_j)$) and weighted by the bin hours where the bin condition occurs

Note 1 to entry: For calculation of $SCOP_{on}$, the energy consumption during thermostat-off mode, standby mode, off mode and crankcase heater mode are excluded. The energy consumption of a supplementary heater is added for the part load conditions where the declared capacity of the unit is lower than the heating load, regardless whether this supplementary heater is included in the unit or not included in the unit.

Note 2 to entry: Expressed in kWh/kWh.

3.1.3

active mode seasonal energy efficiency ratio

$SEER_{on}$

average energy efficiency ratio of the unit in active mode for the cooling function, determined from part load and bin-specific energy efficiency ratios ($EER_{bin}(T_j)$) and weighted by the bin hours where the bin condition occurs

Note 1 to entry: For calculation of $SEER_{on}$, energy consumption during thermostat-off mode, standby mode, off mode and that of the crankcase heater is excluded.

Note 2 to entry: Expressed in kWh/kWh.

3.1.4

annual energy consumption for space cooling

Q_{CE}

energy consumption required to meet the reference annual cooling demand and calculated as the reference annual space cooling demand divided by the active mode seasonal energy efficiency ratio ($SEER_{on}$) and the energy consumption of the unit for thermostat-off-, standby-, off- and crankcase heater-mode during the cooling season

Note 1 to entry: Expressed in kWh.

3.1.5

annual energy consumption for heating

Q_{HE}

energy consumption required to meet the reference annual heating demand for a designated heating season and calculated as the reference annual heating demand divided by the active mode seasonal coefficient of performance ($SCOP_{on}$) and the energy consumption of the unit for thermostat-off-, standby-, off- and crankcase heater-mode during the heating season

Note 1 to entry: Expressed in kWh.

3.1.6

average climate conditions

temperature conditions characteristic for the city of Strasbourg for the heating season

3.1.7

bin

outdoor temperature interval of 1 K

3.1.8

bin hours

h_j

hours per season for which an outdoor temperature occurs for each bin j

3.1.9

bin limit temperature

temperature in the bin for which no more heating or cooling is required

Note 1 to entry: The bin limit temperature equals 16 °C for all climates in space cooling and space heating applications.

3.1.10

bin-specific coefficient of performance

$COP_{bin}(T_j)$

coefficient of performance specific for every bin j with outdoor temperature T_j in a season

3.1.11

bin-specific energy efficiency ratio

$EER_{bin}(T_j)$

energy efficiency ratio specific for every bin j with outdoor temperature T_j in a season

3.1.12

bin temperature

T_j

outdoor air dry bulb temperature

Note to entry 1: Expressed in °C

Note to entry 2: The relative humidity may be indicated by a corresponding wet bulb temperature

3.1.13

bivalent temperature

T_{biv}

lowest outdoor temperature point at which the unit is declared to have a capacity able to meet 100 % of the heating load without supplementary heater, whether it is integrated in the unit or not

Note 1 to entry: Below this point, the unit may still provide capacity, but additional supplementary heating is necessary to fulfil the full heating load.

Note 2 to entry: Bivalent temperature does not apply to hybrid heat pumps.

3.1.14

capacity control

ability of the unit to change its capacity by changing the volumetric flow rate of the refrigerant

Note 1 to entry: Units are indicated as '*fixed*' if the unit cannot change its volumetric flow rate, '*staged*' if the volumetric flow rate is changed or varied in series of not more than two steps, or '*variable*' if the volumetric flow rate is changed or varied in series of three or more steps.

3.1.15

capacity ratio

CR

cooling (or heating) part load or full load divided by the declared cooling (or heating) capacity of the unit at the same temperature conditions

3.1.16

climate conditions

temperature conditions (dry bulb) characteristic for a specific location

3.1.17

coefficient of performance at declared capacity

COP_d

declared heating capacity of the unit divided by the effective power input of the unit at specific temperature conditions, A, B, C, D, E, F and G, where applicable

Note 1 to entry: Expressed in kW/kW.

3.1.18

coefficient of performance at part load

COP_{bin}

coefficient of performance at the declared capacity, corrected with the degradation coefficient, where applicable

Note 1 to entry: When the declared capacity of the unit is higher than the heating load, the COP includes degradation losses. When the declared capacity of the unit is lower than the heating load (i.e. below the bivalent temperature condition), the COP of the declared capacity is used.

Note 2 to entry: Expressed in kW/kW.

3.1.19

colder climate conditions

temperature conditions characteristic for the city of Helsinki for the heating season

3.1.20

compressor-off state

compressor is not running while the unit is operating in active mode

Note 1 to entry: This is the "off" phase in on/off cycling

3.1.21

conversion coefficient

CC

coefficient for power generation efficiency, the value CC is equal to 2,5

Note to entry: This coefficient is reflecting the estimated 40 % average EU power generation efficiency referred to in Directive 2012/27/EU of the European Parliament and of the Council.

3.1.22

crankcase heater mode operating hours

H_{CK}

annual number of hours the unit is considered to be in crankcase heater mode, the value of which depends on the designated season and type of unit and operating mode(s)

Note 1 to entry: Expressed in h.

3.1.23

crankcase heater mode power input

P_{CK}

power input of the unit due to crankcase heater operation mode

Note 1 to entry: Expressed in W.

3.1.24

crankcase heater (operation) mode

condition where the unit has activated a heating device to avoid the refrigerant migrating to the compressor in order to limit the refrigerant concentration in oil at compressor start

3.1.25

cycling interval capacity for cooling

P_{cycc}

(time-weighted) average cooling capacity output over the cycling interval test

Note 1 to entry: Expressed in kW.

3.1.26

cycling interval capacity for heating

P_{cych}

(time-weighted) average heating capacity output over the cycling interval test

Note 1 to entry: Expressed in kW.

3.1.27

cycling interval efficiency for cooling

EER_{cyc}

average energy efficiency ratio over the cycling interval test (compressor switching on and off)

Note 1 to entry: The cycling interval efficiency for cooling is calculated as the integrated cooling capacity over the interval divided by the integrated power input over that same interval.

Note 2 to entry: Expressed in kWh/kWh.

3.1.28**cycling interval efficiency for heating** **COP_{cyc}**

average coefficient of performance over the cycling interval test (compressor switching on and off)

Note 1 to entry: The cycling interval efficiency for heating calculated as the integrated heating capacity over the interval divided by the integrated power input over that same interval.

Note 2 to entry: Expressed in kWh/kWh.

3.1.29**declared capacity**cooling (P_{dc}) or heating (P_{dh}) capacity a unit can provide at any temperature condition A, B, C, D, E, F or G, as declared by the manufacturer

Note 1 to entry: This is the capacity provided by the refrigerant cycle of the unit without supplementary heaters, even if those are integrated in the unit, except for hybrid heat pumps tested according to the combined method.

Note 2 to entry: P_{dc} in point A, B, C and D are referred to as P_A , P_B , P_C and P_D respectively in process cooling.

3.1.30**degradation coefficient** **C_d**

measure of efficiency loss due to the cycling

Note 1 to entry: If C_d is not determined by measurement then the default degradation coefficient for air-to-water(brine) and water(brine)-to-water(brine) units is 0,9.

Note 2 to entry: If C_d is not determined by measurement then the default degradation coefficient for air-to-air and water(brine)-to-air units is 0,25.

3.1.31**effective power input during compressor-off state** **P_{Coff}** total power input of the unit when the compressor is switched off in active mode, used for the determination of the degradation coefficient C_d

Note 1 to entry: Expressed in kW.

Note 2 to entry: The corrections for pumps and fans according to EN 14511 shall apply.

3.1.32**effective power input with declared capacity** **P_{Con}** total power input when the unit is operating at part load condition, used for the determination of the degradation coefficient C_d

Note 1 to entry: Expressed in kW.

Note 2 to entry: The corrections for pumps and fans according to EN 14511 shall apply.

3.1.33

electric supplementary heater

real or assumed electric supplementary heater, with a *COP* of 1, considered in the calculation of *SCOP* and *SCOP_{on}*

3.1.34

electric supplementary heater capacity

elbu(T_j)

heating capacity of a real or assumed electric supplementary heater supplementing the declared capacity for heating when the capacity of the unit is lower than the heat load for a specific bin temperature *T_j*

Note 1 to entry: Expressed in kW.

3.1.35

energy efficiency ratio at declared capacity

EER_d

declared cooling capacity of the unit divided by the effective power input of a unit at specific temperature conditions A, B, C, D

Note 1 to entry: Expressed in kW/kW.

Note 2 to entry: *EER_d* in point A, B, C and D are referred to as *EER_A*, *EER_B*, *EER_C* and *EER_D* respectively in process cooling.

3.1.36

energy efficiency ratio at part load

EER_{bin}

energy efficiency ratio at the declared capacity, corrected with the degradation coefficient, where applicable

Note 1 to entry: The *EER_{bin}* includes degradation losses when the declared capacity of the unit is higher than the cooling load.

Note 2 to entry: Expressed in kW/kW.

3.1.37

equivalent active mode hours for cooling

H_{CE}

assumed annual number of hours while the unit is assumed to operate at the design load for cooling (*P_{designc}*) in order to satisfy the reference annual cooling demand

Note 1 to entry: Expressed in h.

3.1.38

equivalent active mode hours for heating

H_{HE}

assumed annual number of hours while the unit is assumed to operate at the design load for heating (*P_{designh}*) in order to satisfy the reference annual heating demand

Note 1 to entry: Expressed in h.

3.1.39**fixed outlet**

water(brine) outlet temperature that is used when the control of the unit has no means to automatically vary the water(brine) outlet temperature with the outdoor temperature

3.1.40**fossil fuel supplementary heater**

fossil fuel supplementary heater supplied together with the unit and considered in the calculation of $SCOP$ and $SCOP_{on}$

3.1.41**fossil fuel heater efficiency** **η_{ssup}**

seasonal space heating energy efficiency of a fossil fuel heater, used either as a supplementary heater or as a second heat generator of a hybrid heat pump

Note 1 to entry: Expressed in %.

3.1.42**dry cooler**

self-contained system that cools a single-phase liquid by rejecting sensible heat via a heat exchanger to air that is mechanically circulated by integral fan(s)

3.1.43**design load** **P_{design}**

space cooling ($P_{designc}$) or space heating ($P_{designh}$) load declared by the manufacturer at $T_{designc}$ or $T_{designh}$ conditions respectively

Note 1 to entry: It is possible to calculate the $SEER/SEER_{on}$ or $SCOP/SCOP_{on}/SCOP_{net}$ of a unit for more than one P_{design} value.

Note 2 to entry: Expressed in kW.

3.1.44**full load** **$P_{designr}$**

process cooling load declared by the manufacturer at reference ambient temperature

Note 1 to entry: Expressed in kW.

3.1.45**high temperature application**

application where the unit delivers its declared heating capacity at an indoor heat exchanger water(brine) outlet temperature of 65°C, at standard conditions

3.1.46**hybrid heat pump**

encased assembly or assemblies designed as a unit consisting of an air/water(brine)/DX-to-water(brine) electrically driven heat pump with a second heat generator using fossil fuel, and managed by a common controller providing an optimized operation of the heat generators for space heating

Note 1 to entry: The unit may also provide domestic hot water and/or space cooling.

3.1.47

information or status display

continuous function providing information or indicating the status of the equipment on a display, including clocks

3.1.48

intermediate temperature application

application where the unit delivers its declared heating capacity at an indoor heat exchanger water(brine) outlet temperature of 45 °C, at standard conditions

3.1.49

low temperature application

application where the unit delivers its declared heating capacity at an indoor heat exchanger water(brine) outlet temperature of 35 °C, at standard conditions

3.1.50

low temperature process cooling application

application where the unit delivers its rated cooling capacity at an indoor heat exchanger outlet temperature of – 25 °C, at standard rating conditions

3.1.51

low temperature heat pump

heat pump that is specifically designed for low-temperature application, and that cannot deliver heating water(brine) with an outlet temperature of 52°C at an inlet dry (wet) bulb temperature of – 7 °C (– 8 °C) in the reference design conditions for average climate

3.1.52

medium temperature application

application where the unit delivers its declared heating capacity at an indoor heat exchanger water(brine) outlet temperature of 55 °C, at standard conditions

3.1.53

medium temperature process cooling application

application where the unit delivers its rated cooling capacity at an indoor heat exchanger outlet temperature of – 8 °C, at standard rating conditions

3.1.54

net seasonal coefficient of performance

$SCOP_{net}$

seasonal efficiency of a unit in active heating mode without supplementary heaters which is determined from mandatory conditions given in this European Standard

Note 1 to entry: For calculation of $SCOP_{net}$, the energy consumption during active mode is used. This excludes the energy consumption during thermostat-off mode, standby mode, off mode or that of the crankcase heater. For the part load conditions where the declared capacity of the unit is lower than the heating load, the energy consumption of a supplementary heater is not included.

Note 2 to entry: Expressed in kWh/kWh.

Note 3 to entry: $SCOP_{net}$ does not apply to hybrid heat pumps.

3.1.55**off mode**

mode wherein the unit is completely switched off and cannot be reactivated by control device, external signal or by a timer

Note 1 to entry: Off mode means a condition in which the equipment is connected to the mains and is not providing any function. The following will also be considered as off mode: conditions providing only an indication of off mode condition; conditions providing only functionalities intended to ensure electromagnetic compatibility.

3.1.56**off mode operating hours**

H_{OFF}

annual number of hours the unit is considered to be in off mode, the value of which depends on the designated season and type of unit and operating mode(s)

Note 1 to entry: Expressed in h.

3.1.57**off mode power input**

P_{OFF}

power input of the unit while in off mode

Note 1 to entry: Expressed in W.

3.1.58**operation limit temperature**

TOL

outdoor temperature below which the declared capacity is equal to zero

Note 1 to entry: Expressed in °C.

3.1.59**part load for cooling**

$P_c(T_j)$

cooling load at a specific bin temperature T_j , calculated as the design load multiplied by the part load ratio

Note 1 to entry: Expressed in kW.

3.1.60**part load for heating**

$P_h(T_j)$

heating load at a specific bin temperature T_j , calculated as the design load multiplied by the part load ratio

Note 1 to entry: Expressed in kW.

3.1.61**part load ratio**

$pl(T_j)$

bin temperature minus 16 °C divided by the reference design temperature minus 16 °C

3.1.62

part load ratio for process chillers

$P_R(T_j)$

value limited between 80 % and 100 % and proportional to the bin temperature T_j

3.1.63

reactivation function

function facilitating the activation of other modes, including active mode, by remote switch including remote control, internal sensor, timer to a condition providing additional functions, including the main function, but excluding thermostats

3.1.64

reference annual cooling demand

Q_c

reference cooling demand to be used as basis for calculation of *SEER* and calculated as the product of the design load for cooling (P_{designc}) and the equivalent active mode hours for cooling (H_{CE})

Note 1 to entry: Expressed in kWh

3.1.65

reference annual heating demand(s)

Q_H

reference heating demand for a designated heating season, to be used as basis for calculation of *SCOP* and calculated as the product of the design load for heating (P_{designh}) and the equivalent active mode hours for heating (H_{HE})

Note 1 to entry: There are three reference heating demands: "A" average, "C" colder and "W" warmer, corresponding to the three reference heating seasons.

Note 2 to entry: Expressed in kWh.

3.1.66

reference cooling season

set of operating conditions describing per bin the combination of outdoor temperatures and the number of hours these temperatures occur for cooling for which the unit is declared fit for purpose

3.1.67

reference design conditions for space cooling

T_{designc}

temperature conditions at 35 °C dry bulb (24 °C wet bulb) outdoor temperature and 27 °C dry bulb (19 °C wet bulb) indoor temperature

3.1.68

reference design conditions for space heating

T_{designh}

temperature conditions for average, colder and warmer climates

3.1.69

reference heating season(s)

set of operating conditions describing per bin the combination of outdoor temperatures and the number of hours these temperatures occur for heating for which the unit is declared fit for purpose

Note 1 to entry: There are three reference heating seasons: "A" average, "C" colder and "W" warmer.

3.1.70**seasonal coefficient of performance****SCOP**

overall coefficient of performance of the unit, representative for the whole designated heating season

Note 1 to entry: The value of *SCOP* pertains to a designated heating season. *SCOP* is calculated as the reference annual heating demand divided by the annual energy consumption for heating.

Note 2 to entry: Expressed in kWh/kWh.

3.1.71**seasonal energy efficiency ratio****SEER**

overall energy efficiency ratio of the unit, representative for the whole cooling season

Note 1 to entry: The seasonal energy efficiency ratio is calculated as the reference annual cooling demand divided by the annual energy consumption for cooling.

Note 2 to entry: Expressed in kWh/kWh.

3.1.72**seasonal energy performance ratio****SEPR**

overall efficiency ratio of a unit for providing process cooling, representative of variations in load and ambient temperature throughout the year

Note 1 to entry: The seasonal performance efficiency ratio is calculated as the ratio between annual process cooling demand and annual energy consumption.

Note 2 to entry: Expressed in kWh/kWh.

3.1.73**seasonal space heating energy efficiency** **$\eta_{s,h}$**

ratio between the space heating demand for a designated heating season, supplied by a space heater and the annual energy consumption required to meet this demand

Note 1 to entry: Expressed in %.

3.1.74**seasonal space cooling energy efficiency** **$\eta_{s,c}$**

ratio between the space cooling demand for the cooling season, supplied by a space cooling unit and the annual energy consumption required to meet this demand

Note 1 to entry: Expressed in %.

3.1.75**standby mode**

mode wherein the unit is switched off partially and can be reactivated by a control device (such as a remote control), an external signal or a timer

Note 1 to entry: The unit is connected to the mains, depends on signal input to work as intended and provides only the following functions, which may persist for an indefinite time: reactivation function, or reactivation function and only an indication of enabled reactivation function, and/or information or status display.

3.1.76

standby mode operating hours

H_{SB}

annual number of hours the unit is considered to be in standby mode, the value of which depends on the designated season and type of unit and operating mode(s)

Note 1 to entry: Expressed in h.

3.1.77

standby mode power input

P_{SB}

power input of the unit due to standby mode operation

Note 1 to entry: Expressed in W.

3.1.78

supplementary heater

heater that generates heat in case the heat load is greater than the declared capacity of the heat pump, using the Joule effect in electric heating elements or the combustion of fossil fuel

3.1.79

supplementary capacity for heating

$sup(T_j)$

required capacity of supplementary heater that supplements the declared heating capacity to meet the part load for heating at a specific bin temperature T_j

Note 1 to entry: Expressed in kW

Note 2 to entry: When the supplementary heater is or is assumed to be electrical then $sup(T_j)$ is equal to $elbu(T_j)$

3.1.80

switch temperature boiler off

$T_{fb,off}$

for hybrid systems, temperature above which the fossil boiler is switched off and heat only provided by the heat pump

Note 1 to entry: $T_{fb,off}$ shall be used in place of T_{biv} which is not relevant for hybrid systems.

3.1.81

switch temperature heat pump off

$T_{hp,off}$

for hybrid system, temperature below which the heat pump is switched off and heat only provided by the fossil fuel boiler

Note 1 to entry: $T_{hp,off}$ shall be used in place of TOL which is not relevant for hybrid systems.

3.1.82

temperature control

equipment that interfaces with the end-user regarding the values and timing of the desired indoor temperature, and communicates relevant data to an interface of the heater such as a central processing unit, thus helping to regulate the indoor temperature(s)

3.1.83**thermostat-off mode**

mode corresponding to the hours with no cooling or heating demand of the building, whereby the cooling or heating function of the unit is switched on, but is not operational, as there is no cooling or heating demand

Note 1 to entry: Cycling on / off in active mode is not considered as thermostat-off.

3.1.84**thermostat-off mode operating hours**

H_{To}

annual number of hours the unit is considered to be in thermostat-off mode, the value of which depends on the designated season and type of unit and operating mode(s)

Note 1 to entry: Expressed in h.

3.1.85**thermostat-off mode power input**

P_{To}

power input of the unit due to thermostat-off mode operation

Note 1 to entry: Expressed in W.

3.1.86**variable outlet**

water(brine) outlet temperature that is used when the control of the unit has means to automatically vary the water(brine) outlet temperature with the outdoor temperature

3.1.87**warmer climate conditions**

temperature conditions characteristic for the city of Athens for the heating season

3.2 Symbols, abbreviated terms and units

Table 1 provides the symbols, abbreviated terms and units as used in this standard. Deviating symbols may be defined in the European regulations. The deviating symbols for the different product groups are specified in the respective columns.

The different product groups in the table are indicated by Roman numbers I to IV. Deviating symbols are given for:

- I: air-to-air units ≤ 12 kW referred to in informative Annex ZA;
- II: air-to-water(brine), water(brine)-to-water(brine) and DX-to-water(brine) units ≤ 400 kW referred to in informative Annex ZB and Annex ZC;
- III: process cooling application, air-to-water(brine) and water(brine)-to-water(brine) units, referred to in the informative Annex ZD;
- IV: air heating products, air-to-air > 12 kW, water(brine)-to-air; cooling products, air-to-air units > 12 kW, all others units referred to in the informative Annex ZE.

Table 1 — Symbols, abbreviated terms and units

Symbol and abbreviated terms	Denomination	Units	Remark	
			Product group	deviating symbols
CC	Conversion Coefficient	—		
C_d	Degradation Coefficient	—	I	C_{dc}, C_{dh}
			II	C_{dh}
			III	C_c
			IV	C_{dh}, C_{dc}
COP	Coefficient of Performance	kW/kW		
COP_{bin}	Coefficient of Performance at Part Load	kW/kW		
$COP_{bin}(T_j)$	bin-specific Coefficient of Performance	kW/kW		
COP_{cyc}	Cycling interval efficiency for heating	kWh/kWh		
COP_d	Coefficient of Performance at the declared capacity	kW/kW	I	$COP_d(T_j)$
			II	
			IV	
CR	Capacity Ratio	kW/kW		
DX	Direct exchange as defined in EN 15879-1			
EER	Energy Efficiency Ratio	kW/kW		
EER_d	Energy Efficiency Ratio at the Declared Capacity	kW/kW	I	$EER_d(T_j)$
			IV	
			III	EER_{DC}
EER_{bin}	Energy Efficiency Ratio at Part Load	kW/kW		
$EER_{bin}(T_j)$	Bin-specific Energy Efficiency Ratio	kW/kW	III	EER_j
EER_{cyc}	Cycling interval efficiency for cooling	kWh/kWh		
$elbu$	Required capacity of an electric supplementary heater	kW	III	P_{sup}
$elbu(T_j)$	Required capacity of an electric supplementary heater for the corresponding temperature T_j	kW		
$F(1)$	Correction for controls	%		
$F(2)$	Correction for pumps	%		

Symbol and abbreviated terms	Denomination	Units	Remark	
			Product group	deviating symbols
G_{CV}	gross calorific value of the reference fuel oil	kJ/kg		
h_j	Bin Hours	h	II	H_j
H_{CE}	Equivalent active mode hours for cooling	h		
H_{HE}	Equivalent active mode hours for heating	h	I	bin_j
			IV	
H_{CK}	Crankcase heater mode operating hours	h		
H_{OFF}	Off mode operating hours	h		
H_s	gross calorific value of dry reference test gas at 15 °C and 1013,25 hPa	MJ / m ³		
H_{SB}	Standby mode operating hours	h		
H_{TO}	Thermostat-off mode operating hours	h		
j	Bin number	-		
m_1	mass of fuel before the test	kg		
m_2	mass of fuel at the end of the test	kg		
n	total number of bins	-		
$P_c(T_j)$	Part load for cooling	kW		
P_{CK}	Crankcase heater mode power input	W		
P_{Coff}	effective power input during compressor-off state	kW		
P_{Con}	effective power input with declared capacity	kW		
P_{cycc}	Cycling interval capacity for cooling	kW		
P_{cych}	Cycling interval capacity for heating	kW		
P_{dc}	Declared capacity in cooling mode	kW		
P_{dh}	Declared capacity in heating mode	kW		
P_{design}	Design load	kW		
$P_{designc}$	Design Load Cooling	kW	IV	$P_{design,c}$
$P_{designh}$	Design Load Heating	kW	IV	$P_{design,h}$
$P_{designr}$	Full load value for process cooling	kW		
$P_{elec}(T_j)$	Electrical power input for the corresponding temperature T_j	kW		

Symbol and abbreviated terms	Denomination	Units	Remark	
			Product group	deviating symbols
$P_h(T_j)$	Part load for heating	kW		
P_{OFF}	Off mode power input	W		
P_{SB}	Standby mode power input	W		
P_{sup}	Rated heat output of a supplementary heater	kW		
P_{TO}	Thermostat-off mode power input	W		
p_a	atmospheric pressure	hPa		
p_g	excess pressure of dry gas at the meter	hPa		
$p_l(T_j)$	Part Load Ratio for bin temperature T_j	-		
$P_R(T_j)$	Part load ratio for process cooling at the corresponding temperature T_j	-		
Q_C	Reference Annual Cooling Demand	kWh		
Q_{CE}	Annual energy consumption for cooling	kWh		
Q_H	Reference Annual Heating Demand	kWh		
Q_{HE}	Annual energy consumption for heating	kWh		
$Q_{fossil}(T_j)$	Fossil fuel power input for the corresponding temperature T_j ,	kW		
$Q_{fuel}(T_j)$	Liquid fuel power input for the corresponding temperature T_j ,	kW		
Q_g	Power consumption of gas boiler under operating conditions	kW		
$SCOP$	Seasonal Coefficient of Performance	kWh/kWh		
$SCOP_{net}$	Net seasonal coefficient of performance	kWh/kWh		
$SCOP_{on}$	Active mode seasonal coefficient of performance	kWh/kWh		
$SEER$	Seasonal Energy Efficiency Ratio	kWh/kWh		
$SEER_{on}$	Active mode seasonal energy efficiency ratio	kWh/kWh		
$SEPR$	seasonal energy performance ratio	kWh/kWh		
$sup(T_j)$	Supplementary Capacity for Heating	kW		
T_{biv}	Bivalent Temperature	°C		

Symbol and abbreviated terms	Denomination	Units	Remark	
			Product group	deviating symbols
$T_{designc}$	Reference Design Temperature Conditions for cooling	°C	IV	$T_{design,c}$
$T_{designh}$	Reference Design Temperature Conditions for heating	°C	IV	$T_{design,h}$
$T_{fb,off}$	Switch temperature boiler off	°C		
$T_{hp,off}$	Switch temperature heat pump off	°C		
T_j	Bin Temperature Outdoor Temperature	°C		
TOL	Operation Limit Temperature	°C	I	T_{ol}
			IV	T_{ol}
T_g	temperature of gas at the meter	°C		
$\dot{V}$	gas volume flow under operating conditions	m ³ / h		
$\eta_{s,c}$	Seasonal Space Cooling Energy Efficiency	%		
$\eta_{s,h}$	Seasonal Space Heating Energy Efficiency	%	II	η_s
η_{ssup}	Seasonal Space Heating Energy Efficiency of Fossil Fuel Heater	%	IV	$\eta_{s,th}$

4 Part load conditions for space cooling

4.1 General

For the purpose of calculation of $SEER/SEER_{on}$ as explained in Clause 5, the part load ratios mentioned below shall be based on the part load ratio formulas and not on the rounded figures of Tables 2 to 5.

For the purpose of $SEER$ and $SEER_{on}$ the different conditions are defined by a reference design temperature $T_{designc}$ equal to 35 °C.

4.2 Air-to-air units

For outdoor air-to-recycled air units, the part load conditions for determining the declared capacity (P_{dh}) and the declared energy efficiency ratio (EER_d) are given in Table 2.

Table 2 — Part load conditions for outdoor air -to- recycled air units

	Part load ratio	Part load ratio %	Outdoor air dry bulb temperature °C	Indoor air dry bulb (wet bulb) temperatures °C
A	$(35-16)/(T_{designc} - 16)$	100	35	27(19)
B	$(30-16)/(T_{designc} - 16)$	74	30	27(19)
C	$(25-16)/(T_{designc} - 16)$	47	25	27(19)
D	$(20-16)/(T_{designc} - 16)$	21	20	27(19)

4.3 Water(brine)-to-air units

The part load conditions for determining the declared capacity (P_{dc}) and the declared energy efficiency ratio (EER_d) are given in Table 3.

Table 3 — Part load conditions for water(brine)-to-air

	Part load ratio	Part load ratio	Outdoor heat exchanger			Indoor heat exchanger
			Cooling tower or water(brine) loop application Inlet/outlet water(brine) temperatures	Ground coupled application Inlet/outlet water(brine) temperatures	Dry cooler application Inlet/outlet water(brine) temperatures	Air dry bulb (wet bulb) temperatures
			°C	°C	°C	°C
A	$(35-16)/(T_{\text{designc}}-16)$	100	30 / 35	10 / 15	50 / 55	27(19)
B	$(30-16)/(T_{\text{designc}}-16)$	74	26 / ^a	10 / ^a	45 / ^a	27(19)
C	$(25-16)/(T_{\text{designc}}-16)$	47	22 / ^a	10 / ^a	40 / ^a	27(19)
D	$(20-16)/(T_{\text{designc}}-16)$	21	18 / ^a	10 / ^a	35 / ^a	27(19)

^a With the flow rate as determined during "A" test for units with a fixed flow rate or a fixed delta T of 5 °K for units with a variable flow rate. If for any of the test conditions the resulting flow rate is below the minimum flow rate then this minimum flow rate is used as a fixed flow rate with the inlet temperature for this test condition.

4.4 Air-to-water(brine) units

For each application, units either allowing or not allowing a variation of the outlet water(brine) temperature with the outdoor temperature are considered. The part load conditions for determining the declared capacity (P_{dc}) and the declared energy efficiency ratio (EER_d) are given in Table 4.

The variable outlet temperature ($T_{outlet,average}$) shall only be applied when the control provides an outdoor air temperature dependant modification of the outlet temperature.

For units with variable outlet that have to cycle on/off to reach the required part load ratio, the inlet and outlet temperatures of the indoor heat exchanger shall be determined according to Formula (35) in 11.5.1.

Table 4 — Part load conditions for air-to-water(brine) units

	Part load ratio	Part load ratio %	Outdoor heat exchanger	Indoor heat exchanger		
			Air dry bulb temperature °C	Fan coil application Inlet/outlet water(brine) temperatures		Cooling floor application Inlet/outlet water(brine) temperatures °C
				Fixed outlet °C	Variable outlet ^b °C	
A	$(35-16)/(T_{designc}-16)$	100	35	12 / 7	12 / 7	23 / 18
B	$(30-16)/(T_{designc}-16)$	74	30	^a / 7	^a / 8,5	^a / 18
C	$(25-16)/(T_{designc}-16)$	47	25	^a / 7	^a / 10	^a / 18
D	$(20-16)/(T_{designc}-16)$	21	20	^a / 7	^a / 11,5	^a / 18
^a With the flow rate as determined during “A” test for units with a fixed flow rate or with a fixed delta T of 5 K for units with a variable flow rate. If for any of the test conditions the resulting flow rate is below the minimum flow rate then this minimum flow rate is used as a fixed flow rate with the outlet temperature for this test condition.						
^b if the variable outlet temperature is above the maximum of the operating range of the unit, this maximum should be considered.						

4.5 Water(brine)-to-water(brine) units

For each application, units either allowing or not allowing a variation of the outlet water(brine) temperature with the outdoor temperature are considered. The part load conditions for determining the declared capacity (P_{dc}) and the declared energy efficiency ratio (EER_d) are given in Table 5.

The variable outlet temperature ($T_{outlet,average}$) shall only be applied when the control provides an outdoor air temperature dependant modification of the outlet temperature.

For units with variable outlet that have to cycle on/off to reach the required part load ratio, the inlet and outlet temperatures of the indoor heat exchanger shall be determined according to Formula (35) in 11.5.1.

Table 5 — Part load conditions for water(brine)-to-water(brine) and DX-to-water units

	Part load ratio	Part load ratio	Outdoor heat exchanger				Indoor heat exchanger		
			Cooling tower or water(brine) loop application Inlet/outlet water(brine) temperatures	Ground coupled application Inlet/outlet water(brine) temperatures	Dry cooler application Inlet/outlet water (brine) temperatures	DX	Fan coil application Inlet/outlet water(brine) temperatures		Cooling floor application Inlet/outlet water(brine) temperatures
							Fixed outlet	Variable outlet ^c	
		%	°C	°C	°C	°C	°C	°C	°C
A	(35–16)/ ($T_{design\ c} - 16$)	100	30 / 35	10 / 15	50 / 55	30	12 / 7	12 / 7	23 / 18
B	(30–16)/ ($T_{design\ c} - 16$)	74	26 / ^b	10 / ^b	45 / ^b	30	^a / 7	^a / 8,5	^a / 18
C	(25–16)/ ($T_{design\ c} - 16$)	47	22 / ^b	10 / ^b	40 / ^b	30	^a / 7	^a / 10	^a / 18
D	(20–16)/ ($T_{design\ c} - 16$)	21	18 / ^b	10 / ^b	35 / ^b	30	^a / 7	^a / 11,5	^a / 18
^a With the flow rate as determined during “A” test for units with a fixed flow rate or with a fixed delta T of 5 K for units with a variable flow rate. If for any of the test conditions the resulting flow rate is below the minimum flow rate then this minimum flow rate is used as a fixed flow rate with the outlet temperature for this test condition. ^b With the flow rate as determined during “A” test for units with a fixed flow rate or with a fixed delta T of 5 K for units with a variable flow rate. If for any of the test conditions the resulting flow rate is below the minimum flow rate then this minimum flow rate is used as a fixed flow rate with the inlet temperature for this test condition. ^c if the variable outlet temperature is above the maximum of the operating range of the unit, this maximum should be considered.									

5 Calculation methods for seasonal space cooling efficiency $\eta_{s,c}$, *SEER* and *SEER_{on}*

5.1 General

For units, except multi-split air-to-air units > 12 kW cooling capacity at standard rating conditions and multi-split water (brine)-to-air, the calculation method as described below shall be used.

Where related to multi-split air-to-air units > 12 kW and multi-split water(brine)-to-air the calculations shall be based on the rating of the outdoor unit as described in Annex N.

5.2 Calculation of the seasonal space cooling efficiency $\eta_{s,c}$

The seasonal space cooling efficiency $\eta_{s,c}$ expressed in %, is defined as given in Formula (1)

$$\eta_{s,c} = \frac{1}{CC} \times SEER - \sum F(i) \quad (1)$$

where

CC	is the conversion coefficient, equal to 2,5
SEER	is the Seasonal Energy Efficiency Ratio (see 5.3)
$\Sigma F(i)$	is the correction calculated according to Formula (2):
$\Sigma F(i) = F(1) + F(2)$	(2)

where

$F(1)$	is the correction that accounts for a negative contribution to the seasonal energy efficiency ratio due to adjusted contributions of temperature controls, equal to 3 %;
$F(2)$	is the correction that accounts for the negative contribution to the seasonal energy efficiency ratio by energy consumption of ground water (brine) pumps. This factor is only for water(brine)-to-water(brine) and water(brine)-to-air units and is equal to 5 %.

5.3 General formula for calculation of SEER

The *SEER* is defined as reference annual cooling demand Q_c divided by the annual energy consumption for cooling Q_{CE} according to Formula (3):

$$SEER = \frac{Q_c}{Q_{CE}} \quad (3)$$

where

Q_c	is the reference annual cooling demand expressed in kWh;
Q_{CE}	is the annual energy consumption for cooling expressed in kWh.

The climate conditions and all hours to be used for *SEER* calculations for air-to-air units ≤ 12 kW are given in Annex A.

The climate conditions and all hours to be used for *SEER* calculations for air-to-air units > 12 kW, water(brine)-to-air units and comfort chillers are given in Annex D.

5.4 Calculation of the reference annual cooling demand Q_c

The reference annual cooling demand Q_c is expressed in kWh and is calculated according to Formula (4):

$$Q_c = P_{desingc} \times H_{CE} \quad (4)$$

where

- P_{designc} is the design cooling load of the building the unit is suitable for as declared by the manufacturer, expressed in kW;
- H_{CE} is the number of equivalent active mode hours for cooling, expressed in hours. For air-to-air units < 12 kW, the number is given in Annex A. For air-to-air units > 12 kW and for water(brine)-to-air units, the numbers are given in Annex D ("On mode hours").

5.5 Calculation of the reference annual energy consumption for cooling Q_{CE}

The annual energy consumption for cooling Q_{CE} , expressed in kW, includes the energy consumption during active mode, thermostat-off mode, standby mode, off mode and that of the crankcase heater and is calculated according to Formula (5).

The energy consumption during active mode is derived from the calculation of $SEER_{\text{on}}$. For determination of $SEER_{\text{on}}$, see 5.6.

$$Q_{\text{CE}} = \frac{Q_{\text{C}}}{SEER_{\text{on}}} + H_{\text{TO}} \times P_{\text{TO}} + H_{\text{SB}} \times P_{\text{SB}} + H_{\text{CK}} \times P_{\text{CK}} + H_{\text{OFF}} \times P_{\text{OFF}} \quad (5)$$

where

- Q_{C} is the reference annual cooling demand, expressed in kWh;
- $SEER_{\text{on}}$ is the active mode seasonal energy efficiency ratio
- $H_{\text{TO}}, H_{\text{SB}}, H_{\text{CK}}, H_{\text{OFF}}$ are the numbers of hours the unit is considered to work in thermostat-off mode, standby mode, crankcase heater mode and off mode respectively, expressed in h;
- $P_{\text{TO}}, P_{\text{SB}}, P_{\text{CK}}, P_{\text{OFF}}$ are the power inputs during thermostat-off mode, standby mode, crankcase heater mode and off mode respectively, expressed in kW.

5.6 Calculation of $SEER_{\text{on}}$

The $SEER_{\text{on}}$ is determined according to Formula (6).

$$SEER_{\text{on}} = \frac{\sum_{j=1}^n h_j \times P_c(T_j)}{\sum_{j=1}^n h_j \left(\frac{P_c(T_j)}{EER_{\text{bin}}(T_j)} \right)} \quad (6)$$

where

- T_j is the bin temperature;
- j is the bin number;
- n is the total number of bins;
- $P_c(T_j)$ is the cooling load for the corresponding temperature T_j , in kW;
- h_j is the number of bin hours occurring at the corresponding temperature T_j ;
- $EER_{\text{bin}}(T_j)$ is the EER value of the unit for the corresponding temperature T_j .

The cooling load $P_c(T_j)$ is determined by multiplying the design load value (P_{designc}) with the part load ratio for each corresponding bin. This part load ratio is calculated according to Formula (7):

$$pl(T_j) = (T_j - 16) / (35 - 16) \quad (7)$$

The EER values and capacity values at each bin are determined via interpolation of the EER_{bin} and capacity values at part load conditions A, B, C and D. Interpolation of EER_{bin} and capacities are done between with the two closest part load conditions (as mentioned in the tables of Clause 4).

For part load conditions above part load condition A, the same EER values as for condition A are used.

For part load conditions below part load condition D, the same EER values as for condition D are used.

5.7 Calculation procedure for determination of EER_{bin} values at part load conditions A, B, C, D

5.7.1 General

In part load condition A (design load), the declared capacity of a unit is considered to be equal to the cooling load ($P_{designc}$). The EER_{bin} is then the EER corresponding to $P_{designc}$. In part load conditions B, C and D, there can be two possibilities:

- if the declared capacity of a unit is matching with the required cooling load, the corresponding EER_d shall be considered as EER_{bin} . This may occur with staged or variable capacity units (see 5.7.3);
- if the declared capacity of a unit is higher than the required cooling load, the unit has to cycle on/off. This may occur with fixed capacity or staged or variable capacity units. In such cases, a degradation coefficient (Cd) has to be used to calculate the corresponding EER_{bin} value. Such calculation is explained below.

In that case, the capacity ratio (CR) is required. CR is the ratio of the cooling load (P_c) over the declared capacity (P_{dc}) of the unit at the same temperature conditions (see Formula (8)).

$$CR = pl(T_j) \times \frac{P_{designc}}{P_{dc}} \quad (8)$$

where

$pl(T_j)$	is the Part Load Ratio as given in (7)
$P_{designc}$	is the cooling design load, expressed in kW
P_{dc}	is the declared capacity of the unit at the same temperature conditions as for part load conditions B, C and D, expressed in kW

NOTE If the value of CR is higher than 1 then CR is equal to 1.

5.7.2 Calculation procedure for fixed capacity units

5.7.2.1 Air-to-air and water(brine)-to-air units

For each part load condition B, C and D, the EER_{bin} is calculated according to Formula (9):

$$EER_{bin} = EER_d \times (1 - Cd \times (1 - CR)) \quad (9)$$

where

EER_d is the EER corresponding to the declared capacity (P_{dc}) of the unit at the same temperature conditions as for part load conditions B, C and D;

Cd is the degradation coefficient for cooling mode;

CR is the capacity ratio.

For determination of the Cd value, see 11.5.2. If Cd is not determined by test then the default degradation coefficient Cd shall be 0,25.

5.7.2.2 Air-to-water(brine), water(brine)-to-water(brine)

For each part load conditions B, C and D, the EER_{bin} is calculated according to Formula (10):

$$EER_{bin} = EER_d \times \frac{CR}{Cd \times CR + (1 - Cd)} \quad (10)$$

where

EER_d is the EER corresponding to the declared capacity (P_{dc}) of the unit at the same temperature conditions as for part load conditions B, C and D;

Cd is the degradation coefficient for cooling mode;

CR is the capacity ratio.

For determination of the Cd value, see 11.5.3. If Cd is not determined by test then the default degradation coefficient Cd shall be 0,9.

5.7.3 Calculation procedure for staged and variable capacity units

Determine the declared capacity and EER_d at the closest step or increment of the capacity control of the unit to reach the required cooling load. If this step allows to reach the required cooling load within $\pm 10\%$ (e.g. between 9,9 kW and 8,1 kW for a required cooling load of 9 kW), the target capacity is considered as achieved and the measured EER shall be used as EER_{bin} . If this step does not allow to reach the required cooling part load within $\pm 10\%$, determine the capacity and the effective power input at the defined part load temperatures for the step on the other side of the required cooling load. The part load power input at the required cooling part load is then determined by linear interpolation between the results obtained from these two steps. The EER_{bin} is then determined by the required cooling part load divided by the interpolated part load power input.

For air-to-air and water(brine)-to-air units, if the smallest control step of the unit exceeds the required cooling load by more than 10 % the EER_d at the required part load ratio is calculated using Formula (9) as for fixed capacity units.

For air-to-water(brine), water(brine)-to-water(brine) and DX-to-water(brine) units, if the smallest control step of the unit exceeds the required cooling load by more than 10 % the EER_d at the required part load ratio is calculated using Formula (10) as for fixed capacity units.

6 Part load conditions for space heating

6.1 General

For the purpose of calculation of $SCOP/SCOP_{on}/SCOP_{net}$ as explained in Clause 8, the part load ratios mentioned below shall be based on the part load ratio formulas and not on the rounded values given for each climate in the following tables.

For the purpose of $SCOP$ and $SCOP_{on}/SCOP_{net}$, there are three reference design conditions: average (A), warmer (W) and colder (C).

The relevant $T_{designh}$ values are defined as follows:

- Average climate: dry bulb temperature conditions at -10 °C outdoor temperature and 20 °C indoor temperature;
- Colder climate: dry bulb temperature conditions at -22 °C outdoor temperature and 20 °C indoor temperature;
- Warmer climate: dry bulb temperature conditions at $+2\text{ °C}$ outdoor temperature and 20 °C indoor temperature,

For outdoor air dry bulb temperatures higher or equal to -10 °C the wet bulb temperature equals the dry bulb temperature minus 1 K. For dry bulb temperatures below -10 °C , the wet bulb temperature is not defined.

For heat pumps, the relevant T_{biv} is defined as follows:

- for the average heating season, the dry bulb bivalent temperature is $+2\text{ °C}$ or lower;
- for the colder heating season, the dry bulb bivalent temperature is -7 °C or lower;
- for the warmer heating season, the dry bulb bivalent temperature is $+7\text{ °C}$ or lower;

For heat pumps, the relevant TOL is defined as follows:

- for the average heating season, the dry bulb temperature is -7 °C or lower;
- for the colder heating season, the dry bulb temperature is -15 °C or lower;
- for the warmer heating season, the dry bulb temperature is $+2\text{ °C}$ or lower;

If the declared TOL is lower than the $T_{designh}$ of the considered climate, then the outdoor dry bulb temperature is equal to $T_{designh}$ for the part load condition E in Table 6, Tables 8 to 11.

In case of colder climate and if TOL is below -20 °C , an additional part load condition G at -15 °C shall apply for air-to-air and air-to-water heat pumps.

For hybrid heat pumps:

- T_{biv} is not applicable but replaced by $T_{fb,off}$, the temperature above which the fossil boiler is switched off. The limitation for T_{biv} does not apply to $T_{fb,off}$.
- TOL is not applicable but replaced by $T_{hp,off}$, the temperature below which the heat pump is switched off. If the declared $T_{hp,off}$ is lower than $T_{designh}$ of the considered climate then $T_{hp,off}$ shall be considered equal to $T_{designh}$.

6.2 Air-to-air units

For outdoor air-to-recycled air units, the part load conditions for determining the declared capacity P_{dh} and the declared coefficient of performance COP_d are given in Table 6:

Table 6 — Part load conditions for outdoor air-to-recycled air units for the reference heating seasons

“A” = average, “W” = warmer and “C” = colder

Condition	Part Load Ratio in %				Outdoor heat exchanger	Indoor heat exchanger
	Formula	A	W	C	Inlet dry (wet) bulb temperature °C	Indoor air dry bulb temperature °C
A	$(-7 - 16) / (T_{\text{designh}} - 16)$	88	n/a	61	-7(-8)	20
B	$(+2 - 16) / (T_{\text{designh}} - 16)$	54	100	37	2(1)	20
C	$(+7 - 16) / (T_{\text{designh}} - 16)$	35	64	24	7(6)	20
D	$(+12 - 16) / (T_{\text{designh}} - 16)$	15	29	11	12(11)	20
E	$(TOL - 16) / (T_{\text{designh}} - 16)$				<i>TOL</i>	20
F	$(T_{\text{biv}} - 16) / (T_{\text{designh}} - 16)$				<i>T_{biv}</i>	20
G	$(-15 - 16) / (T_{\text{designh}} - 16)$	n/a	n/a	82	-15	20

6.3 Water(brine)-to-air-units

The part load conditions for determining declared capacity (*Pdh*) and the declared coefficient of performance *COP_d* are given in Table 7:

Table 7 — Part load conditions for water(brine)-to-air units for the reference heating seasons
“A” = average, “W” = warmer and “C” = colder

Condition	Part Load Ratio in %				Outdoor heat exchanger inlet / outlet temperature			Indoor heat exchanger
	Formula	A	W	C	Water °C	Brine °C	Water loop °C	Dry bulb °C
A	$(-7 - 16) / (T_{\text{designh}} - 16)$	88	n/a	61	10 / ^a	0 / ^a	20/ ^a	20
B	$(+2 - 16) / (T_{\text{designh}} - 16)$	54	100	37	10 / ^a	0 / ^a	20/ ^a	20
C	$(+7 - 16) / (T_{\text{designh}} - 16)$	35	64	24	10 / ^a	0 / ^a	20/ ^a	20
D	$(+12 - 16) / (T_{\text{designh}} - 16)$	15	29	11	10 / ^a	0 / ^a	20/ ^a	20
E	$(T_{\text{designh}} - 16) / (T_{\text{designh}} - 16)$	100	100	100	10 / ^a	0 / ^a	20/ ^a	20
F	$(T_{\text{biv}} - 16) / (T_{\text{designh}} - 16)$				10 / ^a	0 / ^a	20/ ^a	20

^a With the flow rate as determined at the standard rating conditions of EN 14511-2 for units with a fixed flow rate or with a fixed delta T of 3 K for units with a variable flow rate. If for any of the test conditions the resulting flow rate is below the minimum flow rate then this minimum flow rate is used as a fixed flow rate with the inlet temperature for this test condition.

6.4 Air-to-water(brine) units

6.4.1 General

The part load conditions for determining the declared capacity (P_{dh}) and the declared coefficient of performance (COP_d) are given in Table 8, Table 9, Table 10 and Table 11.

The variable outlet temperature ($T_{\text{outlet,average}}$) shall only be applied when the control provides an outdoor air temperature dependant modification of the outlet temperature.

For units with variable outlet that have to cycle on/off to reach the required part load ratio the inlet and outlet temperatures of the indoor heat exchanger shall be determined according to Formula (35) in 11.5.1.

For hybrid heat pumps T_{biv} and TOL mentioned in Table 8, Table 9, Table 10 and Table 11 of part load conditions shall be replaced by $T_{\text{fb,off}}$ and $T_{\text{hp,off}}$ respectively as explained in 6.1. For hybrid heat pumps using the combined test method (see 8.6.2.2) in case $T_{\text{hp,off}}$ is greater than T_{designh} an additional part load condition at T_{designh} is required.

6.4.2 Low temperature application

Table 8 — Part load conditions for air-to-water(brine) units in low temperature application for the reference heating seasons “A” = average, “W” = warmer and “C” = colder

Condition	Part Load Ratio in %				Outdoor heat exchanger		Indoor heat exchanger			
					Inlet dry (wet) bulb temperature °C		Fixed outlet °C	Variable outlet ^d °C		
	Formula	A	W	C	Outdoor air	Exhaust air	All climates	A	W	C
A	$(-7 - 16) / (T_{\text{designh}} - 16)$	88	n/a	61	-7(-8)	20(12)	a / 35	a / 34	n/a	a / 30
B	$(+2 - 16) / (T_{\text{designh}} - 16)$	54	100	37	2(1)	20(12)	a / 35	a / 30	a / 35	a / 27
C	$(+7 - 16) / (T_{\text{designh}} - 16)$	35	64	24	7(6)	20(12)	a / 35	a / 27	a / 31	a / 25
D	$(+12 - 16) / (T_{\text{designh}} - 16)$	15	29	11	12(11)	20(12)	a / 35	a / 24	a / 26	a / 24
E	$(TOL - 16) / (T_{\text{designh}} - 16)$				TOL	20(12)	a / 35	a / b	a / b	a / b
F	$(T_{\text{biv}} - 16) / (T_{\text{designh}} - 16)$				T_{biv}	20(12)	a / 35	a / c	a / c	a / c
G	$(-15 - 16) / (T_{\text{designh}} - 16)$	n/a	n/a	82	-15	20(12)	a / 35	n/a	n/a	a / 32

^a With the flow rate as determined at the standard rating conditions given in EN 14511-2 at 30/35 conditions for units with a fixed flow rate, and with a fixed delta T of 5 K for units with a variable flow rate. If for any of the test conditions the resulting flow rate is below the minimum flow rate then this minimum flow rate is used as a fixed flow rate with the outlet temperature for this test condition.

^b Variable outlet shall be calculated by interpolation from T_{designh} and the temperature which is closest to the TOL.

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

^d If the variable outlet temperature is below the minimum of the operation range of the unit, this minimum should be considered.

6.4.3 Intermediate temperature application

Table 9 — Part load conditions for air-to-water(brine) units in intermediate temperature application for the reference heating seasons “A” = average, “W” = warmer and “C” = colder

Condition	Part Load Ratio in %				Outdoor heat exchanger		Indoor heat exchanger			
					Inlet dry (wet) bulb temperature °C		Fixed outlet °C	Variable outlet ^d °C		
	Formula	A	W	C	Outdoor air	Exhaust air	All climates	A	W	C
A	$(-7 - 16) / (T_{\text{designh}} - 16)$	88	n/a	61	-7(-8)	20(12)	^a / 45	^a / 43	n/a	^a / 38
B	$(+2 - 16) / (T_{\text{designh}} - 16)$	54	100	37	2(1)	20(12)	^a / 45	^a / 37	^a / 45	^a / 33
C	$(+7 - 16) / (T_{\text{designh}} - 16)$	35	64	24	7(6)	20(12)	^a / 45	^a / 33	^a / 39	^a / 30
D	$(+12 - 16) / (T_{\text{designh}} - 16)$	15	29	11	12(11)	20(12)	^a / 45	^a / 28	^a / 31	^a / 26
E	$(TOL - 16) / (T_{\text{designh}} - 16)$				<i>TOL</i>	20(12)	^a / 45	^a / ^b	^a / ^b	^a / ^b
F	$(T_{\text{biv}} - 16) / (T_{\text{designh}} - 16)$				<i>T_{biv}</i>	20(12)	^a / 45	^a / ^c	^a / ^c	^a / ^c
G	$(-15 - 16) / (T_{\text{designh}} - 16)$	n/a	n/a	82	-15	20(12)	^a / 45	n/a	n/a	^a / 41

^a With the flow rate as determined at the standard rating conditions given in EN 14511-2 at 40/45 conditions for units with a fixed flow rate, and with a fixed delta *T* of 5 K for units with a variable flow rate. If for any of the test conditions the resulting flow rate is below the minimum flow rate then this minimum flow rate is used as a fixed flow rate with the outlet temperature for this test condition.

^b Variable outlet shall be calculated by interpolation from *T_{designh}* and the temperature which is closest to the *TOL*.

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

^d If the variable outlet temperature is below the minimum of the operation range of the unit, this minimum should be considered.