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Radiators and convectors - Part 2: Test methods and rating

Heizkörper und Konvektoren - Teil 2: Prüfverfahren und Leistungsangabe

Radiateurs et convecteurs - Partie 2 : Méthodes d'essai et d'évaluation

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Radiators and convectors - Part 2: Test methods and rating

Radiateurs et convecteurs - Partie 2 : Méthodes d'essai et d'évaluation

Radiatoren und Konvektoren - Teil 2: Prüfverfahren und Leistungsangabe

This European Standard was approved by CEN on 11 October 2014.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (EN 442-2:2014) has been prepared by Technical Committee CEN/TC 130 “Space heating appliances without integral heat sources”, the secretariat of which is held by UNI.

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of an identical text or by endorsement, at the latest by June 2015, and conflicting national standards shall be withdrawn at the latest by June 2015.

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

This document supersedes EN 442-2:1996.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

The most significant changes that have been made in this new edition of EN 442-2 are the following ones:

— some new definitions have been added;

— the straight or curved towel or bathroom radiator have been included;

— different surface treatments have been included;

— a new normative Annex J "Calibration Procedure" has been added;

— a new normative Annex K "Pretreatment and paint testing method" has been added.

This European Standard comes from an output of the project SMT4 - CT97 - 2127 funded by the European Commission DGXII-RDT.

This European Standard, *Radiators and convectors*, consists of the following parts:

— *Part 1: Technical specifications and requirements*;

— *Part 2: Test methods and rating* [the present document].

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

Introduction

This European Standard results from the recognition that the heating appliances falling into the field of application hereinafter stated are traded on the basis of their thermal output.

To evaluate and compare different appliances it is therefore necessary to refer to a single stipulated value, hereinafter called the standard rated thermal output.

In addition, for low temperature systems a standard low temperature thermal output is given.

The standard thermal outputs (standard rated thermal output and standard low temperature thermal output) are defined value taken from the characteristic equation.

The pre-requisites of the standard thermal outputs, as defined by this European Standard, are the following:

— to be representative of the actual output of the appliance in different operating conditions;

— to be reproducible within the tolerances defined by this European Standard, taking into account the state of measuring techniques;

— to be representative of the thermal outputs, obtainable under the same test conditions, of any identical sample taken out of the current production (within the tolerances defined by this European Standard taking into account the state of measuring techniques and methods of manufacture).

1 Scope

This European Standard defines procedures for determining the standard thermal outputs and other characteristics of radiators and convectors installed in a permanent manner in construction works, fed with water or steam at temperatures below 120 °C, supplied by a remote energy source.

This European Standard specifies the laboratory arrangements and testing methods to be adopted, the admissible tolerances, the criteria for selecting the samples to be tested and for verifying the conformity of the current production with the samples tested at the initial test.

This European Standard also defines the additional common data that the manufacturer shall provide with the product in order to ensure the correct application of the products.

This European Standard does not apply to fan assisted radiators, fan assisted convectors and trench convectors and to independent heating appliances.

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 10088-1, *Stainless steels — Part 1: List of stainless steels*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025)*

ISO 16269-7, *Statistical interpretation of data — Part 7: Median — Estimation and confidence intervals*

3 Terms, definitions, symbols and units

3.1 Terms and definitions

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

3.1.1
heating appliance
device having the purpose of transferring heat in order to provide specific temperature conditions inside buildings

3.1.2
independent heating appliance
self-contained heating appliance which does not need to be connected to a remote energy source (e.g. a boiler) as it contains its own energy source (e.g. gas fired appliances, electric appliances, air to air heat pump appliances)

3.1.3
radiator
heating appliance produced with different materials (e.g. steel, aluminium, cast-iron) and with different designs (e.g. plate type, column type, tube type, finned tube type), which emits heat by free convection and radiation

3.1.4
sectional heating appliances (mainly applied to radiators)
heating appliance manufactured in sections of identical design and traded in this form which can be joined together into modular assemblies so that the desired output can be obtained

3.1.5
free convection heating appliance
heating appliance which does not contain a fan or similar device to activate the air flow over heat emitter

3.1.6
convector
heating appliance which emits heat almost entirely by free convection

Note 1 to entry: A convector comprising at least a heat emitter and a casing which provides an unheated convective chimney of defined height.

3.1.7
skirting convector
convector of limited height running along the base of an interior wall

3.1.8
height of the unheated convective chimney
vertical distance between the lowest edge of the convector and the bottom of the air outlet section

Note 1 to entry: It applies to convectors only, being a main factor influencing their thermal output.

3.1.9
wet heating surface; primary heating surface
portion of the heat emitting surface which is always in contact with the primary fluid (water or steam)

3.1.10
dry heating surface; secondary heating surface
portion of the heat emitting surface which is in contact with air only (e.g. fins projecting from the wet surface)

3.1.11
family of heating appliances

group of heating appliances of similar design and construction and of identical material, positions of primary fluid connections and other related variables that particularly affect the conditions of flow of the primary fluid within the heating appliance

3.1.12
type of radiators/convectors
group of heating appliances of similar design whose cross-section remains unchanged while the height or length varies or which have a systematic variation of only one characteristic dimension of the dry heating surfaces providing that this does not affect the water side (e.g. the height of convector fins on panel radiator)

Note 1 to entry: For the calculation in conformity to Annex D, at least three models are required.

3.1.13
model
heating appliance of defined height, length and depth within a type

3.1.14
range of heights
difference between the maximum and minimum height of the models in a type

3.1.15
module of heating appliances
reference length of the useful portion of a heating appliance

Note 1 to entry: The module coincides with:

— the section, in the case of sectional heating appliances;

— a length of 1 m, in the case of non-sectional heating appliances;

— a finned length of 1 m, in the case of finned tube convectors.

3.1.16
sample
representative heating appliance used for the determination of one or more of the performance characteristics

3.1.17
inlet water temperature
bulk temperature of the water entering the heating appliance

3.1.18
outlet water temperature
bulk temperature of the water leaving the heating appliance

3.1.19
temperature drop
difference between inlet and outlet water temperature

3.1.20
mean water temperature
arithmetical mean of inlet and outlet water temperature

3.1.21
reference air temperature
air temperature measured on the vertical line at the centre of the test booth, 0,75 m above the floor level

3.1.22
excess temperature
difference between mean water temperature and reference air temperature

3.1.23
standard excess temperature
excess temperature of 50 K as determined in the standard conditions

Note 1 to entry: Inlet water temperature of 75 °C, outlet water temperature of 65 °C and reference air temperature of 20 °C.

3.1.24
standard excess low temperature
excess temperature of 30 K at standard flow rate

3.1.25
air pressure
air pressure measured at the test place

3.1.26
standard air pressure
101,325 kPa (1,013 25 bar)

3.1.27
water flow rate
amount of water flowing through the heating appliance per unit of time

3.1.28
standard water flow rate
water flow rate relating to standard test conditions

3.1.29
standard rated thermal output
thermal output of a heating appliance defined at 50 K excess temperature

3.1.30
standard low temperature thermal output
thermal output of a heating appliance defined at 30 K excess temperature

3.1.31
characteristic equation
power function with a specific characteristic exponent that gives the thermal output as a function of the excess temperature at constant water flow rate

3.1.32
standard characteristic equation
characteristic equation which is valid for standard water flow rate and from which the standard thermal output can be found for the standard excess temperature of 50 K

3.1.33
regression equation of a type
equation which gives the standard thermal outputs and the characteristic exponent of all the models within a type as a function of one characteristic dimension

Note 1 to entry: The regression equation for the determination of thermal outputs is a power function, in which the characteristic exponent is a linear function of the characteristic dimension.

3.1.34
standard thermal output of the module
standard thermal output of a model divided either by the number of sections or by the length in metres

3.1.35
test pressure
relative pressure to which the heating appliance is submitted during the manufacturing process (i.e. factory test pressure)

3.1.36
maximum operating pressure
MOP
maximum relative pressure of the system to which the heating appliance may be submitted as chosen by manufacturer

Note 1 to entry: The maximum operating pressure is expressed in [kPa].

3.1.37
maximum operating temperature
maximum inlet water temperature allowed by the manufacturer

3.1.38
test installation
combination of:

— test booth and other related parts, and

— measuring instruments and related equipment

3.1.39
test system
combination of:

— test installation, and

— master radiators

3.1.40
test systems circuit
group of test systems convened to comply with the specifications and procedures of this European Standard and to a periodical comparison of test results

3.1.41
repeatability of a test installation
capability of one test installation to provide test results on one given set of master radiator within the tolerance specified by this European Standard

Note 1 to entry: See 5.2.4.

3.1.42
reproducibility of a test installation
capability of different test installations to provide test results on one given set of master radiators within the tolerance specified by this European Standard

Note 1 to entry: See 5.2.4.

3.1.43
pressure drop
difference of pressure between water inlet and water outlet of the heating appliance

3.1.44
standard pressure drop
drop in pressure between inlet and outlet of the appliance heat emitter on the primary fluid side, when the appliance is fed at the standard water flow rate

3.1.45
supplementary test
test for the purpose of establishing the effect of minor technical modifications on the thermal output of radiators that have already been tested

3.1.46
radiated heat output factor
Sk
assumed ratio between the radiation heat output and the overall heat output of the radiator, which is only valid for air pressure correction purposes

3.1.47
exponent np
exponent for the air pressure correction of the measured heat output of the radiator

3.1.48
emissivity
ratio of energy radiated by a particular material to energy radiated by a black body at the same temperature

3.1.49
master radiator
sample used for the calibration of test installations

Note 1 to entry: Master radiators are used to determine repeatability and reproducibility of the results of the test installations (see 5.2.3).

3.2 Symbols and units of measurement

Table 1 — Symbols, quantity and units of measurement

Quantity	Symbol	Unit
Thermal output	Φ	W
Standard thermal output	Φ_S	W
Modular thermal output	Φ_L	W
Reference value of a master radiator	Φ_0	W
Reference value of a primary set of master radiators for interlaboratory comparisons	Φ_M	W
Electrical method heat losses	Φ_V	W
Electric power	P_{el}	W
Thermodynamic temperature	T	K
Temperature	t	°C
Inlet water temperature	t_1	°C
Outlet water temperature	t_2	°C
Temperature drop	t_1-t_2	K
Mean water temperature	t_m	°C
Reference room air temperature	t_r	°C
Excess temperature	ΔT	K
Specific heat capacity	c_p	J/kg·K
Specific enthalpy	h	J/kg
Inlet water enthalpy	h_1	J/kg
Outlet water enthalpy	h_2	J/kg
Water flow rate	q_m	kg/s
Standard water flow rate	q_{ms}	kg/s
Pressure	p	kPa
Maximum operating pressure/resistance to pressure	p_{max}	kPa
Pressure drop	Δp	kPa
Repeatability tolerance	S_0	-
Reproducibility tolerance	S_m	-
Overall height of the heating appliance	H	m
Range of heights	H_r	m
Overall length of the heating appliance	L	m
Length of a section	L_S	m
Number of sections	N_S	-
Thermal resistance	R	m^2·K/W
Time interval	τ	s
Radiated heat output factor	Sk	-
Emissivity	ε	-

4 Selection of heating appliances to be tested

4.1 Classification

4.1.1 Heating appliances shall be grouped into families and types according to the definition in this European Standard. A family can include different types.

4.1.2 For the purposes of determining catalogue outputs, a family shall be divided into a number of separate types (in a family of radiators there may, for example, be single or double panels, with or without convector surfaces, using the same basic components).

4.1.3 The output of each model shall not be greater than 3 500 W and the minimum thermal output of the selected model shall be not less than 200 W at standard excess temperature.

On request of the manufacturer lower thermal output could be tested and the deviation from the previous requirements shall be registered in the test report.

4.2 Selection of models to be tested for determining the thermal outputs of a type

4.2.1 Selection of models to be tested when the variable characteristic dimension is the overall height and the cross-section of the variable part is constant

4.2.1.1 When a type includes only models of height 300 mm and greater, the models to be tested within that type shall be selected in accordance with 4.2.1.2, 4.2.1.3, 4.2.1.4 and 4.2.1.5.

If the type also includes heights below 300 mm the minimum height below 300 mm shall be tested in addition to the above models.

For a type in which all heights are below 300 mm, only the minimum and the maximum height shall be tested.

4.2.1.2 The minimum number of models to be tested within a type is determined by the range of heights as shown in Table 2.

Table 2 — Minimum number of models to be tested

Range of heights (m) $H_r = H_{max} - H_{min}$	Number of models to be tested
≤ 1 m	3
> 1 m	4

4.2.1.3 The minimum length of finned coil of the models to be tested shall be 1 m or the closest to 1 m. For skirting convectors only the finned coil length shall be the closest to 3 m. In the case of sectional radiators, having height $H \leq 1$ m, the minimum number of sections shall be 10 or the minimum length 0,8 m. For sectional radiator having height greater than 1 m the minimum length shall be 0,45 m.

For towel radiators see 4.2.2.

4.2.1.4 In the case of $H_r \leq 1$ m, the models to be tested shall be three; the minimum and maximum height of the range and an intermediate height so that H_{int} is equal, to or the closest value greater than:

$$H_{int} = H_{max} - \tfrac{1}{2} \times H_r$$

where

H_{max} is the maximum height of the type.

4.2.1.5 In the case of 1 m < H_r ≤ 2,5 m, the models to be tested shall be four; the minimum and maximum height of the range and two intermediate heights so that H_{int1} and H_{int2} are the closest values respectively to:

$$H_{int1} = H_{max} - \tfrac{1}{3} \times H_r$$

and

$$H_{int2} = H_{max} - \tfrac{2}{3} \times H_r$$

4.2.2 Selection of models to be tested when the variable characteristic dimension for the type is other than the overall height

4.2.2.1 General principle

The minimum number of models to be tested is three, having the same overall height and respectively, the minimum, intermediate and maximum value of the relevant characteristic dimension (see 4.2.1.4).

The measured values shall be used to determine the characteristic equation of the type.

For the equation to be valid, all the measured thermal outputs shall fall within ± 2 % of the prediction of the equation.

If any value falls outside this range, the type shall be divided and new equations derived for each subset of the results.

4.2.2.2 Selection of models to be tested when a type includes horizontal parallel flow models

This procedure applies to tubular radiator classified as “towel or bathroom radiators”, according to Figure G.3.

If a type includes horizontal parallel flow models, with different heights and lengths, the thermal outputs of models having L_{min} and L_{max} respectively shall be tested. If there are more than 3 heights, the thermal output for all heating appliances having L_{min} and L_{max} respectively shall be established using the respective characteristic equation. For each height, the thermal output for models having length included between L_{min} and L_{max} shall be linearly interpolated. The adopted procedure shall be noted in the test report.

4.2.2.3 Straight or curved towel or bathroom radiator

For “towels and bathroom radiators” having similar external size (height, length, external diameter of the tubes) and different shape of horizontal tube (straight or curved):

If it is proved by at least 2 tests that the difference between the thermal outputs of the model having straight tubes and the model having curved tubes, is within ± 4,0 %, then the catalogue data of the models having curved tubes can be assumed equal to the equivalent models having straight tubes.

If the difference exceeds ± 4,0 % the models are classified as different type and so tested for any specific geometry.

4.2.2.4 Towel and bathroom radiator water circulation

For “towel and bathroom radiator” having the same external size (height, length, depth and external diameter of the tube) but different internal circulation of the hot water, if it is proved by at least 2 tests that the difference between the thermal outputs of the models having different internal circulation is within ± 4,0 %, then the catalogue data of all the models can be assumed to be equal. If the difference exceeds ± 4,0 % the models are classified as different type and so tested for any specific internal water circulation.