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Condensing units for refrigeration — Rating conditions, tolerances and presentation of manufacturer's performance data

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National foreword

This British Standard is the UK implementation of EN 13215:2016. It supersedes BS EN 13215:2000 which is withdrawn.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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Condensing units for refrigeration - Rating conditions, tolerances and presentation of manufacturer's performance data

Unités de condensation pour la réfrigération - Détermination des caractéristiques, tolérances et présentation des performances du fabricant

Verflüssigungssätze für die Kälteanwendung - Nennbedingungen, Toleranzen und Darstellung von Leistungsdaten des Herstellers

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European foreword

This document (EN 13215:2016) has been prepared by Technical Committee CEN/TC 113 “Heat pumps and air conditioning units”, the secretariat of which is held by AENOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2017, and conflicting national standards shall be withdrawn at the latest by May 2017.

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This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA which is an integral part of this document.

The main changes with respect to the previous edition are listed below:

a) part load conditions according to M/495 “Standardisation mandate to CEN, CENELEC and ETSI under Directive 2009/125/EC relating to harmonised standards in the field of Ecodesign” are taken into account;

b) inclusion of the calculation of seasonal energy performance ratio (*SEPR*).

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1 Scope

This European Standard specifies the rating conditions, tolerances and presentation of manufacturer's performance data for condensing units for refrigeration with compressors of the positive-displacement type. These include single stage compressors and single and two stage compressors having an integrated means of fluid sub cooling. This is required so that a comparison of different condensing units can be made. The data relate to the refrigerating capacity and power absorbed and include requirements for part-load performance where applicable.

2 Normative references

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

EN 378-1:2008+A2:2012, *Refrigerating systems and heat pumps - Safety and environmental requirements - Part 1: Basic requirements, definitions, classification and selection criteria*

EN 13771-2, *Compressors and condensing units for refrigeration - Performance testing and test methods - Part 2: Condensing units*

ISO 817, *Refrigerants — Designation and safety classification*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 378-1:2008+A2:2012 and the following apply.

3.1
condensing unit
combination of one or more compressors, condensers/gas coolers and, where applicable, liquid receivers and the regularly furnished accessories

3.2
refrigerating capacity
Q
product of the mass flow of refrigerant through the condensing unit and the difference between the specific enthalpy of the refrigerant at the condensing unit inlet, the refrigerant being superheated above the suction dew point temperature to the appropriate value (see Table 3), and the specific enthalpy of the liquid refrigerant at the condensing unit outlet

3.3
sub-cooling
difference between the bubble point temperature of the refrigerant corresponding to the pressure at the condensing unit outlet and the temperature of the liquid refrigerant at the condensing unit outlet

3.4
superheat
difference between the dew point temperature of the refrigerant corresponding to the pressure at the condensing unit inlet and the temperature of the refrigerant vapour at the condensing unit inlet

3.5
power absorbed
P
power demand to drive the condensing unit

3.6
coefficient of performance
COP
refrigerating capacity to the power absorbed

3.7
seasonal energy performance ratio
SEPR
reference annual refrigeration demand divided by the annual electrical energy demand

4 Symbols and abbreviations

Table 1 — Symbols and abbreviations

Symbol	Designation	Unit
LT	Low evaporating temperature	-
MT	Medium evaporating temperature	-
HT	High evaporating temperature	-
COP	Coefficient of performance	-
CR	Capacity ratio	-
d	Duration	h
E	Annual electrical energy demand	kWh
P	Power	W
q	Refrigeration demand ratio	-
Q	Refrigerating capacity	W
SEPR	Seasonal energy performance ratio	-
t	Temperature	°C

Table 2 — Indices

Index	Designation
LT	Low evaporating temperature
MT	Medium evaporating temperature
amb	ambient
cor	corrected
dm	demand
low	low
A, B, C and D	Rating conditions
j	bin-number
R	rated

5 Parameters for the presentation of performance data

The parameters as shown in Table 3 shall be used for the presentation of the performance data.

Table 3 — Parameters for the presentation of performance data

Parameters refrigerant	Suction temperature (°C) or superheat (K) at the condensing unit inlet	Condensing unit application
Halocarbons and hydrocarbons including refrigerant blends	32 °C	Household and similar refrigerators/freezers
	20 °C or 10 K	Other applications
R717	5 K	Any application using ammonia
R744	32 °C	Household and similar
	10 K	Other application using CO_2

6 General requirements

The performance data of a condensing unit for refrigeration shall be presented in either tabular or graphical form as shown in 7.3. Data outside the allowable working range of the condensing unit shall not be included.

The performance of the condensing unit at the standard reference points in Table 4 shall also be reported.

To calculate the performance at other suction temperatures/superheat and at other compressor speeds, correction factors shall be given as shown in Clause 10.

Refrigerants shall be designated in accordance with ISO 817. The source from which the thermodynamic properties are taken shall be stated.

It is recommended that an example illustrating the use of the performance data and the correction factors should be given.

Other data such as the swept volume, number of cylinders and speed range may also be shown.

7 Performance data

7.1 General

Published performance shall be based on data obtained from tests performed in accordance with EN 13771-2.

The performance data shall be presented as stated in Clause 8 and for:

— open compressors at the rated speed;

— motor compressors at the rated voltage and frequency.

7.2 Part load performance data

The performance data with capacity control shall be presented for:

— all capacity control steps for condensing units with 2 to 4 control steps, e.g. blocked suction, condensing units with more than one compressor or multi-speed compressor motors;

— condensing units with more than 4 steps or other variable capacity (e.g. variable speed or quasi stepless) at maximum, minimum and at least one additional control step inside the control range.

In the case of nonlinear performance behaviour between published values, the interpolation method, necessary to keep within the tolerances, is to be stated.

Part load data for *SEPR* calculation according to Annex A shall be declared in addition.

7.3 Tabular or graphical form

The performance data to be given, in either tabular or graphical form, shall comprise:

a) the refrigerating capacity, in values able to be read to an accuracy of ± 2 %;

b) the power absorbed, in values able to be read to an accuracy of ± 2 %;

c) the evaporating temperature/suction dew point temperature, at intervals not greater than 5 K.

7.4 Determination of the power absorbed by the condensing unit

7.4.1 Condensing units including the compressor motor

Power absorbed consists of the electrical power input to the compressor motor and the power of the fan(s) and other electrical auxiliaries.

7.4.2 Motors with a specific factory assembled or factory specified means for variable speed

The motor power is the electrical power input at the terminals of the frequency inverter or other means for variable speed.

7.4.3 Externally driven compressors without motor

Power absorbed consists of the power at the compressor shaft and the power of the fan(s) and other electrical auxiliaries.

8 Rating conditions

8.1 General

A rating condition consists of a reference point of Table 4 and an ambient temperature from 8.3 for air cooled condensing unit respectively a condensing temperature from 8.4 for water cooled condensing units.

The following data shall be given:

— refrigerating capacity;

— value of subcooling at the condensing unit outlet;

— power absorbed, including fan motors and factory supplied accessories;

— *COP*.

The following further information shall be available upon request:

— application limits related to air or water temperature (minimum-maximum);

— for air cooled condensing units: air flow;

— for water cooled condensing units: water flow and pressure drop.

8.2 Standard reference points

The standard reference points shall be in accordance with Table 4.

Table 4 — Standard reference points

Condensing unit applications **Reference points**	**Low evaporating temperature (LT)**	**Medium evaporating temperature (MT)**	**High evaporating temperature (HT)**	**Household and similar**
Evaporating temperature (°C) **— suction dew point**	−35	−10	+5	−25
Suction temperature (°C) **or superheat (K)**	+20 10 or 5 [a]	+20 10 or 5 [a]	+20 10 or 5 [a]	+32
Applicable for evaporating temperatures (°C)	≤ −20	−20 < t < −5	≥ −5	n.a.
Ambient temperature for air cooled condensing units	see 8.3			
Condensing temperature for water cooled units (°C)	see 8.4			
[a] For R717.				

8.3 Air cooled condensing units

8.3.1 General

The condensing unit performance shall refer to an ambient temperature of 32 °C. The performance given applies to a clean condenser.

Performance data shall be declared for ambient temperature of

— +32 °C,

— +25 °C and

— +43 °C, if the condensing unit is designed for this.

8.3.2 Data for *SEPR* calculation

Condensing units with refrigerating capacity above 2 kW at low evaporating temperature and above 5 kW at medium evaporating temperature at 32 °C ambient temperature are considered as higher refrigerating capacity.

Performance data for higher refrigerating capacity shall be declared for ambient temperature of

— +32 °C,

— +25 °C,

— +15 °C,

— +5 °C and

— +43 °C, if the condensing unit is designed for this.

The *SEPR* value and the annual electrical energy demand (*E*) shall be declared, see Annex A. Where the COP_{cor} is calculated based on a special control scheme, this shall be stated (e.g. running on/off at higher capacity control step instead of switching between steps).

8.4 Water cooled condensing units

The standard reference points shall be 40 °C condensing temperature/dew point temperature corresponding to the compressor discharge pressure. The water inlet temperature shall be 30 °C and the fouling factor 5×10^{-5} m² K/W.

9 Tolerances

The following tolerances shall apply to manufacturer's stated performance in relation to the measured data obtained at the standard reference points in Table 4. These tolerances are needed to take into account manufacturing differences during production.

Refrigerating capacity or mass flow and *COP* shall not be lower than shown in Table 5. Power absorbed shall not be more than the percentage shown in Table 5.

Table 5 — Actual performance in relation to published data

Condensing unit applications Tolerance	Low evaporating temperature	Medium evaporating temperature	High evaporating temperature	Part load condition	Household and similar refrigerators/freezers
Refrigerating capacity [a] or mass flow	90,0 % [b] or 87,5 %	90,0 %	92,5 %	87,5 %	92,5 % or –10 W [c]
Power absorbed [a]	112,5 %	110,0 %	107,5 %	112,5 %	107,5 % or +10 W [c]

[a] In any case, the *COP* shall not be less than 90 %.

[b] The 90,0 % limit applies for 32 °C ambient temperature.

[c] Maximum deviation for values less than 100 W.

The *SEPR* calculated according to Annex A shall not be less than 90 % of the manufacturer's published data.

10 Correction factors

10.1 Superheat

The correction factors applicable to the performance data relating to superheat (see Clause 6) shall comprise:

a) the change in refrigerating capacity (or mass flow) as a function of the superheat;

b) the change in power absorbed as a function of the superheat.

Conversion factors or calculation method for different values of superheat shall be based on experimental data.

10.2 Compressors speed

The correction factors applicable to the performance data relating to the rated speed (see 7.1) shall comprise:

a) the refrigerating capacity (or mass flow) as a function of varying compressor speeds;

b) the power absorbed as a function of varying compressor speeds.

These correction factors do not apply to motor compressors.

Annex A
(normative)

Calculation of *SEPR*

A.1 General

The energy efficiency of condensing units shall be stated at one rating condition for lower capacity or at four rating conditions for higher capacity (see 8.3), plus via a calculated seasonal value *SEPR* based on the four rating conditions.

The methodology for the calculation of this *SEPR*-value is described here.

The SEPR is calculated based on the *COP*s determined for operation at the four rating conditions A, B, C and D, see Table A.1. This determination is as follows:

The refrigerating capacity demand at a given ambient temperature is given in Formula (A.12) for medium temperature (MT) refrigeration and low temperature (LT) in Formula (A.10) refrigeration.

For quasi stepless capacity control resulting in a capacity matching the demand ± 3 % defined at the given ambient temperature of the rating condition, the *COP* is unchanged.

A.2 Condensing unit without capacity control

For condensing units with on/off cycling control (i.e. without capacity control), the *COP* is corrected via a coefficient of 0,25 according to Formula (A.1) for rating conditions B, C and D.

For rating condition A, the *COP* is not corrected.

Refrigerating capacity Q_R is the capacity at the given ambient temperature rating condition.

$$COP_{cor} = COP_R \left(1 - 0,25 \times \left(1 - CR\right)\right) \quad \text{(A.1)}$$

$$CR = \frac{Q_{R,A} \times q}{Q_R} \quad \text{(A.2)}$$

$$P = \frac{Q_R}{COP_{cor}} \quad \text{(A.3)}$$

A.3 Condensing unit with stepwise capacity control

For stepwise capacity control the COP_{cor} is interpolated between two given capacity control steps Q_R and $Q_{R,low}$, without degradation, or between a capacity control step and off mode with degradation according to Formula (A.1), whereby Q_R is the value for the chosen capacity control step.

$$COP_{cor} = COP_{R,low} + \frac{\left(COP_R - COP_{R,low}\right) \times \left(q \times Q_{R,A} - Q_{R,low}\right)}{\left(Q_R - Q_{R,low}\right)} \quad \text{(A.4)}$$

Table A.1 — Required input for *SEPR* calculation

Rating condition	t_{amb}	Q_{dm}	Q_R	COP_R	$Q_{R,low}$	$COP_{R,low}$	COP_{cor}
A	32						
B	25						
C	15						
D	5						

A.4 Calculation of SEPR

For every ambient temperature $t_{amb,j}$ the value for $COP_{cor,j}$ is calculated, see Table A.2. Between the four rating conditions A, B, C and D the $COP_{cor,j}$ is interpolated linearly depending on ambient temperature between the two nearest rating conditions. For $t_{amb,j}$ below rating condition D the $COP_{cor,j}$ is kept on the value of condition D, above rating condition A the *COP* is kept at the value of A.

The *SEPR* is calculated via the 58 values for the yearly duration d_j per ambient temperature degree step $t_{amb,j}$.

$$SEPR = \frac{\sum_{j=1}^{58}\left(Q_{dm,j} \times d_j\right)}{\sum_{j=1}^{58}\left(\frac{Q_{dm,j} \times d_j}{COP_{cor,j}}\right)} \quad \text{(A.5)}$$

$$q = q_{LT} = q_{MT} = 1 \quad \text{for } t_{amb} \geq 32\ °C \quad \text{(A.6)}$$

$$q_{LT} = 0,8 \quad \text{for } t_{amb} \leq 5\ °C \quad \text{(A.7)}$$

$$q_{MT} = 0,6 \quad \text{for } t_{amb} \leq 5\ °C \quad \text{(A.8)}$$

$$q_{LT} = \frac{\left(t_{amb,j} - 5\right)}{27} \times 0,2 + 0,8 \quad \text{for } 5\ °C < t_{amb} < 32\ °C \quad \text{(A.9)}$$

$$Q_{dm,LT,j} = q_{LT,j} \times Q_{R,LT,A} \quad \text{(A.10)}$$

$$q_{MT} = \frac{\left(t_{amb,j} - 5\right)}{27} \times 0,4 + 0,6 \quad \text{for } 5\ °C < t_{amb} < 32\ °C \quad \text{(A.11)}$$

$$Q_{dm,MT,j} = q_{MT,j} \times Q_{R,MT,A} \quad \text{(A.12)}$$

$$COP_{cor,j} = COP_{B,cor} - \left(COP_{B,cor} - COP_A\right) \times \frac{\left(t_{amb,j} - 25\right)}{7} \quad \text{between A and B} \quad \text{(A.13)}$$

$$COP_{cor,j} = COP_{C,cor} - \left(COP_{C,cor} - COP_{B,cor}\right) \times \frac{\left(t_{amb,j} - 15\right)}{10} \quad \text{between B and C} \quad \text{(A.14)}$$

$$COP_{\mathrm{cor,j}} = COP_{\mathrm{D,cor}} - \left(COP_{\mathrm{D,cor}} - COP_{\mathrm{C,cor}}\right) \times \frac{\left(t_{\mathrm{amb,j}} - 5\right)}{10} \qquad \text{between C and D} \qquad \text{(A.15)}$$

$$E = \sum_{\mathrm{j=1}}^{58} \left(\frac{Q_{\mathrm{dm,j}} \times d_{\mathrm{j}}}{COP_{\mathrm{cor,j}}} \right) \qquad \text{(A.16)}$$

Table A.2 — Ambient temperatures and duration for *SEPR* determination

j	$t_{\mathrm{amb,j}}$ **°C**	d_{j} **h**
1	−19	0,08
2	−18	0,41
3	−17	0,65
4	−16	1,05
5	−15	1,74
6	−14	2,98
7	−13	3,79
8	−12	5,69
9	−11	8,94
10	−10	11,81
11	−9	17,29
12	−8	20,02
13	−7	28,73
14	−6	39,71
15	−5	56,61
16	−4	76,36
17	−3	106,07
18	−2	153,22
19	−1	203,41
20	0	247,98
21	1	282,01
22	2	275,91
23	3	300,61
24	4	310,77
25	5	336,48
26	6	350,48
27	7	363,49

j	$t_{amb,j}$ °C	d_j h
28	8	368,91
29	9	371,63
30	10	377,32
31	11	376,53
32	12	386,42
33	13	389,84
34	14	384,45
35	15	370,45
36	16	344,96
37	17	328,02
38	18	305,36
39	19	261,87
40	20	223,9
41	21	196,31
42	22	163,04
43	23	141,78
44	24	121,93
45	25	104,46
46	26	85,77
47	27	71,54
48	28	56,57
49	29	43,35
50	30	31,02
51	31	20,21
52	32	11,85
53	33	8,17
54	34	3,83
55	35	2,09
56	36	1,21
57	37	0,52
58	38	0,4

Annex ZA
(informative)

Relationship between this European Standard and the eco-design requirements of Commission Regulation (EU) No 2015/1095

This European Standard has been prepared under a Commission's standardization request M/495 (Ecodesign) to provide one voluntary means of conforming to the ecodesign requirements of Commission Regulation (EU) No 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.

Once this standard is cited in the Official Journal of the European Union under that Regulation, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding ecodesign requirements of that Regulation and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Commission Regulation (EU) No 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 and Commission's standardization request M/495 (Ecodesign)

Ecodesign Requirements of Regulation (EU) No 2015/1095	**Clause(s)/subclause(s) of this EN**	**Remarks/Notes**
Annex I 16, 20, 21	Annex A A.4	— Refrigeration demand ratio (the regulation refers to part load ratio) — *SEPR* calculation — Annual electrical energy demand (the regulation refers to annual electricity consumption)
Annex V 2	6	Refrigerant
Annex V 2	8.2	Evaporating temperature
Annex V 2	8.3	— Capacity — Power absorbed (the regulation refers to Power input) — *SEPR* — Annual electrical energy demand (the regulation refers to annual electricity consumption)
Annex VI	Annex A	— Calculation of *SEPR* — temperature bins
Annex X 2 b	9	*SEPR* tolerance
Annex X 2c and d	9, Table 5	*COP* tolerance

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WARNING 2 — Other Union legislation may be applicable to the products falling within the scope of this standard.

Bibliography

[1] EN 12693, *Refrigerating systems and heat pumps - Safety and environmental requirements - Positive displacement refrigerant compressors*

[2] EN 12900, *Refrigerant compressors - Rating conditions, tolerances and presentation of manufacturer's performance data*

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