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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Household electric instantaneous water heaters – Methods for measuring the performance –
Part 1: General aspects

Chauffe-eau instantanés électrodomestiques – Méthodes de mesure de l'aptitude à la fonction –
Partie 1: Aspects généraux

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HOUSEHOLD ELECTRIC INSTANTANEOUS WATER HEATERS – METHODS FOR MEASURING THE PERFORMANCE –

Part 1: General aspects

FOREWORD

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International Standard IEC 63159-1 has been prepared by subcommittee 59C: Electrical heating appliances for household and similar purposes, of IEC technical committee 59: Performance of household and similar electrical appliances.

The text of this International Standard is based on the following documents:

Draft	Report on voting
59C/267/FDIS	59C/271/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

A list of all the parts in the IEC 63159 series, published under the general title *Household electric instantaneous water heaters – Methods for measuring the performance*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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- replaced by a revised edition, or
- amended.

HOUSEHOLD ELECTRIC INSTANTANEOUS WATER HEATERS – METHODS FOR MEASURING THE PERFORMANCE –

Part 1: General aspects

1 Scope

This document applies to electric instantaneous water heaters for domestic hot water heating for household and similar applications, which show both of the following characteristics:

– fulfilling at least one load pattern from Annex A;

– heating up to temperatures below the boiling temperature.

This document specifies terms, definitions and measurement methods for the assessment of energy efficiency.

This document does not take into account requirements regarding the safety of the appliances.

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.

IEC 63159-2-1, *Household electric instantaneous water heaters – Methods for measuring the performance – Part 2-1: Multifunctional electric instantaneous water heaters*

IEC 63159-2-2, *Household electric instantaneous water heaters – Methods for measuring the performance – Part 2-2: Efficiency of single point of use electric instantaneous water heaters*

ISO 2768-1, *General tolerances – Part 1: Tolerances for linear and angular dimensions without individual tolerance indications*

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads – Part 1: Dimensions, tolerances and designation*

3 Terms and definitions

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

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

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

3.1
instantaneous water heater
appliance intended to heat water while it flows through the appliance

3.1.1
electric instantaneous water heater
instantaneous water heater using electric energy as its energy source

3.1.2
closed instantaneous water heater
instantaneous water heater intended to operate at the pressure of the water system, the flow of water being controlled by one or more valves in the outlet system

3.1.3
open-outlet instantaneous water heater
instantaneous water heater in which the flow of water is controlled by a valve in the inlet pipe, there being no valve in the outlet pipe

3.1.4
hydraulic instantaneous water heater
instantaneous water heater whose heating elements are each switched on or off, depending on the water flow rate or water pressure

3.2
temperature selector
actuator that presets the temperature set-point value of the water outlet and that can be adjusted by the user

3.3
temperature control
actuator that adjusts the temperature of the outlet water by varying the flow of water through the appliance or by varying the power applied to the heater(s), or by varying a combination of the two

3.4
independent flow control
actuator that adjusts the flow of water through the appliance with no significant change in the outlet's water temperature

3.5
flow regulator
actuator that limits the flow of water through the appliance regardless of variations in line pressure

3.6
flow restrictor
device that defines a flow of water through the appliance for a set pressure

3.7
power selector
actuator that presets electrical power of the unit and that can be adjusted by the user

Note 1 to entry: The water outlet temperature depends on flow rate and/or inlet temperature.

3.8
load profile
load pattern
means of illustrating the power consumption of an instantaneous water heater over a 24-hour period

3.9
smart control
system that can demonstrate a reduction in energy consumption

3.10
useable water
water at or above the temperature T_m for the relevant draw-off and load pattern specified in the tables of Annex A

3.11
static electric losses
part of the energy that is dissipated by unwanted effects, including energy lost by unwanted heating of resistive components

3.12
smart control factor
SCF
factor describing the water heating energy efficiency gain due to smart control

Note 1 to entry: The SCF value is between 0 and 1.

3.13
energy-related product
ErP
product that uses energy, or that does not use energy but has an impact on energy consumption

3.14
conversion coefficient
CC
factor to indicate how much primary energy is used to generate a unit of electricity

3.15
annual electricity consumption
AEC
electricity consumption per year

3.16
declared load profile
load profile declared by the manufacturer for the appliance

4 General test conditions

4.1 Measurement equipment

Table 1 gives the accuracy of measurement equipment.

Table 1 – Measurement equipment accuracy

Measurement parameters	Unit	Measurement uncertainty (accuracy)	Remarks
Ambient temperature	°C/K	±1,0 K	e)
Time	s	±0,1 s	b)
Cold inlet water temperature	°C/K	±0,2 K	b)
Hot outlet water temperature	°C/K	±1,0 K	a) b)
Water flow rate	l/min	±0,1 l/min or ±1 %	b) d)
Water pressure	Mpa	±5 %	c)
Input power	kW	±1 %	b)
Input power	W	±1 %	e)
Voltage	V	±0,5 %	b)
Current	A	±0,5 %	b)

a) Thermocouple with a diameter of maximum 0,5 mm, in midstream, positioned directly at the outlet and inlet of the appliance.

b) The measured values shall be expressed rounded to one decimal place.

c) The measured values shall be expressed rounded to three decimal places.

d) Whichever is higher.

e) The measured values shall be expressed rounded to integer.

4.2 Number of appliances to be tested

The test shall be performed on a single appliance.

4.3 General conditions

Unless otherwise specified, the appliance shall be installed, commissioned and operated in accordance with the information provided in the installation and operating instructions.

Commissioning procedures shall be repeated following a supply voltage interruption, if required by the installation and operating instructions.

The supply voltage shall be maintained at the main terminal at the maximum rated voltage marked on the appliance ±1 % as defined by the manufacturer’s installation guide, while the heating elements are switched on. The supply frequency shall be at a nominal 50 Hz ± 0,05 Hz or 60 Hz ± 0,06 Hz, in accordance with the manufacturer's instructions.

The measured voltage and frequency of the power supply used during testing shall be reported.

The tests shall be carried out in a draft free environment at an ambient temperature of 20 °C ± 5 °C. The environment shall not deviate by more than 2 K during the test period.

NOTE See conditions (t_{amb}) for other countries.

The flow rates provided to the appliance for the test shall be maintained within a tolerance of ±0,3 l/min or ±3 %, whichever is higher, but shall not be below the minimum required for the individual draw-off. The flow rates supplied during the test shall be reported.

Unless otherwise specified, the cold inlet water temperature shall be 10 °C ± 1 °C.

4.4 Test setup

The appliance shall be installed in accordance with the installation instructions.

The declared load profile in accordance with Annex A can be the maximum, or one below the maximum load profile the water heater can fulfil.

The measurement setup shall correspond to Annex B (Figure B.1 to Figure B.4).

5 Energy efficiency

5.1 Test methods

5.1.1 General

The following tests are required to determine the values of Q_{elec}.

5.1.2 Static efficiency

5.1.2.1 Defined value

The static losses in electronic instantaneous water heaters are mainly determined by lines and electronic components (active power losses). The ratio of static losses to the rated power is very small, so the static loss Eta_{stat} is set to 0,99. Alternatively, the measurement procedure of 5.1.2.2 shall be used.

5.1.2.2 Measurement procedure

This test shall measure the static loss of the appliance P_{loss} at nominal load P_{nom} under steady-state conditions.

If the appliance has a power selector, the selector should be adjusted to the highest value. If the appliance has an independent flow control, it shall be adjusted to achieve the value stated in the manufacturer's installation instructions, or where this is not stated, it shall be set to the highest value.

If the appliance has a temperature control, the selector shall be adjusted to the highest value.

For the purposes of this test, the result is independent from the water inlet temperature; therefore, this test can be carried out with a cold water inlet temperature in the range of 10 °C to 25 °C. The inlet water temperature and flow rate shall be such that the appliance is caused to operate at full power continuously.

The value of P_{nom} is the power consumption of the appliance measured after a minimum of 30 min of operation under full load conditions.

The value of P_{loss} is the sum of all internal power losses (product of current and voltage losses between the terminals and the heating elements) of the appliance measured after a minimum of 30 min of operation under full load conditions.

For instantaneous water heaters with semiconductor power switches (e.g. triacs), the voltage across the semiconductor power terminals is subtracted from the measured voltage losses if the semiconductor power switches are thermally connected to the water pipe. In this case, the heat developed by the semiconductor power switches is transferred to useful energy to heat up the water.

The static efficiency is calculated from the formula:

$$\eta_{\text{static}} = \frac{P_{\text{nom}} - P_{\text{loss}}}{P_{\text{nom}}}$$

where

P_{nom} nominal power consumption of the appliance, in kW;

P_{loss} measured internal static losses of the appliance, in kW;

η_{static} static efficiency of the appliance as a factor.

5.1.3 Start-up losses

This test shall measure the time t_{start_i} that elapses between energizing the heating elements and the delivery of useable water and the power consumption P_{static_i} of the appliance at steady state during the delivery of useable water for each different draw-off of the declared load pattern of Annex A. The test method assumes the power consumption of the appliance during the start-up period is equal to the power consumed in steady-state conditions of the appliance for the specific draw-off i.

If the appliance has a power selector, the selector should be adjusted to the highest value. If the appliance has an independent flow control, it shall be adjusted to achieve the value stated in the manufacturer's installation instructions, or where this is not stated, it shall be set to the highest value.

If the appliance has a temperature control, the selector should be adjusted to the highest value.

The prescribed minimum flow rate f_i of each individual draw-off of the tapping pattern is used in accordance with Annex A. If this is not achievable, increase the flow rate until the appliance is able to provide hot water continuously with static heating conditions. This increased flow rate is used for the individual draw-off instead of the prescribed minimum flow rate. It can be necessary to determine the required flow rate for each individual draw-off where the product may not be able to run continuously at the prescribed minimum flow rate by experimentation before beginning the full series of draw-offs for the declared load pattern of Annex A.

Three measurements shall be performed for each specific draw-off type i and the mean value calculated from these measurements. Each of these measurements shall be performed with the product flushed. This should be done by flowing cold water through the product without the heating elements being energized and by monitoring the inlet and outlet temperatures until the difference between the inlet and outlet temperatures is within 1 K.

The start-up loss for each specific draw-off i is calculated from the formula:

$$Q_{\text{start}_i} = P_{\text{static}_i} \times \frac{t_{\text{start}_i}}{3\,600}$$

where

t_{start_i} is the measured start-up time, in s;

P_{static_i} is the measured steady-state power consumption, in kW, for specific draw-off i;

Q_{start_i} is the start-up losses, in kWh, for specific draw-off i.

5.2 Calculation methods

5.2.1 General

The following calculation methods enable the values of Q_{elec} to be calculated using the results from the tests described in 5.1 for a chosen tapping pattern, in accordance with Annex A.

5.2.2 Daily energy demand

The daily energy demand Q_{elec} is the sum of losses and useful energy of all individual draw-off i per day, in accordance with Annex A.

The daily energy demand is calculated from the formula:

$$Q_{elec} = \sum_{i=1}^{n} \left(Q_{start_i} + \frac{Q_{tap_i}}{\eta_{static}} \right)$$

Where

Q_{elec} is the daily energy demand, in kWh;

Q_{start_i} is the start-up loss for specific draw-off i, in kWh, determined in 5.1.3;

Q_{tap_i} is the predefined useful energy content per draw-off i, in kWh, as specified for the relevant load pattern in Annex A;

η_{static} is the static efficiency of the appliance determined in 5.1.2.

5.2.3 Efficiency calculation

5.2.3.1 Determination of the smart control factor SCF

For instantaneous water heaters, to be set as SCF = 0.

NOTE The value of SCF can differ for other appliances, such as electrical storage water heaters. Nevertheless, the formulas used are the same.

5.2.3.2 Correction factor

The correction factor is calculated from the formula:

$$Q_{cor} = -k \times CC \times (Q_{elec} - Q_{ref})$$

where

k is 0,23 for load profiles 3XS to XL and 0 for profiles XXL to 4XL;

CC is the primary energy factor;

NOTE The value of CC is given by the local regulation. In Europe, the value of CC is currently 2,5.

Q_{elec} is the daily energy demand determined in 5.2.2;

Q_{ref} is the daily (24 h) useful energy content as specified for the declared load pattern in Annex A.

5.2.3.3 Energy efficiency

The efficiency of the appliance is calculated from the formula: