



SLOVENSKI STANDARD

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

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

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

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

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This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 113.

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Foreword

This document (prEN 14825:2008) has been prepared by Technical Committee CEN/TC 113 "Heat pumps and air conditioning units", the secretariat of which is held by AENOR.

This document is currently submitted to the CEN Enquiry.

This document will supersede CEN/TS 14825:2003.

Introduction

Heat pumps, air conditioners and liquid chilling packages are, at present, selected and compared at a rated condition. This condition does not represent the usual operating conditions of the equipment over a season. This operating condition can be better assessed by comparing equipment at representative reduced capacities and determining the Seasonal Energy Efficiency Ratio and Seasonal Coefficient of Performance.

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 standard gives the rating conditions and test methods for testing heat pumps, air conditioners and liquid chilling packages at part load

It also gives formulae for calculating the Seasonal Energy Efficiency Ratio ($SEER_{on}$) and Seasonal Coefficient of Performance ($SCOP_{on}$) of such units when operating.

Other energy consumptions can occur when the unit is not operating such as those from a crank

case heater or when the unit is on standby. These consumptions should be considered and included if a total annual energy consumption is to be determined.

The rating conditions and test methods of units operating at full load are given in EN 14511-2 and EN 14511-3.

1 Scope

This European standard covers reduced capacity testing of air conditioners, heat pumps and liquid chilling packages for part load conditions.

It provides calculation methods for the determination of seasonal energy efficiency and seasonal coefficient of performance.

The standard applies to factory made units defined in EN14511-1, except single duct, control cabinet and close control units.

2 Normative references

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

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

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

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

3 Terms and definitions

For the purposes of this European standard the definitions given in EN 14511-1 apply together with the following.

3.1

compensation load

the heating or cooling load imposed by the test apparatus on the test object.

3.2

reference cooling capacity

Rated capacity as defined by the standard rating conditions given in EN 14511.

3.3

reference heating capacity

Rated capacity as measured at „A“ temperature conditions as defined in EN 14511 (standard rating or application rating conditions as applicable).

3.4

part load capacity

a capacity which is lower than the reference cooling or heating capacity.

3.5

part load ratio

Ratio of the capacity at any temperature conditions of the tables of this standard for a defined type of unit and the capacity measured in the „A“ temperature conditions of the considered table.

3.6

EER_{x%}

the EER of a unit operating at x% of part load ratio.

3.7

COP_{x%}

the COP of a unit operating at x% of part load ratio

prEN 14825:2008 (E)**3.8****fixed capacity unit**

air conditioner, heat pump or liquid chilling package, which does not have the possibility to change automatically (in minimum two steps or continuously) the amount of refrigerant flowing through the system.

Note: Where no refrigerant is flowing through the indoor side (or one of the indoor units) it is not considered a capacity step.

3.9**variable capacity unit**

air conditioner, heat pump or liquid chilling package, where the capacity is varied or changed in a series of steps or increments. This variation can be achieved by off loading the compressor(s), by a number of compressors operating in sequence, , by varying the speed of the compressor(s), normally by inverter control or by other means.

3.10**SEER_{on} (SCOP_{on})**

The ratio of the total amount of heat removed (supplied) expressed in Wh by a unit during the annual cooling (heating) operation to the total effective electric energy consumed during the same period, expressed in Wh.

3.11**Reference SEER_{on} (SCOP_{on})**

The SEER_{on} (SCOP_{on}) determined from mandatory conditions that is used for marking, comparison and certification purposes

Note : These mandatory conditions represent the average conditions of use for Europe.

3.12**Application SEER_{on} (SCOP_{on})**

The SEER_{on} (SCOP_{on}) that takes into account the specific application and the specific location of the system, which are different from the ones used for determining the reference SEER_{on} (SCOP_{on}) given in this standard

3.13**Sizing temperature**

The outdoor temperature at which the heat pump alone is considered to give 100% part load heating capacity.

4 REFERENCE SEASONAL ENERGY EFFICIENCY RATIO (SEER_{on})**4.1 General Formula**

The calculation of the SEER_{on} that applies to all types of units is given by the following formula:

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[Eq.1]

Where

A, B, C, D are the weighting factors affecting the part load EER values,

EER_A, EER_B, EER_C and EER_D are the EER values determined for the corresponding part load ratio at the defined temperature conditions.

4.2 Weighting factors

The weighting factors are defined to evaluate the seasonal energy efficiency ratio of any type of unit for an average European climate profile and an average building load representative of residential, commercial and tertiary applications.

Table 1 – Weighting factors for SEER_{on} calculation

| | Part load ratio | Weighting factor |
|---|-----------------|------------------|
| A | 100% | 4% |
| B | 75% | 26% |
| C | 50% | 40% |
| D | 25% | 30% |

4.3 Air-to-air units

4.3.1 Temperature conditions for SEER_{on} calculation

The temperature conditions for determining the four part load EER values to be used in the general formula [Eq.1] are given in the following table :

Table 2 - Temperature conditions for SEER_{on} calculation of air-to-air units

| | Part load ratio | Outdoor air dry bulb temperature (°C) | Indoor air dry bulb (wet bulb) temperatures (°C) |
|---|-----------------|---------------------------------------|--|
| A | 100% | 35 | 27(19) |
| B | 75% | 30 | 27(19) |
| C | 50% | 25 | 27(19) |
| D | 25% | 20 | 27(19) |

4.3.2 Calculation procedure for fixed capacity units

For each part load ratio of the general formula [Eq.1], the EER is calculated as follows :

$$EER_{part\ load} = EER_{full\ load} * (load / (Cd * load + (1 - Cd)))$$

Where

$EER_{part\ load}$: EER when the unit operates at the considered part load ratio

$EER_{full\ load}$: EER at the considered part load temperature conditions when the unit is operating steady state continuously

Cd : degradation factor that shall be calculated according to 6.4.1.

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load : ratio between the reference cooling capacity at the “A” test conditions multiplied by the part load ratio, and the capacity when the unit is operating continuously (and in steady state) at the considered part load temperature conditions

All tests with a continuous and steady state operation of the unit shall be conducted according to EN 14511-3 procedure.

4.3.3 Calculation procedure for staged capacity control units

- Determine the part load capacity and EER at each step of capacity control of the unit. If the steps do not allow to reach the required part load ratio within $\pm 3\%$ (e.g. between 22% and 28% for a required part load ratio of 25%), determine the capacity and EER at the defined part load temperatures for the steps on either side of the control step of the unit. The part load capacity and the EER at the required part load ratio are then determined by interpolation between the results obtained from these two steps.
- If the smallest control step of the unit is higher than the required part load ratio (D and/or C and/or B), the EER at the required part load ratio is calculated using Equation [Eq.2] as for fixed capacity units.

All the tests shall be conducted according to EN 14511-3 procedure.

4.3.4 Calculation procedure for continuous variable capacity control units

- Perform the tests at the required part load ratios with the corresponding setting of the capacity control of the unit.
- If the electronic control of the unit does not allow to obtain the required part load ratio, the calculation procedure given for staged capacity in 4.3.3 shall be applied.
- If the smallest setting of the capacity control does not allow reaching one or several part load ratios, the EER at the required part load ratio(s) shall be calculated using [Eq.2] as for fixed capacity units in 4.3.2

All the tests shall be conducted according to EN 14511-3 procedure.

4.4 Water-to-air units**4.4.1 Temperature conditions for SEER_{on} calculation**

The temperature conditions are given in the following table :

Table 3 - Temperature conditions for SEER_{on} calculation of water-to-air units

| | Part load ratio | Outdoor heat exchanger | | Indoor heat exchanger |
|---|-----------------|---|--|---|
| | | Cooling tower or water loop application Inlet / outlet water temperatures (°C) | Ground water application Inlet / outlet water temperatures (°C) | Air dry bulb (wet bulb) temperatures (°C) |
| A | 100% | 30 / 35 | 15 / 20 | 27(19) |
| B | 75% | 26 / * | 15 / * | 27(19) |
| C | 50% | 22 / * | 15 / * | 27(19) |
| D | 25% | 18 / * | 15 / * | 27(19) |

(*) with the water flow rate as determined during the “A” test

4.4.2 Calculation procedure

The calculation procedures given in 4.3.2 to 4.3.4 for air-to-air units also apply to water-to-air units.

4.5 Air-to-water units

4.5.1 Temperature conditions for SEER_{on} calculation

The temperature conditions are given in the following table :

Table 4 - Temperature conditions for SEER_{on} calculation of air-to-water units

| | Part load ratio | Outdoor heat exchanger | Indoor heat exchanger | |
|---|-----------------|-------------------------------|--|---|
| | | air dry bulb temperature (°C) | Fan coil application Inlet / outlet water temperatures (°C) | Cooling floor application Inlet / outlet water temperatures (°C) |
| A | 100% | 35 | 12 / 7 | 23 / 18 |
| B | 75% | 30 | * / 7 | * / 18 |
| C | 50% | 25 | * / 7 | * / 18 |
| D | 25% | 20 | * / 7 | * / 18 |

(*) with the water flow rate as determined during "A" test

4.5.2 Calculation procedure for fixed capacity units

Considering the four part load EER values required for the SEER formula [Eq. 1], one might use one of the two alternative calculation procedures:

- Part load testing at the four temperature conditions given in Table 4

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- Full load testing at the four temperature conditions given in Table 4 and application of the following formula .

$$EER_{part\ load} = EER_{full\ load} * (load / (Cc * load + (1 - Cc)))$$

Where

$EER_{part\ load}$: EER when the unit operates at the considered part load ratio

$EER_{full\ load}$: EER at the considered part load temperature conditions when the unit is operating steady state continuously

$load$: ratio between the reference cooling capacity at the "A" test conditions multiplied by the part load ratio, and the capacity when the unit is operating continuously (and in steady state) at the considered part load temperature conditions

Cc :degradation factor to be determined according to 6.4.2.2. A default value of 0.9 for Cc can be used.

All tests with a continuous and steady state operation of the unit shall be conducted according to EN 14511-3 procedure. The part load tests shall be conducted in accordance with Clause 6.