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This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Rooftop units - Testing and rating at standard rating conditions and part load conditions for calculation of seasonal performance

Unités de toiture - Essais et détermination des performances nominales et à charge partielle pour le calcul de performances saisonnières

Dachgeräte - Prüfung und Bewertung unter Standardbedingungen und Teillastbedingungen zur Berechnung der jahreszeitlichen Leistung

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European foreword

This document (prEN 17625:2024) has been prepared by Technical Committee CEN/TC 113 “Heat pumps and air conditioning units”, the secretariat of which is held by UNE.

This document is currently submitted to the CEN Enquiry.

1 Scope

This document specifies the terms and definitions, the test conditions, and the test methods for rating the performance of rooftop units with electrically driven compressor(s), which may be equipped with a supplementary heater using electrical resistance or combustion of fossil fuel.

This document covers air-to-air units with integrated indoor and outdoor fans as well as water(brine)-to-air units with integrated indoor fan(s) and integrated or not liquid pump.

This document covers rooftop units with 2, 3 or 4 dampers, including several features as the free cooling, mixing air flows (on both sides) and internal heat recovery. Illustrations of rooftop unit configurations are given in Annex A.

Rooftop units with remote condensers are not in the scope of this document.

This document deals with rooftop units providing space heating and/or cooling for comfort application. Process applications are not covered by this document.

This document provides the part load conditions and the calculation methods taking into account rooftop units features, such as free cooling and air flow mixtures, for the determination of seasonal energy efficiencies $SEER$, $SEER_{on}$ and $SEER_F$, seasonal space cooling energy efficiency $\eta_{s,c}$, seasonal coefficients of performance $SCOP$, $SCOP_{on}$ and $SCOP_{net}$, seasonal space heating energy efficiency $\eta_{s,h}$ and the overall annual efficiency. The informative Annex B provides additional definitions for the determination of $SEER_{OA}$ and $SCOP_{OA}$ performance indexes dealing with space cooling/heating while working with a minimum mixture of outdoor air and recycled air.

Such calculation methods may 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 the determination of power input during thermostat-off mode, standby mode, off-mode and crankcase heater mode.

A rooftop unit that is not using at least the thermodynamic cycle for space heating is considered as a cooling only unit.

For the purpose of this document, rooftop units equipped with additional air heating and/or cooling heat exchangers are rated without operation of these heat exchangers.

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 14511-1:2022, *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 14511-3:2022, *Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors - Part 3: Test methods*

3 Terms, definitions, symbols, abbreviated terms and units

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1.1

exhaust air

air from the air conditioned space entering the outdoor heat exchanger

3.1.2

recycled air

air from the air conditioned space entering the indoor heat exchanger

3.1.3

extracted air

air removed from the conditioned space and rejected outdoors without entering the indoor nor the outdoor heat exchanger

Note 1 to entry: The extracted air may be entering a heat recovery device to enhance the efficiency of the unit.

3.1.4

outdoor air

air from the outdoor environment

3.1.5

supply air

air leaving the indoor heat exchanger for entering the space that is to be air conditioned

3.1.6

rooftop

air conditioning unit which main function is space cooling or heating, or both, using a vapour compression cycle driven by electric compressor(s) and in which the evaporator, compressor, condenser and supplementary heaters are integrated into a single package

Note 1 to entry: Rooftop units use recycled air or a mixture of recycled air and outdoor air on the indoor heat exchanger, and outdoor air or a mixture of outdoor air and extracted air on the outdoor heat exchanger, with capability of free cooling and may be equipped with a heat recovery system to benefit from the extracted air.

Note 2 to entry: Air mixtures ratio can vary from 0 % to 100 %.

Note 3 to entry: It can have means for cleaning and/or dehumidifying the air.

3.1.7

single-package rooftop

factory-made assembly constituting a unique functional unit provided by the manufacturer, that can be provided on one or two separate frames

3.1.8**2-damper rooftop**

rooftop including indoor fan(s) for air supply, one damper on the recycled air circuit and one damper on the outdoor air circuit that allow to vary the ratio of outdoor air into the indoor heat exchanger from 0 % to 100 %

Note 1 to entry: See Figure A.1.

3.1.9**3-damper rooftop**

rooftop including fan(s) for air supply and fan(s) for air extraction, one damper on the recycled air circuit, one damper on the outdoor air circuit and a third damper on the extract air circuit ahead of the air extraction fan, with both fans functioning simultaneously that allow to vary the ratio of outdoor air into the indoor heat exchanger from 0 % to 100 %

Note 1 to entry: The extracted air can be mixed with outdoor air before entering the outdoor heat exchanger.

Note 2 to entry: See Figures A.2 and A.3.

3.1.10**4-damper rooftop**

rooftop equipped with four dampers for providing mixtures of outdoor air and exhaust air at the inlet of both outdoor and indoor heat exchangers that allow to vary independently the ratio of outdoor air entering both heat exchangers from 0 % to 100 %

Note 1 to entry: See Figures A.4 and A.5.

3.1.11**space heating mode**

operation of the rooftop providing space heating by means of the thermodynamic cycle and supplementary heater, where relevant

3.1.12**space cooling mode**

operation of the rooftop providing space cooling by means of the active cooling or free cooling, where relevant

3.1.13**active cooling**

operation of the rooftop in which the cooling capacity is only provided by the use of thermodynamic cycle

3.1.14**free cooling**

operation mode of the rooftop in which the cooling capacity is partially or totally provided by direct supply of outdoor air or of a mixture of outdoor air/recycled air to air-conditioned space, with or without using the thermodynamic cycle

3.1.15**supplementary heater**

any hot water coil, electrical, or fossil fuel heater that is used to provide the missing heating capacity of the thermodynamic cycle and considered in the calculation of seasonal performance regardless whether it is integrated in the rooftop or not

3.1.16

heat recovery device

any device capable to recover an amount of energy from the extracted air for the purpose of improving the overall rooftop efficiency

3.1.17

free cooling temperature

T_{free}

highest outdoor temperature at which the thermodynamic cycle is switched off and the cooling capacity is provided by outdoor air or a mixture of outdoor and recycled air only

Note 1 to entry: For temperatures below or equal than T_{free} , the thermodynamic cycle is switched off.

Note 2 to entry: T_{free} , is declared by the manufacturer of the rooftop.

3.1.18

active mode

mode corresponding to the hours with a space 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.

3.1.19

active mode seasonal coefficient of performance

$SCOP_{\text{on}}$

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 ($COP_{\text{bin}}(T_j)$) and weighted by the bin hours where the bin condition occurs

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

3.1.20

active mode seasonal energy efficiency ratio

$SEER_{\text{on}}$

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

Note 1 to entry: For calculation of $SEER_{\text{on}}$, the 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.

3.1.21**annual energy consumption for space cooling** Q_{CE}

energy consumption required to meet the reference annual space 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.

3.1.22**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.

3.1.23**average climate conditions**

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

3.1.24**bin** j

outdoor temperature interval of 1 K

3.1.25**bin hours** h_j

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

3.1.26**bin limit temperature**

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

Note 1 to entry: Expressed in °C.

Note 2 to entry: The bin limit temperature equals 16 °C for all climates in space cooling and space heating applications.

3.1.27**conversion coefficient** CC

coefficient for power generation efficiency

Note 1 to entry: The value of CC to apply can be found in the relevant regulation, or is 2.5 by default.

3.1.28**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

3.1.29

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

3.1.30

bin temperature

T_j

outdoor air dry bulb temperature at bin j

Note 1 to entry: Expressed in °C.

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

3.1.31

bivalent temperature

T_{biv}

lowest outdoor bin 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: Expressed in °C.

Note 2 to entry: Below this temperature, the unit may still provide capacity, but additional supplementary heating is necessary to fulfil the full heating load.

Note 3 to entry: The value of T_{biv} is an integer value.

3.1.32

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.

3.1.33

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

Note 1 to entry: Expressed in kW/kW.

3.1.34

climate conditions

temperature conditions characteristic for a specific location

3.1.35

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

3.1.36**coefficient of performance at part load** **COP_{bin}** coefficient of performance COP_d , corrected with the degradation coefficient, where applicable

Note 1 to entry: Expressed in kW/kW.

3.1.37**colder climate conditions**

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

3.1.38**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.

3.1.39**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.

3.1.40**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

3.1.41**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.

3.1.42**cycling interval capacity for heating** **P_{cyh}**

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

Note 1 to entry: Expressed in kW.

3.1.43**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.

3.1.44

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.

3.1.45

declared capacity

cooling (P_{dc}) or heating (P_{dh}) capacity a unit can provide at any temperature condition A, B, C, C', D, E1, E2, E, F or G, as declared by the manufacturer

Note 1 to entry: Expressed in kW.

Note 2 to entry: This is the capacity provided by the rooftop running in the active mode or free cooling mode without supplementary heaters, even if those are integrated in the unit.

3.1.46

degradation coefficient for cooling mode

C_{dc}

measure of efficiency loss due to the cycling for cooling mode

Note 1 to entry: If C_{dc} is not determined by measurement then the default degradation coefficient is 0,25.

3.1.47

degradation coefficient for heating mode

C_{dh}

measure of efficiency loss due to the cycling for heating mode

Note 1 to entry: If C_{dh} is not determined by measurement then the default degradation coefficient is 0,25.

3.1.48

electric supplementary heater

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

3.1.49

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.

3.1.50

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 or C', D, E1 and E2 where applicable

Note 1 to entry: Expressed in kW/kW.

3.1.51**energy efficiency ratio at part load** **EER_{bin}** energy efficiency ratio EER_d , corrected with the degradation coefficient, where applicable

Note 1 to entry: Expressed in kW/kW.

3.1.52**equivalent active mode hours for cooling** **H_{CE}** assumed annual number of hours the unit must provide the design load for space cooling ($P_{designc}$) in order to satisfy the reference annual space cooling demand

Note 1 to entry: Expressed in h.

3.1.53**equivalent active mode hours for heating** **H_{HE}** assumed annual number of hours the unit must provide the design load for heating ($P_{designh}$) in order to satisfy the reference annual heating demand

Note 1 to entry: Expressed in h.

3.1.54**fossil fuel supplementary heater**fossil fuel supplementary heater supplied together with the unit and considered in the calculation of $SCOP$ and $SCOP_{on}$ **3.1.55****fossil fuel heater efficiency** **η_{ssup}**

seasonal space heating energy efficiency of a fossil fuel heater, used either as a supplementary heater to fulfil the heating load at temperatures below the bivalent temperature

Note 1 to entry: Expressed in %.

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

Note 2 to entry: Expressed in kW.

3.1.57**information or status display**

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

3.1.58

net seasonal coefficient of performance

$SCOP_{net}$

seasonal coefficient of performance of a unit in active mode without supplementary heaters which is determined from mandatory conditions given in this document

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.

3.1.59

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.

3.1.60

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, type of unit and operating mode(s)

Note 1 to entry: Expressed in h.

3.1.61

off mode power input

P_{OFF}

power input of the unit while in off mode

Note 1 to entry: Expressed in W.

3.1.62

operation limit temperature

TOL

outdoor bin temperature below which the unit will not be able to deliver any heating capacity and the declared capacity is equal to zero

Note 1 to entry: Expressed in °C.

3.1.63

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.

3.1.64**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.

3.1.65**part load ratio** **$p_l(T_j)$**

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

3.1.66**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

3.1.67**reference annual cooling demand** **Q_c** reference cooling demand to be used as basis for calculation of $SEER/SEER_F$ 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

3.1.68**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.

3.1.69**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 and for which the unit is declared fit for purpose

3.1.70**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

3.1.71

reference design conditions for space heating

T_{designh}

temperature conditions for average, colder and warmer climates

Note 1 to entry: Expressed in °C.

3.1.72

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 and 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.

3.1.73

seasonal coefficient of performance

SCOP

overall coefficient of performance of the unit, representative for the whole designated heating season for units with no free cooling capabilities running at 100% recycled air

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

Note 2 to entry: Expressed in kWh/kWh.

3.1.74

seasonal energy efficiency ratio

SEER

overall energy efficiency ratio of the unit, representative for the whole cooling season for units with no free cooling capabilities running at 100% recycled air

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

Note 2 to entry: Expressed in kWh/kWh.

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, 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 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 $elbu(T_j)$.**3.1.79****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 space heater or the space cooling unit such as a central processing unit, thus helping to regulate the indoor temperature(s)

3.1.80**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.

3.1.81**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, type of unit and operating mode(s)

Note 1 to entry: Expressed in h.

3.1.82**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.

3.1.83**warmer climate conditions**

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

3.1.84

available external static pressure difference

Δ_{pe}

positive pressure difference measured between the air (or water) outlet section and the air (or water) inlet section of the unit, which is available for overcoming the pressure drop of any additional ducted air (or water) circuit

Note 1 to entry: Expressed in Pa.

3.1.85

seasonal energy efficiency ratio in free cooling mode

$SEER_F$

overall energy efficiency ratio of the unit, representative for the whole cooling season for units with free cooling capabilities running at 100% recycled air above T_{free} temperature

Note 1 to entry: $SEER_F$ is calculated as the reference annual cooling demand Q_c divided by the annual energy consumption for cooling $Q_{CE,F}$.

Note 2 to entry: Expressed in kWh/kWh.

3.1.86

outdoor air ratio

OAR

ratio of outdoor air volume and supply air volume at standard air conditions

3.1.87

active mode seasonal energy efficiency ratio in free cooling mode

$SEER_{on,F}$

average energy efficiency ratio of the unit in active mode for the space cooling function and with free cooling capabilities running at 100% recycled air above T_{free} temperature, 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 $SEER_{on,F}$, the 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.

3.1.88

annual energy consumption for space cooling in free cooling mode

$Q_{CE,F}$

energy consumption required to meet the reference annual space cooling demand including free cooling mode and calculated as the reference annual space cooling demand divided by the active mode seasonal energy efficiency ratio in free cooling mode ($SEER_{on,F}$) 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.

3.2 Symbols, abbreviated terms and units

Table 1 provides the symbols, abbreviated terms and units as used in this document.

Table 1 — Symbols, abbreviated terms and units

Symbols and abbreviated terms	Denomination	Units
CC	Coefficient for electricity generation efficiency	—
C_{dc}	Degradation coefficient for cooling mode	—
C_{dh}	Degradation coefficient for heating mode	—
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
CR	Capacity ratio	kW/kW
EER	Energy efficiency ratio	kW/kW
EER_d	Energy efficiency ratio at the declared capacity	kW/kW
EER_{bin}	Energy efficiency ratio at part load	kW/kW
$EER_{bin}(T_j)$	Bin-specific energy efficiency ratio	kW/kW
EER_{cyc}	Cycling interval efficiency for cooling	kWh/kWh
$elbu$	Required capacity of an electric supplementary heater	kW
$elbu(T_j)$	Required capacity of an electric supplementary heater for the corresponding temperature T_j	kW
h_j	Bin hours	h
OAR	Outdoor air ratio	%
H_{CE}	Equivalent active mode hours for cooling	h
H_{HE}	Equivalent active mode hours for heating	h
H_{CK}	Crankcase heater mode operating hours	h
H_{OFF}	Off mode operating hours	h
H_{SB}	Standby mode operating hours	h
H_{TO}	Thermostat-off mode operating hours	h
j	Bin number	—
n	Total number of bins	—
$P_c(T_j)$	Part load for cooling	kW
P_{CK}	Crankcase heater mode power input	W
P_{cyc}	Cycling interval capacity for cooling	kW

Symbols and abbreviated terms	Denomination	Units
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
$P_{designh}$	Design load heating	kW
$P_h(T_j)$	Part load for heating	kW
P_{OFF}	Off mode power input	W
P_{SB}	Standby mode power input	W
P_{TO}	Thermostat-off mode power input	W
$pl(T_j)$	Part load ratio for bin 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
$SCOP$	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
$SEER_F$	Seasonal energy efficiency ratio in free cooling mode	kWh/kWh
$SEER_{on}$	Active mode seasonal energy efficiency ratio	kWh/kWh
$sup(T_j)$	Supplementary capacity for heating	kW
T_{biv}	Bivalent temperature	°C
$T_{designc}$	Reference design temperature conditions for space cooling	°C
$T_{designh}$	Reference design temperature conditions for space heating	°C
T_{free}	Free cooling temperature	°C
T_j	Bin temperature / outdoor temperature	°C
TOL	Operation limit temperature	°C
η_{ssup}	Seasonal space heating energy efficiency of fossil fuel heater	%

4 Test conditions

4.1 Standard rating conditions

The standard rating conditions for rooftop units are given in Tables 2 and 3.

Table 2 — Standard rating conditions – Air-to-air rooftop units

	Outdoor heat exchanger			Indoor heat exchanger		
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Air flow mixture	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Air flow mixture
Heating mode	7	6	100 % outdoor air	20	15 max	100 % recycled air
Cooling mode	35	—	100 % outdoor air	27	19	100 % recycled air

Table 3 — Standard rating conditions – Water-to-air rooftop units

		Outdoor heat exchanger		Indoor heat exchanger		
		Inlet water temperature °C	Outlet water temperature °C	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Air flow mixture
Heating mode	Water ^a	10	7	20	15 max	100 % recycled air
	Water loop	20	17	20	15 max	100 % recycled air
	Brine	0	–3	20	15 max	100 % recycled air
Cooling mode	Water	30	35	27	19	100 % recycled air
	Brine	10	15	27	19	100 % recycled air

^a The term “water” includes indifferently water from a river, a lake or ground water.

4.2 Part load conditions

4.2.1 General

This document allows the test of rooftop units under two different configurations, depending on capabilities or data exploitation requirements with regards to the use or not of free cooling capabilities:

- 1) Units running with no free cooling capabilities, running only at 100 % recycled air;
- 2) Units running with free cooling capabilities.

For units operating with minimum mixture of outdoor air and recycled air, the informative Annex B provides additional information to evaluate performances considering these mixtures

When temperature values are calculated, rounded values to the closest integer shall be used for testing.

The part load ratios mentioned below shall be based on the part load ratio formulas and not on the rounded values given in the Table 5 to Table 8.

Test conditions are specified in the Tables 5 to 8 and shall be combined with requirements from 4.2.2 to 4.2.4 when applicable.

4.2.2 Units running with no free cooling capabilities, running only at 100 % recycled air

100 % recycled air (0 % OAR) shall be used for all test conditions.

Seasonal performances shall be named *SEER* and *SCOP*.

4.2.3 Units running with free cooling capabilities

100 % recycled air (0 % OAR) shall be used for all test conditions, except for the cooling mode and the tests at outdoor temperatures T_{free} and below, where up to 100 % OAR configuration (free cooling) can be used.

Seasonal performances shall be named *SEER_F* and *SCOP*.

4.2.4 Cooling mode

Table 4 — Relationship between outdoor dry bulb and wet bulb temperatures

T_{DB}	35	34	33	32	31	30	29	28	27	26	25
T_{WB}	24	23	22	21	21	20	20	19	19	18	18
T_{DB}	24	23	22	21	20	19	18	17	16	15	14
T_{WB}	17	17	16	16	15	14	13	13	13	13	13

Table 5 — Part load conditions for air-to-air units for the cooling mode

	Part load ratio	Part load ratio	Outdoor air dry bulb temperature	Outdoor air wet bulb temperature	Recycled air dry bulb (wet bulb) temperatures
		%	°C	°C	°C
A	$(35-16)/(T_{\text{designc}}-16)$	100	35	See Table 4	27(19)
B	$(30-16)/(T_{\text{designc}}-16)$	74	30		27(19)
C'	$(27-16)/(T_{\text{designc}}-16)$	58	27		27(19)
C	$(25-16)/(T_{\text{designc}}-16)$	47	25		27(19)
D	$(20-16)/(T_{\text{designc}}-16)$	21	20		27(19)
E1	$([T_{\text{free}}+1]-16)/(T_{\text{designc}}-16)$	To be calculated	$T_{\text{free}}+1$		27(19)
E2	$(T_{\text{free}}-16)/(T_{\text{designc}}-16)$	To be calculated	T_{free}		27(19)

Table 6 — Part load conditions for water(brine)-to-air units for the cooling mode

	Part load ratio	Part load ratio	Cooling tower or water(brine) loop application Inlet/outlet temperatures	Ground water(brine) application Inlet/outlet temperatures	Outdoor air dry bulb temperature	Outdoor air wet bulb temperature	Recycled air dry bulb (wet bulb) temperatures
		%	°C	°C	°C	°C	°C
A	$(35-16)/(T_{\text{designc}}-16)$	100	30/35	10/15	35	See Table 4	27(19)
B	$(30-16)/(T_{\text{designc}}-16)$	74	26/ ^a	10/ ^a	30		27(19)
C'	$(27-16)/(T_{\text{designc}}-16)$	58	23,6/ ^a	10/ ^a	27		27(19)
C	$(25-16)/(T_{\text{designc}}-16)$	47	22/ ^a	10/ ^a	25		27(19)
D	$(20-16)/(T_{\text{designc}}-16)$	21	18/ ^a	10/ ^a	20		27(19)
E ₁	$[(T_{\text{free}}+1)-16]/(T_{\text{designc}}-16)$	To be calculated	^{a/b}	10/ ^a	$T_{\text{free}+1}$		27(19)
E ₂	$(T_{\text{free}}-16)/(T_{\text{designc}}-16)$	To be calculated	—	—	T_{free}		27(19)
^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 the resulting flow rate is below the minimum flow rate, then this minimum flow rate is used with the inlet temperature. ^b Inlet temperature shall be calculated by interpolation between the upper and lower outdoor temperatures which are closest to $T_{\text{free}+1}$.							

4.2.5 Heating mode

For the calculation of $SCOP$ and $SCOP_{\text{on}}/SCOP_{\text{net}}$, 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 for 20 °C indoor temperature.
- Colder climate: dry bulb temperature conditions at –22 °C outdoor temperature for 20 °C indoor temperature.
- Warmer climate: dry bulb temperature conditions at +2 °C outdoor temperature for 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:

- Average climate: the dry bulb temperature is +2 °C or lower;
- Colder climate: the dry bulb temperature is -7 °C or lower;
- Warmer climate: the dry bulb temperature is +7 °C or lower.

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

- Average climate: the dry bulb temperature is -7 °C or lower;
- Colder climate: the dry bulb temperature is -15 °C or lower;
- Warmer climate: the dry bulb temperature is +2 °C or lower.

If the declared TOL is lower than the $T_{designh}$ of the considered climate, then the outdoor dry bulb temperature for the part load condition E shall be $T_{designh}$ in Tables 7 and 8.

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 units.

Table 7 — Part load conditions for air-to-air units for the heating mode

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

Table 8 — Part load conditions for water(brine)-to-air units for the heating mode

Condition	Part Load Ratio %				Outdoor heat exchanger inlet / outlet temperature			Indoor heat exchanger
			Climate		Water ^a	Brine	Water loop	Recycled air dry bulb temperatur e
	Formula	Average	Warmer	Colder				
					°C	°C	°C	°C
A	$(-7 - 16) / (T_{\text{designh}} - 16)$	88	n/a	61	10 / ^b	0 / ^b	20/ ^b	20
B	$(+2 - 16) / (T_{\text{designh}} - 16)$	54	100	37	10 / ^b	0 / ^b	20/ ^b	20
C	$(+7 - 16) / (T_{\text{designh}} - 16)$	35	64	24	10 / ^b	0 / ^b	20/ ^b	20
D	$(+12 - 16) / (T_{\text{designh}} - 16)$	15	29	11	10 / ^b	0 / ^b	20/ ^b	20
E	$(T_{\text{designh}} - 16) / (T_{\text{designh}} - 16)$	100	100	100	10 / ^b	0 / ^b	20/ ^b	20
F	$(T_{\text{biv}} - 16) / (T_{\text{designh}} - 16)$				10 / ^b	0 / ^b	20/ ^b	20
^a The term “water” includes indifferently water from a river, a lake or ground water.								
^b With the flow rate as determined at the standard rating conditions of Table 3 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.								

5 Test apparatus

5.1 General requirements

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

5.2 Test room

The size of the test room shall be selected such that any resistance to air flow at the air inlet and air outlet orifices of the test object is avoided. The air flow through the room shall not be capable of initiating any short circuit between these two orifices, and therefore the velocity of the air flows through the room 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 or air outlet orifices shall be not less than 1 m distant from the surfaces of the test room.

Any direct heat radiation by heating units in the test room onto the unit or onto the temperature measuring points shall be avoided.

5.3 Appliances with duct connection

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

5.4 Installation and connection of the test object

5.4.1 General

The test object shall be installed and connected for the test as recommended by the manufacturer in the installation and operation manual. The accessories provided by option are not included in the test. If a back-up heater is provided in option or not, it shall be switched off or disconnected to be excluded from the testing.

For units with brine, the test shall be carried out with the brine and concentration specified by the manufacturer.

Due to the control logic of the unit, when performing a capacity test, all settings shall be adjusted according to the manufacturer's instruction to correctly run the unit in the required operating conditions. These settings may apply to the compressor speed or stage, position of louvers, fans speed, dampers opening, and thermostat set point, and all adjusted setting values shall be provided by the manufacturer.

If skilled personnel is required for the start of the system, the manufacturer or the nominated agent should be in attendance when the system is being installed and prepared for tests.

5.4.2 Measuring points

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

For dry bulb temperature measurements at non-ducted air inlet section of outdoor side, it is required:

- either to have at least one sensor per square meter, with not less than four measuring points and by restricting to 20 the number of sensors equally distributed on the free air surface;
- or to use a sampling device. It shall be completed by four sensors for checking uniformity if the free air surface is greater than 1 m².

Air temperature sensors, either individual or a sampling device, for determining the air inlet temperature shall be placed at a distance between 0,15 cm and 0,30 cm from the minimal enveloping surface containing the outdoor coil of rooftop. For a V-coil configuration, the Figure 1 shows the minimum enveloping surface to be considered.

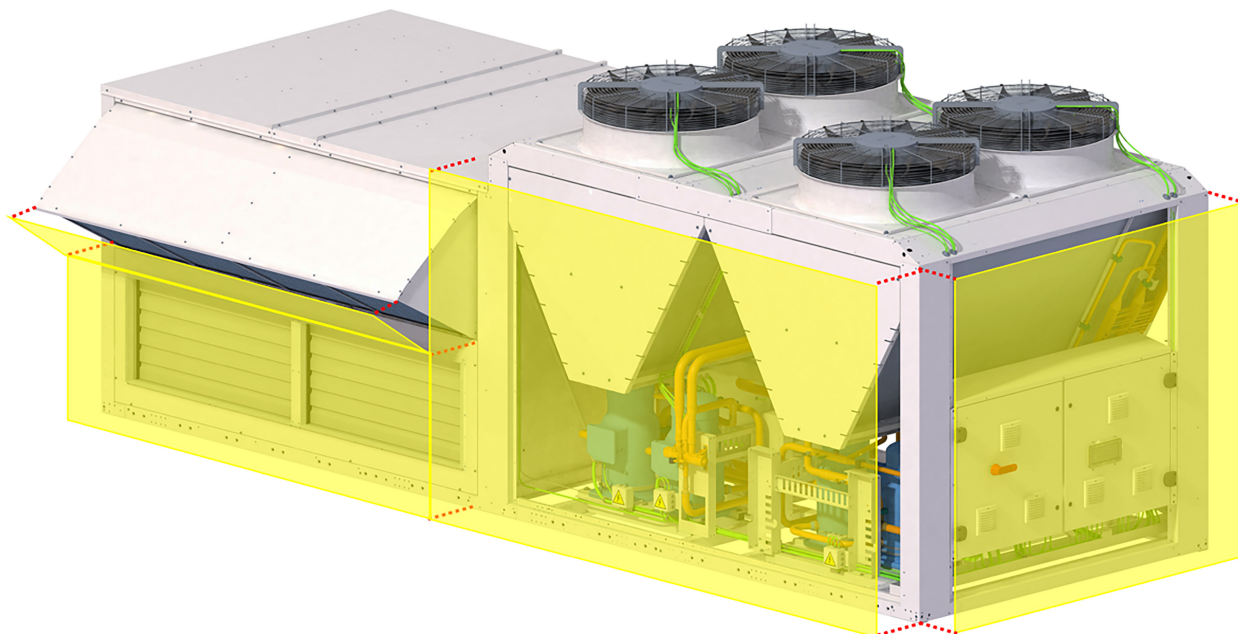


Figure 1 — Example for minimal enveloping surface around the outdoor side coil for a V-coil configuration

5.5 Uncertainties of measurement

The uncertainties of measurement shall not exceed the values specified in Table 9.

Table 9 — Uncertainties of measurement for indicated values

Measured quantity	Unit	Uncertainty of measurement
Liquid		
— temperature difference	K	$\pm 0,15$ K
— temperature inlet/outlet	°C	$\pm 0,15$ K
— volume flow	m ³ /s	± 1 %
static pressure difference	kPa	± 1 kPa ($\Delta P \leq 20$ kPa) or ± 5 % ($\Delta P > 20$ kPa)
Air		
— dry bulb temperature	°C	$\pm 0,2$ K
— wet bulb temperature	°C	$\pm 0,4$ K
— volume flow	m ³ /s	± 5 %
— static pressure difference	Pa	± 5 Pa ($\Delta P \leq 100$ Pa) or ± 5 % ($\Delta P > 100$ Pa)
Concentration (in volume)		
— heat transfer medium	%	± 2
Electrical quantities		
— electric power	W	± 1 %
— voltage	V	$\pm 0,5$ %
— current	A	$\pm 0,5$ %
— electrical energy	kWh	± 1 %