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Edition 4.0 2023-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Methods for measuring the performance of electric storage water heaters for household purposes

Méthodes de mesure de l'aptitude à la fonction des chauffe-eau électriques à accumulation à usages domestiques

IEC 60379:2023-02(en-fr)

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METHODS FOR MEASURING THE PERFORMANCE OF ELECTRIC STORAGE WATER HEATERS FOR HOUSEHOLD PURPOSES

FOREWORD

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IEC 60379 has been prepared by subcommittee SC59C: Electrical heating appliances for household and similar purposes, of IEC technical committee 59: Performance of household and similar electrical appliances. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 1987. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) sustainable development aspects of EU legislation are taken into account, including features such as smart control, V_{40} modification and measuring procedures for multi-tank appliances.

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

Draft	Report on voting
59C/282/FDIS	59C/285/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.

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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- withdrawn,
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METHODS FOR MEASURING THE PERFORMANCE OF ELECTRIC STORAGE WATER HEATERS FOR HOUSEHOLD PURPOSES

1 Scope

This document specifies methods for measuring the performance of electric storage water heaters to produce domestic potable or non-potable hot water for household and similar use.

The object is to state and define the principal performance characteristics of electric storage water heaters and to describe the test methods for measuring these characteristics.

NOTE 1 This document does not apply to:

- storage water heaters that use electricity as a secondary source of heating the water;
- storage water heaters that do not use a tank to store hot water;
- electric storage water heaters that do not meet the minimum (or maximum) output performance of the smallest (or biggest) load profile, as defined in Table 3;
- water-heaters without thermal insulation.

NOTE 2 This document does not specify safety requirements. For safety requirements, see IEC 60335-1 in conjunction with IEC 60335-2-21.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

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

3.1
storage water heater
water heater that uses electric heating elements as the means of heating water for long-term storage in a thermally insulated container and provided with a device to control the water temperature

3.2
primary function
production of hot water for household and similar needs

3.3
energized storage water heater
storage water heater that is designed to supply hot water and be energized for 24 h per day

3.4
off-peak storage water heater
storage water heater that is designed to supply hot water and configured or installed, whilst only being supplied with electrical energy at off-peak/low-tariff periods

Note 1 to entry: The off-peak storage water heater is required to fulfil the requirements of the tapping pattern between 7:00 h and 22:00 h without external energy supply, e.g. to enable operation at off-peak/low-tariff periods and/or to operate in conditions of insecurity of energy supply. A product qualifies as "off-peak" if it is only energized for a maximum of 8 consecutive hours anywhere between 22:00 h and 7:00 h during the test with the 24h load profile.

3.5
load profile
output performance (in terms of flowrates, temperatures, tapping pattern, etc.) of a storage water heater when fulfilling its primary function under specific ambient conditions (see Table 2 and Table 3), as declared by the manufacturer

3.6
energy efficiency
ratio between the delivered energy in the domestic potable or non-potable hot water for its load profile and the consumed electrical energy

3.7
storage volume
rated quantity of water stored in the appliance

3.8
smart control
device that automatically adapts the water heating process to individual usage conditions with the aim of reducing energy consumption

3.9
out-of-the-box mode
standard operating condition, setting or mode set by the manufacturer at factory level, to be active immediately after the appliance's installation, suitable for normal use by the end-user according to the water tapping pattern for which the product has been designed and placed on the market

3.10
closed water heater
unvented storage 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

3.11
cistern-fed water heater
water heater supplied from a cistern in which the flow of water is controlled by one or more valves in the outlet system, and which is provided with a vent open to the atmosphere and so arranged that the expanded water can return to the feed cistern

3.12
open outlet water heater
water heater in which the flow of water is controlled by a valve in the inlet pipe and so arranged that the expanded water can overflow through the outlet pipe

3.13
vented water heater
water heater open to the atmosphere, so that under no condition of use can the pressure at the surface of the water be other than atmospheric

3.14
cistern-type water heater
cistern-fed water heater which has a feed cistern as an integral part of the appliance

3.15
multi-tank water heater
water heater with two or more hydraulic connected containers, designed to have the possibility to work independently in terms of working temperature and/or pressure condition

Note 1 to entry: A multi-tank product has to be defined as directly measurable if it is possible to measure the temperature (immersed or welded sensors) of all the dome tanks without compromising the product's performances, otherwise the product has to be classified as not directly measurable. Based on that definition for the dome tanks' temperature measurement, the multi-tank products are defined as:

- directly measurable, or
- not directly measurable.

3.16
rated capacity
assigned water capacity of the water heater, and marked on it, by the manufacturer

3.17
standing loss per 24 h
energy-consumption of a filled water-heater, after steady-state conditions have been reached, when connected to the electrical supply, during any 24 h duration when no water is withdrawn

3.18
rated voltage
voltage (for three phase-supply, the voltage between phases) assigned to the appliance by the manufacturer

3.19
V_{40Ref}
mixed water quantity delivered at 40 °C with 65 °C storage temperature and 15 °C cold water inlet temperature

3.20
V_{40max}
mixed water quantity delivered at 40 °C with maximum storage temperature setting and 15 °C cold water inlet temperature with heating elements powered on

Note 1 to entry: Maximum rated power of the appliance.

3.21
V_{40}
mixed water quantity delivered at 40 °C with out-of-the-box mode temperature setting and 10 °C cold water inlet temperature

3.22
smart control factor
SCF
factor describing the water heating energy efficiency gain due to smart control

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

3.23
energy-related product
ErP
product that uses energy, or that does not use energy, but has an impact on energy consumption

3.24
conversion coefficient
CC
factor to indicate how much primary energy is used to generate a unit of electricity

3.25
declared load profile
load profile declared by the manufacturer for the appliance

4 Symbols and units

Symbol	Unit	Description
η_{elecwh}	[%]	Electric energy efficiency of a storage water heater.
Q_{ref}	[kWh]	Reference energy for the 24 h tapping pattern for the load profile of the water heater.
Q_{elec}	[kWh]	Electricity consumption with the relevant 24 h tapping pattern.
θ_{amb}	[°C]	Ambient temperature during the tests
θ'_{p}	[°C]	Mean water temperature for the determination of θ_{p}, measured at the outlet
θ_{M}	[°C]	Mean water temperature without withdraw from the tank
f	[l/min]	Minimum flow rate at which hot water is contributing to the reference energy as specified in Table 3.
T_{m}	[°C]	Water temperature at which hot water starts contributing to the reference energy as specified in Table 3
T_{p}	[°C]	Minimum water temperature to be achieved during water draw off as specified in Table 3
T_{set}	[°C]	Set-point temperature
$t_{R,50}$		Reheating time for a water temperature rise of 50 K
$Q_{testelec}$	[kWh]	Measured electricity consumption over 24 h test (step 4 of Figure 1 and Figure 2).
Q_{H2O}	[kWh]	Useful energy content of the hot water of n draw-offs
$V_{\text{full-drawing water}}$	[l]	Sum of quantity of hot water totally delivered during the tapping period.
V_{40_exp}	[l]	Measured volume delivered at the mean water temperature.
V_{40}	[l]	Mixed water quantity delivered at 40 °C.
V_{40Ref}	[l]	mixed water quantity delivered at 40 °C with 65 °C storage temperature and 15°C cold water inlet temperature
V_{40max}	[l]	Mixed water quantity delivered at 40 °C with maximum temperature setting and heating elements powered on
C_{R}	[l]	Rated capacity of water heater (given by manufacturer)
C_{act}	[l]	Actual capacity of water heater
m_{act}	[kg]	Actual weight of water contained inside the tank of the Water Heater
m		Number of tanks (containers) of the appliance
$\theta_{A1tanks}$	[°C]	Mean water temperature calculated as average of the j-tank for the first thermostat cut-out
$\theta_{Antanks}$	[°C]	Mean water temperature calculated as average of j-tank for the last (n) thermostat cut-out
θ_{Mj}	[°C]	Mean water temperature without withdraw of the j-tank
θ_{M_mt}	[°C]	Mean water temperature without withdraw of all the tanks
θ_{Aij}	[°C]	Measured water temperature after a thermostat cut-out for the j-tank

Symbol	Unit	Description
θ_{Aj}	[°C]	Mean water temperature after a thermostat cut-out for the j-tank
θ_{Eij}	[°C]	Measured water temperature after a thermostat cut-in for the j-tank
θ_{Ej}	[°C]	Mean water temperature after a thermostat cut-in for the j-tank
θ_{up}	[°C]	Measured temperature in the upper section of the tank
smart		Presence or not of smart control (value shall be 0 or 1).
SCF		Efficiency gain by smart control function.

5 Calculation of the electrical energy efficiency (η_{elecwh})

The electrical energy efficiency (η_{elecwh}) of a storage water heater is the ratio between the delivered energy in the hot water for the tapping pattern of its load profile and the consumed energy. The consumed energy is the result of the test of the water heater with adjustments for:

- smart control that can reduce the energy consumption

The electrical energy efficiency of a storage water heater shall be calculated with Formula (1):

$$\eta_{elecwh} = \frac{Q_{ref}}{Q_{elec}\left(1 - SCF \cdot smart\right)} \quad (1)$$

where:

Q_{ref} is the delivered energy for the 24 h tapping pattern for the load profile of the water heater, in kWh;

Q_{elec} is the consumption of electric energy with the relevant 24 h tapping pattern, in kWh;

smart indicates the presence of smart control and is yes = 1, no = 0;

SCF factor for efficiency gain by smart control function.

NOTE SCF=0 in case no smart control is detected during testing (see 9.2).

6 Measured parameters

The parameters below shall be established following the measurement methods described in Clause 7 and Clause 9:

1) Q_{elec} electricity consumption [kWh/d]
2) η_{elecwh} electrical energy efficiency [%]
3) C_{act} storage volume [l]

7 General conditions for measurements

Measurements shall be carried out with an electrical supply satisfying the characteristics outlined in Table 1.

Table 1 – Electricity

Measured quantity	Unit	Value	Permissible deviation (average over test period)	Uncertainty of measurement (accuracy)	Notes
Electricity					
Power	W			±2 %	
energy	kWh			±2 %	
voltage	V	Rated value	±2 %	±0,5 %	
electric current	A			±0,5 %	
frequency	Hz	Rated value	±1 %		

Table 2 gives additional test conditions and tolerances for test outputs (i.e. thermal energy).

Table 2 – Test conditions, outputs, set values and tolerances.

Measured quantity	Unit	Value	Permissible deviation (average over test period)	Permissible deviations of individual measured values	Uncertainty of measurement (accuracy)	Notes
Time						
Time	s				±0,1 s	
Maximum interval between samples (during the delivery of hot water)	s	3				
Maximum interval between samples (during the non-deliver of hot water)	s	60				
Domestic potable or non-potable water						
Cold water temperature for 9.1.5 to 9.2	°C/ K	10 °C	±1 K	±1 K	±0,5 K	
Cold water temperature for 9.3 to 9.7	°C/ K	15 °C	±1 K	±1 K	±0,5 K	
Cold-water pressure	MPa	0,3 MPa			± 5 %	
Hot-water temperature	°C/ K	pattern			±0,5 K	a, b
Volume flowrate	l / min	pattern			≥ 5 l/min: ±1% < 5l/min: ±0,05 l/min	
Volume measurements	l				± 0,5 %	
Thermal energy	kWh	pattern	≥ 0,5 kWh: ±2 % < 0,5 kWh: 10 Wh	≥ 0,5 kWh: ±2 % < 0,5 kWh: 10 Wh	≥ 0,5 kWh: ±2 % < 0,5 kWh:10 Wh	c

Measured quantity	Unit	Value	Permissible deviation (average over test period)	Permissible deviations of individual measured values	Uncertainty of measurement (accuracy)	Notes
Ambient air						
Temperature	°C/K	20 °C	±1 K		±1 K	
Humidity	%	< 85				[d]

[a] To be measured with a "rapid response thermometer", meaning an instrument that registers within 1 s at least 90 % of the final temperature rise from 15 °C to 100 °C when the sensor is plunged in still water.

[b] Thermocouple with a maximum diameter of 0,5 mm, centred in stream, directly at outlet.

[c] Apart from the maximum deviation, a correction factor Q_{ref}/Q_{H2O} is applied, whereby Q_{ref} is taken from Table 3 and Q_{H2O} is the energy content of the useful water actually delivered during the test. "Useful water" is water with a temperature higher than a threshold value T_m for tappings in a profile specified in Table 3.

[d] The values for temperature and relative humidity are only valid at steady-state conditions and not at the moment when hot water is withdrawn from the water heater.

All other installation requirements are carried out in accordance with the manufacturer's instructions. All pipe connections of the test setup shall be thermally insulated, in accordance with the values given in Table B.1.

8 Reference conditions

Table 3 specifies the tapping patterns for the chosen load profile. Parameters in the table are:

a) load profile [XXS-4XL, in header row of table];

b) h: hour [hh:mm] starting at 0:00 h;

c) Q_{tap} [kWh]: useful energy content of water withdrawal to be achieved in the draw-off;

d) f [l/min]: minimum flow rate to be reached during tapping;

e) T_m [°C]: temperature from which counting of useful energy content starts;

f) T_p [°C]: minimum (peak) temperature to be achieved during tapping;

g) Q_{ref} [kWh/d]: daily (24 h) useful energy content of all water draw-offs, effectively the sum of all Q_{tap}.

As much as possible, the test method uses a 'black-box' approach, i.e. largely technology-independent. This means, among other things, that the laboratory uses the original appliance thermostat, in the out-of-the-box mode.

Table 3 – Load profile of the water heater (reference test tapping patterns)

	XXS				XS				S			
	Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p
h	kWh	l/min	°C	°C	kWh	l/min	°C	°C	kWh	l/min	°C	°C
07.00	**0,105**	2	25						**0,105**	**3**	**25**	
07.05												
07.15												
07.26												
07.30	**0,105**	2	25		**0,525**	**3**	**35**	-	**0,105**	**3**	**25**	
07.45												
08.01												
08.05												
08.15												
08.25												
08.30	**0,105**	2	25						**0,105**	3	25	
08.45												
09.00												
09.30	**0,105**	2	25						**0,105**	3	25	
10.00												
10.30												
11.00												
11.30	**0,105**	2	25						**0,105**	3	25	
11.45	**0,105**	2	25						**0,105**	3	25	
12.00	**0,105**	2	25									
12.30	**0,105**	2	25									
12.45	**0,105**	2	25		**0,525**	3	35	-	**0,315**	4	10	55
14.30												
15.00												
15.30												
16.00												
16.30												
17.00												

	M				L				XL			
	Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p
h	kWh	l/min	°C	°C	kWh	l/min	°C	°C	kWh	l/min	°C	°C
07.00	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
07.05	**1,400**	6	40		**1,400**	6	40					
07.15									**1,820**	6	40	
07.26									**0,105**	3	25	
07.30	**0,105**	3	25		**0,105**	3	25					
07.45					**0,105**	3	25		**4,420**	10	10	40
08.01	**0,105**	3	25						**0,105**	3	25	
08.05					**3,605**	10	10	40				
08.15	**0,105**	3	25						**0,105**	3	25	
08.25					**0,105**	3	25					
08.30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
08.45	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
09.00	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
09.30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
10.00									**0,105**	3	25	
10.30	**0,105**	3	10	40	**0,105**	3	10	40	**0,105**	3	10	40
11.00									**0,105**	3	25	
11.30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
11.45	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
12.00												
12.30												
12.45	**0,315**	4	10	55	**0,315**	4	10	55	**0,735**	4	10	55
14.30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
15.00									**0,105**	3	25	
15.30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
16.00									**0,105**	3	25	
16.30	**0,105**	3	25		**0,105**	3	25		**0,105**	3	25	
17.00									**0,105**	3	25	

	XXL				3XL				4XL			
	Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p	Q_{tap}	f	T_m	T_p
h	kWh	l/min	°C	°C	kWh	l/min	°C	°C	kWh	l/min	°C	°C
07.00	**0,105**	3	25		**11,2**	48	40		**22,4**	96	40	
07.05												
07.15	**1,820**	6	40									
07.26	**0,105**	3	25									
07.30												
07.45	**6,240**	16	10	40								
08.01	**0,105**	3	25		**5,04**	24	25		**10,08**	48	25	
08.05												
08.15	**0,105**	3	25									
08.25												
08.30	**0,105**	3	25									
08.45	**0,105**	3	25									
09.00	**0,105**	3	25		**1,68**	24	25		**3,36**	48	25	
09.30	**0,105**	3	25									
10.00	**0,105**	3	25									
10.30	**0,105**	3	10	40	**0,84**	24	10	40	**1,68**	48	10	40
11.00	**0,105**	3	25									
11.30	**0,105**	3	25									
11.45	**0,105**	3	25		**1,68**	24	25		**3,36**	48	25	
12.00												
12.30												
12.45	**0,735**	4	10	55	**2,52**	32	10	55	**5,04**	64	10	55
14.30	**0,105**	3	25									
15.00	**0,105**	3	25									
15.30	**0,105**	3	25		**2,52**	24	25		**5,04**	48	25	
16.00	**0,105**	3	25									
16.30	**0,105**	3	25									
17.00	**0,105**	3	25									