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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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Heizkörper und Konvektoren - Teil 2: Prüfverfahren und Leistungsangabe

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Foreword

This document (prEN 442-2:2010) 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 document is currently submitted to the CEN Enquiry.

This document will supersede EN 442-2:1996, EN 442-2:1996/A1:2000, EN 442-2:1996/A2:2003.

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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 thermal outputs.

The standard thermal outputs 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 output, 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).

This European Standard for radiators and convectors consists of the following Parts:

— Part 1: *Technical specifications and requirements*

— Part 2: *Test methods and rating*

— Part 3: *Evaluation of conformity*

1 Scope

This European Standard defines procedures for determining the standard thermal outputs of heating appliances fed with water or steam at temperatures below 120 °C, supplied by a remote heat 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 to the trade in order to ensure the correct application of the products.

This European Standard does not apply to independent heating appliances.

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 442-1	*Radiators and convectors - Part 1: Technical specifications and requirements*
EN 10088-1	*Stainless steels - Part 1: List of stainless steels*
EN 17025	*General criteria for the operation of testing laboratories*
ISO 31-4	*Quantities and units - Part 4: Heat*
ISO 5725	*Precision of test methods -Determination of repeatability and reproducibility for a standard*

test method by inter-laboratory tests

3 Definitions

For the purposes of this standard, the following definitions apply:

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

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

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

3.4 sectional heating appliances (mainly applied to radiators)
A 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.

3.5 free convection heating appliance
A heating appliance which does not contain a fan or similar device to activate the air flow over heat emitter (see **3.6** and **3.7**).

3.6 forced convection heating appliance
A heating appliance which requires the action of a fan or similar device to blow or draw air over the heat emitter.

3.7 convector
A heating appliance which emits heat almost entirely by free convection. A convector comprising at least a heat emitter and a casing which provides an unheated convective chimney of defined height.

3.8 fan-assisted radiator or convector
A radiator or a convector equipped with a fan to increase the convective heat emission, characterized by two thermal outputs, one with the fan off and the other with the fan in operation.

3.9 height of the unheated convective chimney
The vertical distance between the lowest edge of the convector and the bottom of the air outlet section.
It applies to convectors only, being a main factor influencing their thermal output.

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

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

3.12 family of heating appliances
A 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.

3.13 type of heating appliances
A group of at least three 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).

3.14 model
Heating appliance of defined height, length and depth within a type.

3.15 range of heights
Difference between the maximum and minimum height of the models in a type.

3.16 module of heating appliances
The reference length of the useful portion of a heating appliance. In the case of sectional heating appliances

the module coincides with the section.
In the case of non-sectional heating appliances a length of 1 m is assumed as the module. In the case of convectors, a length of 1 m of the heat emitter (not the casing) is assumed as the module.
The thermal output of any model can be obtained by multiplying the thermal output of the module by the number of sections or the length of the heating appliance in metres, as appropriate.

3.17 sample
A heating appliance whose thermal output shall be determined or has been determined; its dimensions shall not deviate from the data indicated in the production drawings by more than the dimensional tolerances specified in this European Standard

3.18 inlet water temperature
The bulk temperature of the water entering the heating appliance.

3.19 outlet water temperature
The bulk temperature of the water leaving the heating appliance.

3.20 temperature drop
The difference between inlet and outlet water temperature.

3.21 mean water temperature
The arithmetical mean of inlet and outlet water temperature.

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

3.23 excess temperature
Difference between mean water temperature and reference air temperature.

3.24 standard excess temperature
The excess temperature of 50 K as determined in the standard conditions (inlet water temperature of 75 °C, outlet water temperature of 65 °C and reference air temperature of 20 °C).

3.25 standard excess low temperature
The excess temperature of 30 K at standard flow rate.

3.26 air pressure
The air pressure measured at the test place.

3.27 standard air pressure
It is defined as 101,325 kPa (1,01325 bar).

3.28 water flow rate
The amount of water flowing through the heating appliance per unit of time.

3.29 standard water flow rate
The water flow rate relating to standard test conditions.

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

3.31 standard low temperature thermal output
The thermal output of a heating appliance defined at 30 K excess temperature.

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

3.33 standard characteristic equation
The 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.

3.34 regression equation of a type
The 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. 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.

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

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

3.37 maximum operating pressure
The maximum system pressure to which the heating appliance may be submitted as stated by manufacturer.

3.38 maximum operating temperature
The maximum inlet water temperature allowed by the manufacturer.

3.30 test installation
The combination of:

— test booth and other related parts;

— measuring instruments and related equipment.

3.40 test system
The combination of:

— test installation;

— master radiators.

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

3.42 repeatability of a test installation
Capability of one test installation to provide test results on one given master radiator within the tolerance specified by this European Standard (see **6.2.4**).

3.43 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 (see **6.2.4**).

3.44 pressure drop
The difference of pressure between water inlet and water outlet of the heating appliance.

3.45 standard pressure drop

The 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.

3.46 supplementary test

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

(not mentioned in the text of the standard)

4 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	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^2K/W
Time interval	τ	s

5 Selection of heating appliances to be tested

5.1 Classification

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

5.1.2 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).

5.1.3 The output of each model shall not be greater than 3500 W and the minimum thermal output of the selected model shall be not less than 200 W at standard rated 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.

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

5.2.1 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.

5.2.1.1 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 **5.2.1.2** to **5.2.1.5**.

If the type also includes heights below 300 mm the minimum height below 300 mm shall be tested in addition to the above models to be selected in accordance with **5.2.1.2** to **5.2.1.5**.

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

5.2.1.2 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

5.2.1.3 The minimum length of the models to be tested shall be 1 m or the closest to 1 m. In the case of sectional radiators, having height **H** ≤ 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.

5.2.1.4 In the case of H_r ≤ 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.

5.2.1.5 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 $H_{int\,2} = H_{max} - \tfrac{2}{3} \times H_r$

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

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 **5.2.1.4**).

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.

5.2.2.1 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, output 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.

5.2.2.2 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 output of the model having straight tube and the model having curved tube, is within +/- 4,0 % , then the catalogue data of the models having curved tube can be assumed equal to the equivalent models having straight tubes.

5.2.2.3 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 output 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.

5.2.2.4 Different surface treatments (chromed, polished, etc.)

Models having same external size (height, length, depth and external diameter of the tube) but different surface treatment (i.e.: painted, chromed or mechanically polished), shall be tested as follows :

Models painted and chromed shall be tested according to EN 442-2 point 5.2
For models having other surface treatments (for example: satinated or polished) the minimum number of samples to be tested shall be defined as follow:

1) for each other type, two models, having the minimum and the maximum heat output as measured on painted model, shall be tested only to determine the less favourable reduction coefficient;

2) the thermal output of all the models, shall be calculated using the reduction coefficient determined according point *1)* .

5.2.2.5 On request of manufacturers the influence of water flow rate on thermal output shall be verified.

For models in which the mass flow rate has influence on the thermal output additional characteristics must be tested, setting half and double standard mass flow.

5.3 Testing samples submission and identification

5.3.1 On initial application for the testing of a family of heating appliances, or of a type within a family, heating appliance samples and product drawings shall be submitted to the testing laboratory.

Product drawings shall be submitted by the manufacturer

5.3.2 The product drawings shall:

— show all dimensions and features having an influence on the heat emission, including the detail of welds or other assembly methods used;

— state the type of material and the nominal material thicknesses of an wet or dry surfaces, with the thickness tolerances, and type of paint.

5.3.3 Before proceeding with the thermal output testing, the laboratory shall identify the appliance against the drawing and shall note conformity of the sample with the drawing in respect of:

— dimensional tolerances given in table 3;

— material thickness tolerances of convective surfaces, shown on the product drawings.

The laboratory shall also measure the mass and the water content of the sample models. The relevant values shall be reported in the test report.

The models for test shall be selected as specified in **5.2** of this European Standard.

5.3.4 Samples of heating appliances already in production shall be taken from the production line or manufacturer's stock by the laboratory or its authorized representative.

Samples of prototype appliances shall be submitted by the manufacturer.

Table 3 — Dimensional tolerances

dimensions in millimetres or %									
	STEEL RADIATORS				**CAST IRON** (per section)	**EXTRUDED ALUMINIUM** (per section)	**CAST ALUMINIUM** (per section)	**FINNED TUBE CONVECTORS**	
Overall height [(1)] of heat exchanger	Panel Radiators	Tubular	Sectional	Lamellar					
H ≤ 250	+ 4 / - 2	+ 4 / - 2	± 2	+ 4 / - 2	± 3,0	± 2,5	± 2,5	Height of Casing (HC	+4 / -2
250 < H ≤ 500					± 3,5				
500 < H ≤ 600					± 4,0				
600 < H ≤ 900	+ 5 / - 2	+ 5 / - 2	± 2	+ 5 / - 2					+5 / -2
900 < H	+ 6 / - 2	+ 6 / - 2	± 2	+ 6 / - 2					+6 / -2
Overall Depth of heat exchanger									
All measures	+ 4 / - 3	± 1,5	± 2		± 2	± 0,65	+ 0 / - 1	Depth of Casing (TC,	+4 / -3
D ≤ 100				± 2					
100 < D				± 3					