

INTERNATIONAL STANDARD

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**Household electric cooking appliances –
Part 2: Hobs – Methods for measuring performance**

**Appareils de cuisson électrodomestiques –
Partie 2: Tables de cuisson – Méthodes de mesure de l'aptitude à la fonction**



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**Household electric cooking appliances –
Part 2: Hobs – Methods for measuring performance**

**Appareils de cuisson électrodomestiques –
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CONTENTS

FOREWORD	6
1 Scope	8
2 Normative references	8
3 Terms and definitions	8
4 List of measurements	12
4.1 Dimensions and mass	12
4.2 Cooking zones and cooking areas	12
4.3 Cleaning	12
5 General conditions for the measurements	12
5.1 Test room	12
5.2 Electricity supply	12
5.3 Instrumentation and measurements	13
5.4 Positioning the appliance	14
5.5 Initial conditions	14
5.6 Cookware	14
5.6.1 Standardized cookware	14
5.6.2 Alternative cookware	19
6 Dimensions and mass	20
6.1 Overall dimensions	20
6.2 Mass of the appliance	22
6.3 Cooking zones and cooking areas	22
6.3.1 Number of cooking zones per hob	22
6.3.2 Dimensions of cooking zones	22
6.3.3 Dimensions of cooking areas	23
6.4 Level of solid hotplates	23
6.5 Distance between cooking zones	24
7 Energy consumption and heating up time	24
7.1 General	24
7.2 Purpose	24
7.3 Determine a cookware set to assess a hob with cooking zones	24
7.4 Positioning the cookware on a cooking zone	25
7.5 Procedure for measuring the energy consumption of a cooking process	26
7.5.1 Preparation	26
7.5.2 Preliminary measurements	26
7.5.3 Measuring the energy consumption	28
7.5.4 Evaluation and calculation	29
7.6 Procedure for measuring the heating up time	30
8 Ability to control the temperature of a load	31
8.1 Lower control position	31
8.1.1 Purpose	31
8.1.2 Cookware, positioning and ingredients	31
8.1.3 Procedure	31
8.1.4 Assessment	32
8.2 Temperature overshoot of hotplates	32
8.2.1 Purpose	32

8.2.2	Ingredients and cookware	32
8.2.3	Procedure	32
8.2.4	Assessment	33
9	Heat distribution and heat supply	33
9.1	Measuring the heat distribution	33
9.1.1	Test purpose	33
9.1.2	Discs	33
9.1.3	Pre-test for determining the setting	34
9.1.4	Preparation of the disc for the main test	35
9.1.5	Main test	36
9.1.6	Assessment	36
9.2	~~Measuring the~~ Continuous frying	40
9.2.1	~~Purpose~~	
9.2.2	~~Specification of the frying pan~~	
9.2.3	~~Recipe for pancakes~~	
9.2.4	~~Procedure~~	
9.2.5	~~Assessment~~	
9.2.1	Purpose	42
9.2.2	Specification of the frying pan	42
9.2.3	Recipe and amounts	43
9.2.4	Pre-test	44
9.2.5	Main test	44
9.2.6	Assessment	45
10	Heat performance of cooking zones	46
10.1	Purpose	46
10.2	Procedure	47
11	Smallest detected diameter for induction cooking zones	48
11.1	Purpose	48
11.2	Procedure	48
12	Power measurement of low power modes	49
13	Spillage capacity of hobs	50
	Annex A (normative) Further requirements for measuring the energy consumption and heating up time for cooking areas	51
A.1	General	51
A.2	Hob with cooking area	51
A.2.1	General	51
A.2.2	Cooking area without limitative marking	51
A.2.3	Hob with cooking area with limitative marking	52
A.2.4	Hob with cooking zones and cooking areas	53
A.3	Positioning on a cooking area	53
A.3.1	General	53
A.3.2	Positioning on a cooking area without limitative markings	53
A.3.3	Positioning on a cooking area with limitative markings	54
	Annex B (informative) Aids for measuring the energy consumption according to Clause 7	58
B.1	Fixing the temperature measurement instrument to the lid – Example	58
B.2	Marking the lowest possible simmering power setting	58
	Annex C (informative) Examples how to select and position the cookware for measurements according to Clause 7 and Annex A	60

C.1	Example 1 – Cooking zones	60
C.2	Example 2 – cooking zones combined with cooking area with limitative markings	61
C.3	Example 3 – cooking area with limitative markings > 3 controls with the area of control in front.....	64
C.4	Example 4 – cooking area with limitative markings > 3 controls with the area of control at the side	67
Annex D	(normative) Shade chart	70
Annex E	(informative) Data and calculation sheet: energy consumption of a cooking process (see Clause 7 and Annex A)	72
Annex F	(informative) Addresses of suppliers	73
F.1	General.....	73
F.2	Disc material (C45) for measuring the smallest detected diameter	73
F.3	Stainless steel for bottom material of the standardized cookware.....	73
F.4	Cookware for measuring the energy consumption and heating up time.....	73
F.5	Disc for measuring the heat distribution	73
F.6	Lamp for digital measurement systems	73
F.7	Digital measurement system	74
F.8	Testcharts for checking the resolution of the imaging system	74
Annex G	(informative) Example for assessing the lower control position	75
G.1	General.....	75
G.2	Criteria.....	75
Annex H	(informative) Pre-test for determining the simmering setting regarding the measurement of energy consumption.....	76
H.1	Purpose	76
H.2	Procedure to determine an adequate simmering setting	76
Bibliography		78
Figure 1	– Standardized cookware	19
Figure 2	– Dimensions of appliances.....	21
Figure 3	– Dimensions of built-in hobs	22
Figure 4	– Device for checking the level of solid hotplates	23
Figure 5	– Overshoot measurement	26
Figure 6	– Energy consumption measurement process for a cooking process	28
Figure 7	– Diametral lines	40
Figure 8	– Disc to determine the smallest detected diameter	49
Figure A.1	– Layout for a hob with cooking area without limitative marking – Example	51
Figure A.2	– Layouts for a hob with a cooking area with limitative marking – Examples	52
Figure A.3	– Drawing layer.....	54
Figure A.4	– Position a cookware set on a cooking area with limitative markings ≤ 3 controls – Example	55
Figure A.5	– Position a cookware set on a cooking area with limitative markings > 3 controls – Example	57
Figure B.1	– Position of the temperature measurement instrument.....	58
Figure B.2	– Polar coordinate paper – Example	59
Figure C.1	– Example 1: tubular hotplates, solid hotplates, radiant cooking zone or induction cooking zone	60

Figure C.2 – Example 1: selecting and positioning of cookware	61
Figure C.3 – Example 2: induction or radiant cooking zones combined with a cooking area with limitative markings	62
Figure C.4 – Example 2: selecting and positioning of cookware	63
Figure C.5 – Example 3: Cooking area with limitative markings > 3 controls with the area of the control in front	64
Figure C.6 – Example 3: procedure how to shift the cookware into the correct position – Step 1	65
Figure C.7 – Example 3: Procedure how to shift the cookware into the correct position – Step 2	66
Figure C.8 – Example 4: Cooking area with limitative markings > 3 controls with the area of the control at the side	67
Figure C.9 – Example 4: procedure how to shift the cookware into the correct position – Step 1	68
Figure C.10 – Example 4: procedure how to shift the cookware into the correct position – Step 2	69
Table 1 – Instruments	13
Table 2 – Measurements	13
Table 3 – Sizes of standardized cookware and water amounts	16
Table 4 – Criteria for selecting the cookware set regarding cooking zones	25
Table 5 – Amount of oil	31
Table 6 – Specifications for discs used for measuring the heat distribution	34
Table 7 – maximum time $t_{\max}$ for each size of disc	38
~~Table 8 – Ingredients and cooking durations~~	~~43~~
Table 8 – Ingredients	43
Table 9 – Quantities for heat performance test	47
Table 10 – Frying times for potato chips	47
Table 11 – Quantity of batter per pancake	44
Table 12 – Example for the assessment of pancakes	46
Table A.1 – Criteria for the cookware set for measuring cooking areas without limitative marking	52
Table A.2 – Criteria for the cookware set for measuring cooking areas with limitative marking	53
Table D.1 – Classification of shade numbers regarding R_y	70
Table D.2 – Examples for the shade charts regarding L^* , R_y and the specification of the limiting samples H_{limit} and H_{lower}	71

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HOUSEHOLD ELECTRIC COOKING APPLIANCES –**Part 2: Hobs – Methods for measuring performance****FOREWORD**

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60350-2 edition 2.1 contains the second edition (2017-08) [documents 59K/293/FDIS and 59K/294/RVD] and its amendment 1 (2021-05) [documents 59K/329/FDIS and 59K/332/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 60350-2 has been prepared by subcommittee 59K: Performance of household and similar electrical cooking appliances, of IEC technical committee TC 59: Performance of household and similar electrical appliances.

This second edition constitutes a technical revision.

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

- a) terms and definitions revised and new definitions added (see 3);
- b) following the new market trend, requirements related to so-called flexible and free induction zones – in this document named as **cooking areas** – are added;
- c) specification for standardized and alternative cookware is introduced (see 5.6);
- d) measurement procedure reflecting a household-like cooking process for measuring the energy consumption is introduced (see Clause 7 and Annex A);
- e) revision of measurement procedure for determining the accuracy of control (see Clause 8);
- f) new reproducible measurement procedure for assessing the heat distribution (see Clause 9);
- g) additional requirements (according to IEC 62301:2011) on how to measure low-power modes.

In this document, terms in bold characters are defined in Clause 3.

This standard contains attached files in the form of a spreadsheet. These files are intended to be used as a complement and do not form an integral part of the standard.

The French version of this standard has not been voted upon.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60350 series, published under the general title *Household electric cooking appliances*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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HOUSEHOLD ELECTRIC COOKING APPLIANCES –

Part 2: Hobs – Methods for measuring performance

1 Scope

This part of IEC 60350 defines methods for measuring the performance of electric **hobs** for household use.

Appliances covered by this document can be built-in or designed to be placed on a work surface. The **hob** can also be a part of a cooking range.

~~This document does not apply to portable appliances for cooking, grilling and similar functions (see IEC 61817).~~

This document defines the main performance characteristics of **hobs** which are of interest to the user and specifies methods for measuring these characteristics.

This document does not specify a classification or ranking for performance.

NOTE 1 Some of the tests which are specified in this document are not considered to be reproducible since the results can vary between laboratories. They are therefore intended for comparative testing purposes only.

NOTE 2 This document does not deal with safety requirements (IEC 60335-2-6 and IEC 60335-2-9).

NOTE 3 This document is also applicable for portable appliances with similar functionality that were previously covered by the withdrawn IEC 61817.

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 62301:2011, *Household electrical appliances – Measurement of standby power*

IEC 60364-5-54, *Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*

ISO 80000-1:2009, *Quantities and units – Part 1: General*

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

cooking range

appliance having a **hob** and at least one **oven** and which may incorporate a **grill**

Note 1 to entry: Methods for measuring performance of ovens are described in IEC 60350-1.

3.2

hob

appliance or part of an appliance which incorporates one or more **cooking zones** and/or **cooking areas** including a **control** unit

Note 1 to entry: A **hob** is also known as a cooktop.

Note 2 to entry: The **control** unit can be included in the **hob** itself or integrated in a **cooking range**.

3.3

cooking zone

limitative marking on the surface of a hob where one cookware is placed and heated or an attached area to the surface

EXAMPLE

A **cooking zone** can be:

- a **single zone** or a **multiple zone** (see 3.4 and 3.5);
- a **solid hotplate** (see 3.6);
- a **tubular hotplate** (see 3.7);
- a **radiant cooking zone** (see 3.8);
- an **induction cooking zone** (see 3.9).

Note 1 to entry: **Cooking zones** which are used without cookware but by positioning the food directly on the surface are not included.

Note 2 to entry: Sometimes there is a decoration symbol, e.g. a cross, to mark the centre of the **cooking zone** additionally.

3.4

single zone

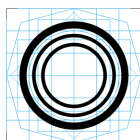
cooking zone marked for one cookware size

3.5

multiple zone

cooking zone marked for more than one cookware size and shape which can be circular, elliptical or a combination

EXAMPLE 1 Circular **multiple zone** for three different cookware sizes:



[IEC 60417-Pr17-001]

EXAMPLE 2 Circular and elliptical **multiple zone**:



[IEC 60417-5492:2002-10]

3.6

solid hotplate

cooking zone having a closed surface, which is usually constructed from cast iron, with an integrated heating element

3.7

tubular hotplate

cooking zone having a surface which is formed by the configuration of a tubular heated heating element in a substantially flat plane

3.8

radiant cooking zone

cooking zone on which the pan is heated by means of a radiant heating element below the glass ceramic which could have a heating ribbon, heating spiral or a tungsten wire which is located in a quartz glass bulb or combination of these

3.9

induction cooking zone

cooking zone on which the pan is heated by means of an induction element below the glass ceramic or similar where the eddy currents are induced in the bottom of the pan by a magnetic field

3.10

cooking area without limitative markings

area where cookware is placed and heated by an inducted magnetic field without limitative markings

EXAMPLE See Figure A.1

Note 1 to entry: **Cooking areas** which are used without cookware but by positioning the food directly on the surface are not included.

Note 2 to entry: Sometimes there are one or more decoration symbols, e.g. a cross, on the **cooking area** to mark the centre position where the cookware is placed.

3.11

cooking area with limitative markings

area where cookware is placed and heated by an inducted magnetic field where the area is marked to show the limits where more than one cookware can be used simultaneously while the cookware pieces can be used and controlled separately from each other at the same time

EXAMPLE See Figure A.2

Note 1 to entry: **Cooking areas** which are used without cookware but by positioning the food directly on the surface are not included.

Note 2 to entry: The **cooking area** is also used combined for one cookware, even if there is more than one control.

3.12

control

part of the **hob** for adjusting the power or temperature respectively of a **cooking zone** or a **cooking area** for one piece of cookware, independent from technical solution (e.g. knobs, touch controls etc.)

Note 1 to entry: The power is generally indicated as numbers, but also temperature values and symbols are possible.

Note 2 to entry: **Controls** integrated outside of the hob in a separate device or as part of a built-in-oven are also included.

3.13

warming zone

area used for keeping food warm usually not used for cooking

Note 1 to entry: Normally one power setting exists – on and off.

3.14

maximum power

maximum possible power setting while only one cookware is used

Note 1 to entry: Boost function is considered.

3.15

standardized cookware

cookware that is in accordance with the specification of 5.6.1

3.16

alternative cookware

commercially available cookware that is in accordance with the requirements given in 5.6.2

3.17

set to off mode

action where the product is switched off using appliance **controls** or switches that are accessible and intended for operation by the user during normal use to attain the lowest power consumption that may persist for an indefinite time while connected to a main power source and used in accordance with the manufacturer's instructions

Note 1 to entry: All actions required to set to off mode like for example remove the cookware etc are considered.

Note 2 to entry: For definition of off mode IEC 62301 is relevant.

3.18

set to standby mode

action where the product is switched to standby using appliance **controls** or switches that are accessible and intended for operation by the user during normal use to attain the lowest power consumption that may persist for an indefinite time while connected to a main power source and used in accordance with the manufacturer's instructions

Note 1 to entry: For definition of standby mode IEC 62301 is relevant.

3.19

open loop control

mode of operation in which the value of the power output is set at a desired value, without taking into account the difference between the actual and desired values

EXAMPLE A cooking zone with an electronic, electromechanical, or mechanical control of the power input, which is controlled independently of the actual temperature in the cookware.

[SOURCE: IEC 60050-314:2001, 314-05-02, modified – In the term itself, "stabilization" has been replaced by "control"; in the definition, "output" has been replaced by "power output", the words "by external means" have been removed and the example has been added.]

3.20

closed loop control

mode of operation in which the value of the output is influenced by comparing of a reference value by the measured value and using the difference between those values, directly or indirectly, to maintain the output quantity at the desired value with a given uncertainty

EXAMPLE The value can be a measured temperature at the cookware or under the glass ceramic.

[SOURCE: IEC 60050-314:2001, 314-05-01, modified – In the term itself, "stabilization" has been replaced by "control"; in the definition, "is compared with a reference value and in which the difference between those values is used" is replaced by "is influenced by comparing of a reference value by the measured value and using the difference between those values" and the example has been added.]

4 List of measurements

4.1 Dimensions and mass

- overall dimensions (see 6.1);
- cooking zones per hob (see 6.2);
- level of solid hotplates (see 6.3);
- distance between the cooking zones (see 6.4);
- mass of the appliance (see 6.5).

4.2 Cooking zones and cooking areas

- energy consumption and time for heating (see Clause 7 and Annex A);
- ability to control the temperature of a load (see Clause 8);
- heat distribution (see Clause 9);
- heat performance of hobs (see Clause 10);
- smallest detected diameter for induction cooking zones (see Clause 11);

4.3 Cleaning

- spillage capacity for hobs (see Clause 13).

5 General conditions for the measurements

5.1 Test room

The tests are carried out in a substantially draught-free room in which the laboratory ambient temperature is maintained at $(20 \pm 5) ^\circ\text{C}$.

Only for the measurements described in Clause 7 shall an ambient temperature of $(23 \pm 2) ^\circ\text{C}$ be maintained throughout the entire test.

This ambient temperature is measured at a point that is at the same height as the **hob** positioned at working height and at a distance of 0,5 m diagonally from one of the front edges of the appliance.

NOTE The working height is normally between 800 mm and 1 000 mm.

The measurement of the ambient temperature shall not be influenced by the appliance itself or by any other appliance.

The absolute air pressure shall be between 913 hPa and 1 063 hPa.

5.2 Electricity supply

The appliance is supplied at rated voltage with a relative tolerance of $\pm 1 \%$.

If the appliance has a rated voltage range, the tests are carried out at the nominal voltage of the country where the appliance is intended to be used.

For the test described in Clause 7, the supply voltage shall be maintained at the main terminal at 230 V with a relative tolerance of $\pm 1\%$ or at 400 V with a relative tolerance of $\pm 1\%$ as defined by the manufacturer's installation guide, while the heating elements are switched on.

The supply voltage shall be essentially sinusoidal.

NOTE In case of a fixed cable, the plug (or the end of the cable) is the reference point to maintain the voltage.

The supply frequency shall be at the rated frequency $\pm 1\%$ throughout the test. If a frequency range is indicated, then the test frequency shall be the nominal frequency of the country in which the appliance is intended to be used.

5.3 Instrumentation and measurements

Instruments used and measurements made for this document shall comply with the specifications in Table 1 and Table 2.

Table 1 – Instruments

Parameter	Unit	Minimum resolution	Minimum accuracy	Additional requirements
Mass (clause 7)	g	0,5 g	$\leq 1\,000\text{ g} \pm 1\text{ g}$ $> 1\,000\text{ g} \pm 3\text{ g}$	
Temperature				
– ambient temperature	°C	0,1 °C	$\pm 1\text{ K}$	
– temperature of the water load (clause 7)	°C	0,1 °C	$\pm 0,5\text{ K}$	3 mm steel tube
– temperature of the oil (clause 8)	°C	0,1 °C	$\pm 0,5\text{ K}$	
Time	s	1 s	$\pm 1\text{ s}$	
Energy	Wh	-	$\pm 1\%$	Very quick electronic on/off periods shall be taken into account by measurement techniques.
Air pressure	hPa	1 hPa	$\pm 1\%$	

Table 2 – Measurements

Parameter	Unit	Minimum resolution	Minimum accuracy	Additional requirements
Voltage	V	-	$\pm 0,5\%$	-
Temperature and energy consumption measurement (Clause 7)		-	-	Sampling rate $\leq 1\text{ s}$ (digital measurement data)
For Clause 12, the power measurement requirements shall be in accordance with IEC 62301		-	-	According to IEC 62301

The required accuracy of temperature measurement in the water load (Clause 7) can be fulfilled by calibrating the temperature measurement or, for instance, by a PT100 sensor according to IEC 60751.

If numbers have to be rounded, they shall be rounded to the nearest number according to ISO 80000-1:2009, B.3, Rule B. If the rounding takes place to the right of the comma, the omitted places shall not be filled with zeros.

5.4 Positioning the appliance

The **hob** or the **cooking range** is installed in accordance with the instructions for its installation.

If no instructions for its installation are given, a **cooking range** is positioned between kitchen cabinets with its back to the wall and tabletop **hobs** are positioned away from sidewalls.

5.5 Initial conditions

The appliance shall be at the laboratory's ambient temperature at the beginning of each test. Forced cooling may be used to assist in reducing the temperature.

All tests are carried out with the default factory settings. Ensure that no network is connected to the appliance for the duration of the measurement.

5.6 Cookware

5.6.1 Standardized cookware

5.6.1.1 General

Cookware is an integral part of the cooking process; it affects different process parameters such as the adaptation of a cooking zone, the required settings and the needed cooking time.

A sufficient degree of reproducibility is only guaranteed if a piece of **standardized cookware** and lid is used as described in 5.6.1.

Hobs working exclusively with a piece of supplied cookware and not with household-like cookware shall be tested with its supplied cookware, but it shall be covered with a lid in accordance with Table 3.

NOTE Suppliers for the stainless steel and for the cookware are indicated in Clauses F.3 and F.4.

5.6.1.2 Standardized cookware – bottom material and construction

- Material: stainless steel AISI type 430, non-shiny surface;
- Thickness: 6 mm $\pm$ 0.2 mm (see Figure 1);
- Dimensions as specified in Table 3;
- Flatness of bottom plate as specified in Table 3;

A convex shaped bottom plate is not allowed. The flatness of the base has to be checked before starting a measurement.

- Annealing required.

For a sufficient permeability of the cookware bottom, the disc has to be annealed. The annealing should be done for approximately 2 h at approximately 650 °C in a nitriding-furnace.

Grinding for adjustment after alteration is allowed within the given tolerances of (6 $\pm$ 0,2) mm.

5.6.1.3 Standardized cookware – sidewall

- Material: stainless steel AISI type 304;
- Thickness: 1 mm $\pm$ 0,05 mm;
- Shape: cylindrical without handles or protrusions (see Figure 1).

The sidewall is fixed to the bottom plate with heat resistant glue.

The sidewall of the cookware can be built up of a metal sheet. The metal sheet is rolled and welded to a sheet-metal jacket. The sidewall can be fixed additionally by three welding points to the bottom, but the required bottom flatness has to be checked.

5.6.1.4 Standardized cookware – lid with temperature sensor

- Material: aluminium;
- Thickness: $2 \text{ mm} \pm 0,05 \text{ mm}$;
- Dimensions as specified in Table 3;
- With holes, where each hole on the circle of the lid has diameter of $(16 \pm 0,1) \text{ mm}$; the holes shall be evenly distributed on the circle (see Figure 1).

NOTE 1 The thermal energy which is needed to keep the water boiling for a real cooking process, including evaporation and the energy absorption of the food during the simmering phase, is considered for the holes.

The flat lid is adapted to accommodate a temperature sensor in the centre. The temperature sensor is positioned $(15 \pm 1) \text{ mm}$ above the inner cookware bottom. To achieve this, place a $(15 \pm 1) \text{ mm}$ reference block on the bottom of the cookware. Mark the sensors and tighten the screws.

NOTE 2 An example how to fix the temperature sensor to the lid is shown in Annex B.

In order to reduce measurement noise generated by the electromagnetic field of an **induction cooking zone** or **cooking area**, the lid of the cookware shall be connected to ground through a clamp (see Figure 1 d)). The ground connection of the electric installation of the testing laboratory shall be according to IEC 60364-5-54.

NOTE 3 An earthed wire of 2 mm^2 cross section and a maximum length of 2 m is welded to the metallic clamp.

5.6.1.5 Standardized cookware – dimensions and water amounts

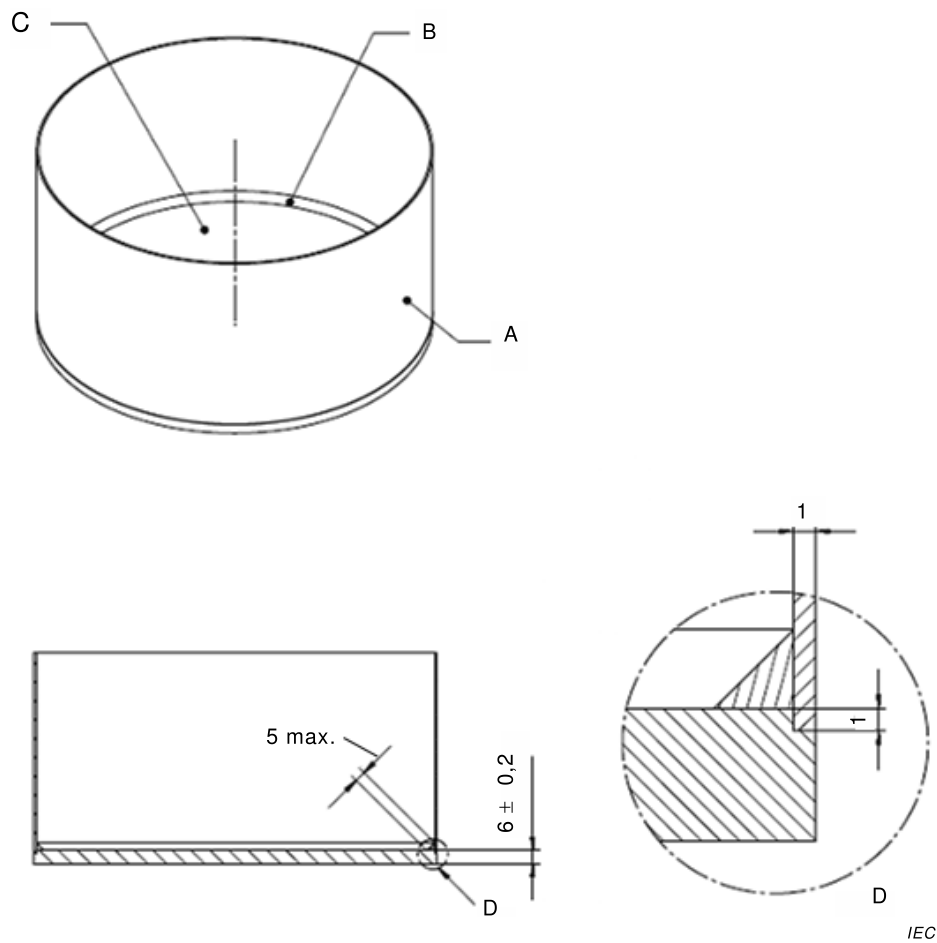
The standardized cookware sizes and water amounts are defined in Table 3.

Table 3 – Sizes of standardized cookware and water amounts

Diameter of the cookware bottom (outside)	Diameter of the lid	Lid hole circle diameter	Number of holes on the circle	Total cookware height (outside)	Flatness of cookware bottom	Water load	Cooking zone size category	Standardised cookware categories
mm	mm	mm		mm	mm	g	mm	
120 ± 0,5	130 ± 1	80 ± 1	7	125 ± 0,5	≥ 0 < 0,075	650	≥ 100 < 130	A
150 ± 0,5	165 ± 1	110 ± 1	11	125 ± 0,5	≥ 0 < 0,075	1 030	≥ 130 < 160	
180 ± 0,5	200 ± 1	140 ± 1	16	125 ± 0,5	≥ 0 < 0,075	1 500	≥ 160 < 190	B
210 ± 0,5	230 ± 1	170 ± 1	22	125 ± 0,5	≥ 0 < 0,1	2 050	≥ 190 < 220	C
240 ± 0,5	265 ± 1	200 ± 1	29	125 ± 0,5	≥ 0 < 0,1	2 700	≥ 220 < 250	
270 ± 0,5	300 ± 1	230/210 ^a ± 1	18/18 ^a	125 ± 0,5	≥ 0 < 0,15	3 420	≥ 250 < 280	D
300 ± 0,5	330 ± 1	260/210 ^a ± 1	23/22 ^a	125 ± 0,5	≥ 0 < 0,15	4 240	≥ 280 < 310	
330 ± 0,5	365 ± 1	290/270 ^a ± 1	27/27 ^a	125 ± 0,5	≥ 0 < 0,15	5 140	≥ 310 ≤ 330	
^a Number of holes are arranged on two hole circles.								

NOTE The standardised cookware categories in Table 3 are only relevant for the standardized cookware. Categories are necessary to make sure that different cookware sizes – as relevant in a household – are considered.

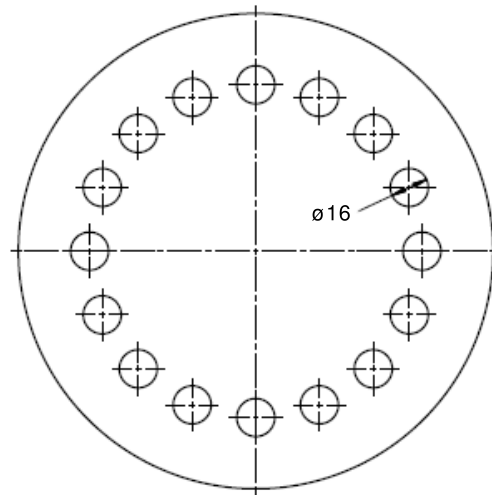
Dimensions in millimetres



Key

- A side wall
- B heat-resistant glue
- C bottom plate
- D detail of the edge

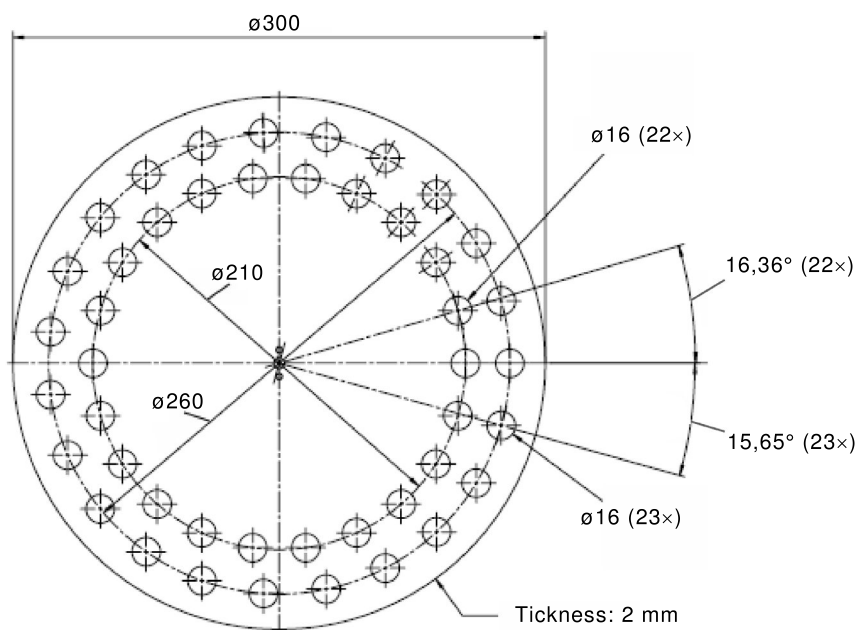
a) Example for a cookware size of 180 mm in diameter



IEC

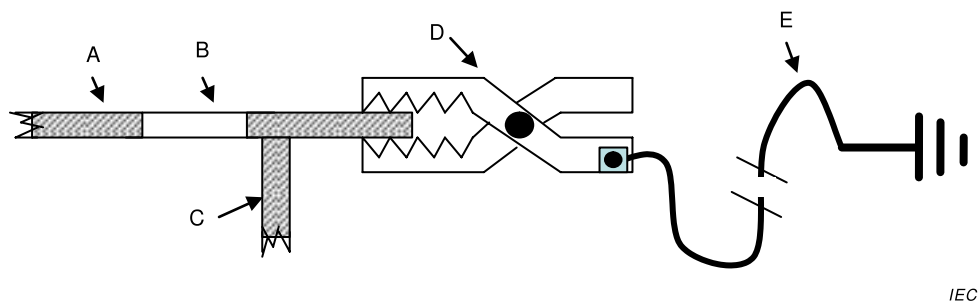
b) Example – lid with a diameter of 180 mm

Dimensions in millimetres



IEC

c) Example – lid with a diameter of 300 mm



Key

- A lid
- B hole
- C cookware
- D clamp
- E ground wire

d) Ground connection

Figure 1 – Standardized cookware

5.6.2 Alternative cookware

5.6.2.1 General

For comparative testing, **alternative cookware** may be used.

The cookware used is noted. For comparative testing, for example on different sizes of cooking zones, always the same cookware samples shall be used.

5.6.2.2 Alternative cookware – bottom material and construction

- Material: stainless steel bottom clad with several layers, which typically clad a stainless steel layer (e.g. AISI 430 or AISI 439 steel), an aluminium layer and a ferromagnetic layer (often also called "sandwich layer bottom" or "aluminium clad").
- Flatness: $< 0,003 a$, where a is the outer diameter of the cookware's bottom.
A convex shaped bottom plate is not allowed. The flatness of the base has to be checked before starting a measurement.
- Thickness: ≥ 3 mm.
- No aluminium or copper spots in the surface.
- Without an aluminium ring outside.
- No ferromagnetic coating or sputtering.
- Without reliefs and stamps. Except one smaller stamp (ferromagnetic material) with a diameter less than 30 % of the outer flat bottom diameter and a depth $< 0,8$ mm in the centre.
- Uncoated.

5.6.2.3 Alternative cookware – sidewall

- Material: non-ferromagnetic stainless steel, e.g. AISI type 304.
- Thickness: $\geq 0,8$ mm.
- Shape: cylindrical, angle between sidewall and hob surface 80° to 90° .
- Uncoated.

5.6.2.4 Alternative cookware – dimensions

The size of cookware shall match the size of the **cooking zone** (see 6.3.2) as well as possible. However, it may vary by a maximum of +20 mm and –10 mm.

For **cooking areas**, the sizes of the cookware under test are described in the test procedures.

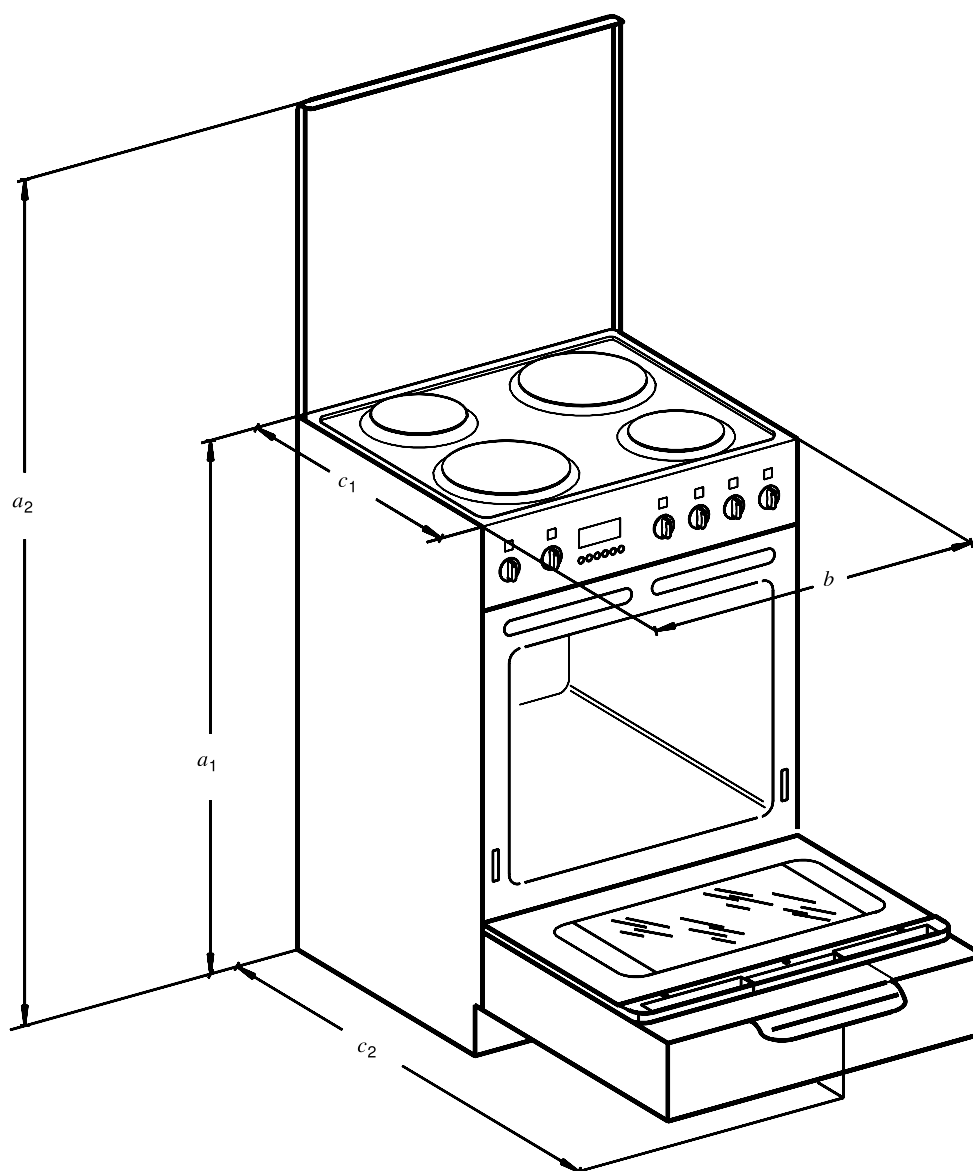
For determining the size of the cookware, the outer diameter of the flat bottom of the cookware (*a*) is measured.

6 Dimensions and mass

6.1 Overall dimensions

The overall dimensions of the appliance are measured and stated in millimetres as follows:

- **cooking ranges** and other appliances placed on a surface are measured as shown in Figure 2;
- built-in **hobs** are measured as shown in Figure 3.



IEC

Key

a_1 height from the supporting surface to the **hob** surface

NOTE If adjustable feet are provided, the height is measured with the feet in both extreme positions.

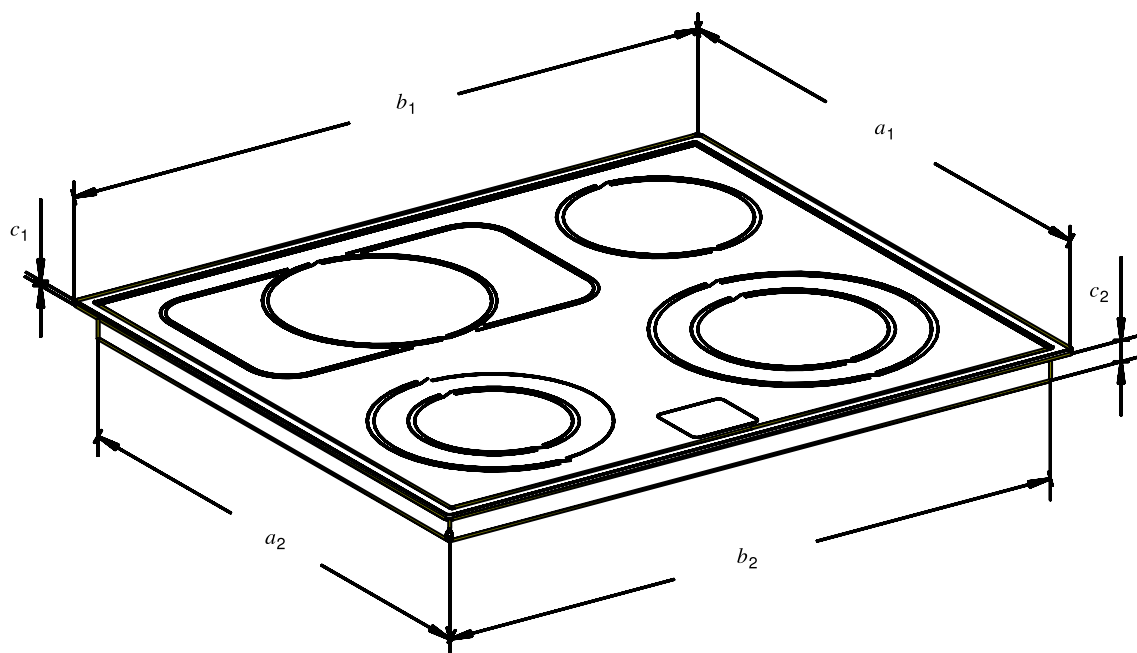
b overall width of the appliance

a_2 maximum height from the supporting surface to the uppermost part of the appliance, with any lid in the open position

c_1 depth of the appliance, ignoring any knobs, etc.

c_2 maximum depth of the appliance, with any doors and drawers fully open

Figure 2 – Dimensions of appliances



IEC

Key

- a_1 depth of the **hob**
- b_1 width of the **hob**
- c_1 height of the **hob** on the outside of the kitchen furniture
- c_2 height of the **hob** on the inside of the kitchen furniture
- a_2 depth of the **hob** on the inside of the kitchen furniture
- b_2 width of the **hob** on the inside of the kitchen furniture

Figure 3 – Dimensions of built-in hobs

6.2 Mass of the appliance

The mass of the appliance is determined and expressed in kg, rounded to the nearest kg.

6.3 Cooking zones and cooking areas

6.3.1 Number of cooking zones per hob

The number of **cooking zones** is determined by the maximum number of **controls** that can be operated independently all at the same time.

6.3.2 Dimensions of cooking zones

The dimension of a **cooking zone** is determined by measuring the marked area on the surface.

For a circular **cooking zone**, the outside diameter of the largest marked circle is measured.

For a **multiple zone**, the dimension for each size is measured.

For a **solid hotplate**, the diameter of the surface intended to come into direct contact with the bottom of the saucepan is measured.

For a **tubular hotplate**, the diameter of the largest periphery excluding any leading section is measured.

If the **cooking zone** is not circular, the dimensions are determined as follows:

- for rectangular and similar shapes, the lengths of the sides are measured;
- for elliptical and similar shapes, the major and minor dimensions are measured.

The dimension of a radiant or induction **cooking zone** is determined by the printing on the surface independently of the size of the heating element.

The dimensions are indicated in mm.

6.3.3 Dimensions of cooking areas

For a **cooking area** that is marked to show the limits where more than one item of cookware can be used simultaneously, the maximum length and maximum width of the marked surface is noted.

6.4 Level of solid hotplates

Cooking ranges with adjustable feet and **hobs** are installed with the perimeter of the hob surface horizontal.

A device consisting of a disc and an annular ring is placed centrally on the **solid hotplate**. A spirit level is placed centrally on the ring, as shown in Figure 4.

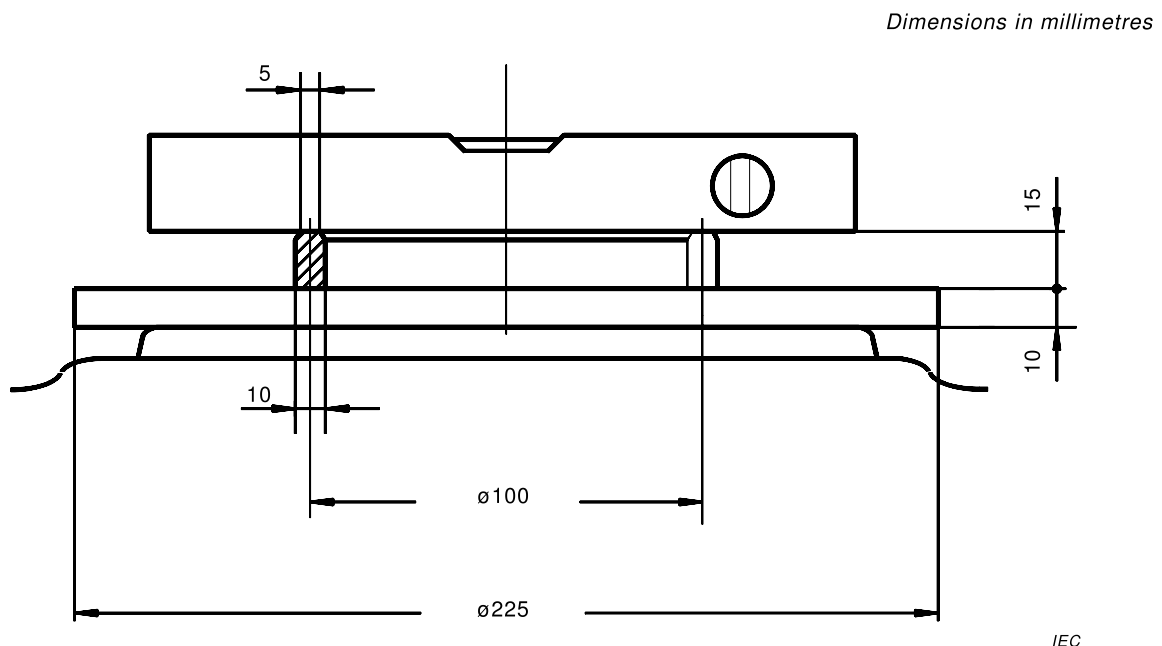


Figure 4 – Device for checking the level of solid hotplates

A mass of 3 kg is placed on each of the remaining **solid hotplates**.

The spirit level is rotated to the position where it shows the maximum inclination from the horizontal. Its lower side is then lifted to the horizontal by inserting a feeler gauge between the level and the ring.

The measurement is carried out on each **solid hotplate**.

The deviation from the horizontal is given by the thickness of the gauge, in mm, to two decimal places. It is expressed as a percentage, rounded to the nearest 0,1 %.

NOTE The direct conversion from mm to percentage is possible due to the ring having a diameter of 100 mm.

6.5 Distance between cooking zones

The shortest distance between the edges of adjacent **cooking zones** is measured and indicated in mm, rounded to the nearest mm. If the **hob** has more than two **cooking zones**, the distance between each pair is determined.

The result may be shown by means of a sketch.

7 Energy consumption and heating up time

7.1 General

To guarantee reproducible results, the tests in Clause 7 shall be carried out with **standardized cookware**.

The tests described in Clause 7 are applicable to **cooking zones** with a diameter ≤ 330 mm and ≥ 100 mm or where one of the sides' lengths is ≤ 330 mm and ≥ 100 mm.

In addition, tests are applicable to **cooking areas**. Further requirements concerning **cooking areas** are described in Annex A.

For **multiple zones** that include a circular and an elliptical or rectangular part, only the circular part is tested.

7.2 Purpose

In the first place, the purpose is to determine the energy consumption for heating up a defined water load and keep it at a defined temperature level for 20 min.

In a second measurement, the heating up time of a defined water load can be determined.

NOTE 1 Heating up and keeping the temperature for a defined period represents a typical household cooking process. Additionally, the quality of the **control** is measured by keeping an amount of water at a defined temperature as exactly as possible.

NOTE 2 The simmering time of 20 min represents an average household cooking duration. Additionally, at least 20 min further simmering time is necessary to assess the quality of a **control** that influences the energy consumption.

7.3 Determine a cookware set to assess a hob with cooking zones

The number of pieces of cookware needed to assess a **hob** shall correspond to the number of **controls** which can be used simultaneously and independently.

The sizes and number of cookware pieces are selected according to Table 4.

Table 4 – Criteria for selecting the cookware set regarding cooking zones

Number of cookware used for tests according to Clause 7	Criteria for selecting a cookware set regarding cooking zones
1	From one standardized cookware category according to Table 3 that is equal to the dimensions of the cooking zone or best fit.
2	At least from one standardized cookware category according to Table 3 that are equal to the dimensions of the cooking zones or best fit.
3	At least from two standardized cookware categories according to Table 3 that are equal to the dimensions of the cooking zones or next best fit cookware category.
4 or more	At least from three standardized cookware categories according to Table 3 that are equal to the dimensions of the cooking zones or next best fit cookware category.

For circular **multiple zones**, the biggest diameter determined according to 6.3.2 is considered.

For non-circular **cooking zones**, the cookware size is determined by the short axis measured according to 6.3.2.

If on an induction **hob** cookware is not detected, the next biggest cookware diameter is chosen independent from the cookware category.

If a standardized cookware category A-D has to be substituted, the next best-fitting cookware is selected. The cookware with the closest bottom diameter compared to the **cooking zone** diameter is chosen. As a result, cookware can be smaller or bigger than the **cooking zone**. Therefore, also smaller diameters of **multiple zones** can be considered. Each **cooking zone** is taken into account only once. The one with the closest diameter to the **cooking zone** is the best fitting cookware size.

If a selected cookware size is out of the range of the sizes allowed by the user manual, then the closest diameter compatible with the defined range shall be chosen.

If it is not clear which cookware size is best fitting, all possibilities are considered in the measurement.

NOTE As mentioned in 7.1, for **multiple zones** which include a circular and an elliptical or rectangular part, only the circular part is tested.

7.4 Positioning the cookware on a cooking zone

On a **cooking zone**, the cookware is used in the centre.

The centre of an elliptical or similar shaped **cooking zone** is determined in the intersection of the shortest and longest axis.

The centre of a rectangular or similar **cooking zone** is determined in the intersection of the two diagonals.

If two **cooking zones** with the same size are available and cookware pieces with different sizes have to be placed there, then the position for the bigger cookware size will be made in accordance with the following order of precedence:

- cooking zones** having highest **maximum power**;
- cooking zones** being located at the rear of the **hob**;
- cooking zones** being located on the left.

7.5 Procedure for measuring the energy consumption of a cooking process

7.5.1 Preparation

Before the first measurement is taken, all cooking zones have to be operated for at least 10 min at maximum setting. This is only necessary once to make sure that residual water in the components is vaporized. Afterwards, the hob has to be cooled down to approximately ambient temperature before starting measuring the energy consumption.

For measuring the energy consumption, only one **control** and one cookware shall be used.

The appliance and the **standardized cookware** shall be at ambient temperature.

The empty **standardized cookware** is filled with the quantity of potable water specified in Table 3. To avoid lime sediment, distilled water may be used.

The water is stirred to ensure a uniform temperature and the temperature of the water is measured when the average temperature of cookware and water has stabilized. The initial temperature shall be in the range of $15\text{ °C} \pm 0,5\text{ °C}$ (T_{15}). The filled cookware should not be stored in the fridge to avoid the rims getting too cold.

The **standardized cookware** covered with the lid is positioned centrally on the **cooking zone** or according to A.3 on the **cooking area**, the **control** is set to **maximum power** and the measurement shall be started immediately.

NOTE Water having an initial temperature of $14,5\text{ °C}$ minimises the stirring time.

If the smaller diameter of **multiple zones** is considered, the corresponding power is used.

7.5.2 Preliminary measurements

7.5.2.1 Determine T_c

A preliminary test is carried out to determine the appropriate water temperature for reducing the power setting (T_c).

The procedure described in 7.5.1 shall be followed.

The power shall be switched off when the water temperature reaches 70 °C (T_{70}).

The temperature rising is recorded continuously (see Table 2). The difference between the highest temperature value and T_{70} is stated as temperature overshoot (ΔT_o) in K, see Figure 5.

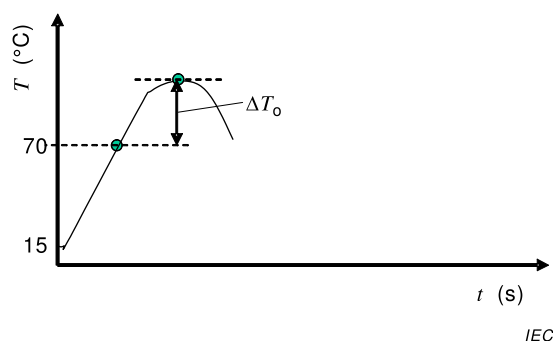


Figure 5 – Overshoot measurement

NOTE 1 For ΔT_o , the value stated on the temperature measuring instrument is taken.

A valid temperature T_{70} is determined by the average of the recorded temperature between $t_{70} - 10$ s and $t_{70} + 10$ s. If the result is within the tolerance of $(70 \pm 0,5)$ °C, then this temperature is noted. If not, the test is repeated by adjusting the switch-off temperature.

T_c , the temperature for reducing the power setting, is calculated according to the following Formula (1):

$$T_c = 93 \text{ °C} - \Delta T_o \quad (1)$$

where T_c is rounded to the nearest integer.

In the event that the temperature limiter of a **radiant cooking zone** switches down the power during the t_c period, i.e. the time when the setting is reduced, a 2 K higher T_c is allowed.

If the calculated T_c is ≤ 80 °C, then 80 °C is taken as T_c .

T_c is stated.

NOTE 2 Empirical tests show that **induction cooking zones / cooking areas**, **radiant cooking zones** and **solid plates** have each a similar T_c . The following values are representative and they can substitute the result of 7.5.2.1 as fixed values:

- **induction cooking zones** and **cooking areas** $T_c = 89$ °C;
- **radiant cooking zones** $T_c = 85$ °C;
- **solid plates** $T_c = 80$ °C.

7.5.2.2 Determine the simmering setting

A second preliminary test is carried out to determine the lowest level to set to achieve ≥ 90 °C during the remaining cooking period.

The procedure stated in 7.5.1 is followed.

If T_c is reached, the setting is reduced to achieve the water simmering at a temperature ≥ 90 °C and as close as possible to 90 °C. A further change of setting is not allowed. For T_c , the tolerances are +1,0 K / -0,5 K.

At first, the lowest simmering setting is selected. If the temperature of the water is < 90 °C during the simmering time, the energy consumption measurement has to be repeated with an increased setting – provided that the temperature of the water is < 90 °C after the measured data T are evaluated according to 7.5.4.1.

When the water temperature reaches 90 °C for the first time (T_{90}), the simmering time starts independently of T_c .

The simmering time is 20 min.

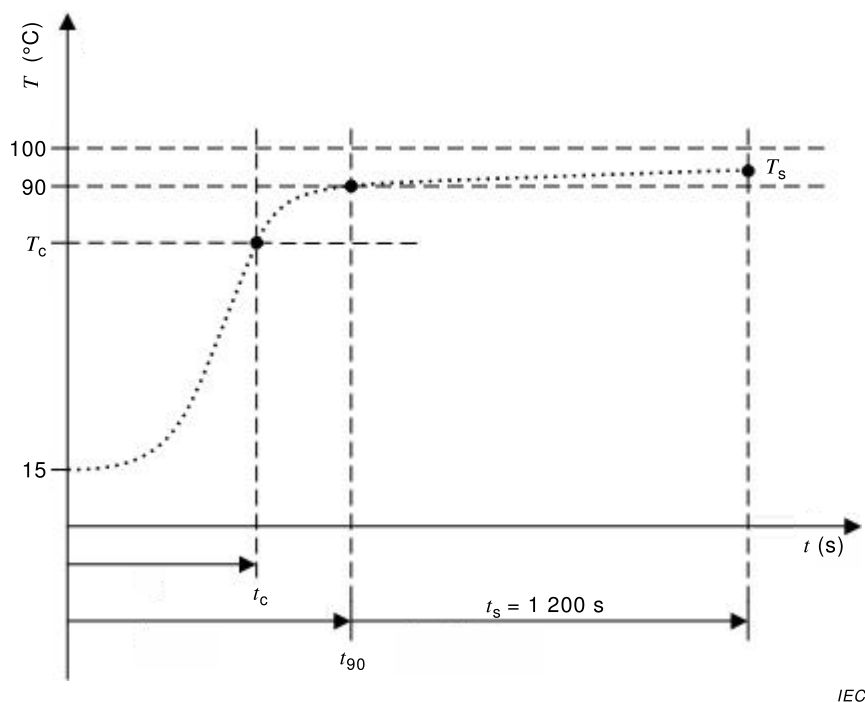
The lowest possible simmering setting is noted.

For **control** units without detent, the knob position should be marked. The simmering setting could differ if a knob is turned from a higher position to a lower position compared to turning from a lower position to a higher position.

NOTE For a clear marking of the lowest possible simmering setting, a polar coordinate paper can be useful (see Annex B).

7.5.3 Measuring the energy consumption

The procedure stated in 7.5.1 is followed. The results from 7.5.2.1 and 7.5.2.2, illustrated in Figure 6, are applied. After finishing, the appliance is **set to off mode**. If the appliance doesn't offer an off mode, it is **set to standby mode**.



where

- t_{90} is the time when the temperature of 90 °C is reached and the simmering period starts, in s;
- t_c is the time when the setting is reduced, in s;
- t_s is the simmering time, in s;
- T_c is the water temperature when the setting is reduced, in °C;
- T_s is the water temperature at the end of the process, in °C.

**Figure 6 – Energy consumption measurement process
for a cooking process**

The following data shall be recorded:

- Continuously, the energy consumption starting at t_0 and ending at $t_s + 1$ min, in W·h;
- t_c and t_{90} , in min and s;
- initial temperature of water, T_c , and the temperature T_s of the water in °C;
- average power during the simmering time t_s , in W;
- ambient temperature in °C at the start of the test (when the **hob** is switched on) and at the end of the test (after 20 min of simmering time);
- relative air pressure at the start of the test and at the end of the test, in hPa.

The test is performed three times if the **hob** is tested only with one or two cookware pieces.

NOTE The energy consumption of components such as fans and displays, which are automatically switched on with the appliance, are included in the measurement.

7.5.4 Evaluation and calculation

7.5.4.1 Evaluation

Temperature measurement noise can be caused by the convection of water and by measurement noise of the measurement setup itself. As a consequence, minor oscillations of the measured temperature occur. In order to determine the actual crossing of 90 °C – excluding possible measurement noise – the measured data T is smoothened with a time interval of $t_{\text{mov}} = 40$ s.

First, the measured data T are considered using an averaging algorithm, see Formula (2), giving the new data $\bar{T}$.

$$\bar{T}_i = \frac{1}{2n+1} \cdot \sum_{j=-n}^n T_{i+j} \quad (2)$$

where

$\bar{T}_i$ is the smoothened temperature data;

i is the sample index;

n is defined by $n = \left\lfloor \frac{t_{\text{mov}} \times f_s - 1}{2} \right\rfloor$ and where $t_{\text{mov}} = 40$ s;

f_s is the sampling rate in $\frac{1}{s}$.

NOTE n is rounded.

Secondly, $\bar{T}_c$ is checked and shall be within the tolerance of +1,0 K / -0,5 K.

Thirdly, the time t_{90} is determined according to $\bar{T}(t_{90}) = 90$ °C .

Fourthly, the data $\bar{T}$ are controlled, $\bar{T} > 90$ °C from t_{90} to t_s . $\bar{T}_s$, the smoothened final water temperature, is stated.

If $\bar{T} < 90$ °C from t_{90} to t_s , the energy consumption measurement shall be repeated with an increased setting. If $\bar{T} > 91$ °C from t_{90} to t_s , check the next lower setting in order to guarantee the lowest possible setting.

Annex H provides a guidance to determine the proper simmering setting.

Finally, the energy consumption during the time $t_{90} + t_s$ is determined and stated in W·h.

7.5.4.2 Calculation of the result for a hob

To calculate the result for a **hob**, the calculated energy consumption according to 7.5.4.1 is used.

The energy consumption per **cooking zone** is equal to E_{cw} and shall be noted with the cookware size under the test normalized to 1 000 g.

The energy consumption per **cooking area** is the arithmetic mean of the energy consumption values of the pieces of cookware considered according to Table A.1 and Table A.2 on this type of **cooking area** normalized to 1 000 g.

The single results according to 7.5.3 and Annex A are determined for a **hob** as follows.

The energy consumption E_{hob} is calculated as follows:

- The result of each cookware is normalised to 1 000 g of water; the energy consumption is divided by the quantity of water used for the cookware under test.
- The average of the normalised energy consumption of the **hob** is calculated considering all cookware pieces under test, see Formula (3).

$$E_{\text{hob}} = \frac{1000g}{n_{\text{cw}}} \times \sum_{\text{cw}=1}^{n_{\text{cw}}} (E_{\text{cw}} / m_{\text{cw}}) \quad (3)$$

where

- E_{hob} is the energy consumption of a **hob** calculated per 1000 g water in W·h;
- E_{cw} is the energy consumption with a single cookware under test in W·h;
- m_{cw} is the quantity of water used for the test of the respective cookware piece in g;
- n_{cw} is the number of cookware pieces on the **hob**.

For an example data and calculation sheet, see Annex E. An Excel 97-2003 data calculation program, which corresponds directly to Annex E, is available with this document for the automatic calculation of the energy consumption. These calculations may be also made in any other spreadsheet programs that lead to equal results.

7.6 Procedure for measuring the heating up time

Before the first measurement is taken, all cooking zones have to be operated for at least 10 min. This is only necessary once to make sure that residual water in the components is vaporized. Afterwards, the hob has to be cooled down to approximately ambient temperature before starting measuring the heating up time.

For measuring the heating up time, only one **control** and one cookware shall be used.

The **standardized cookware** is filled with the quantity of potable water specified in Table 3. The water has a temperature of $(15 \pm 0,5) ^\circ\text{C}$. The **standardized cookware** covered with the lid is positioned centrally on the **cooking zone** or according to A.3 on the **cooking area**.

The **cooking zone** or **cooking area** is heated with **maximum power**.

NOTE If the smaller diameter of **multiple zones** is considered, the corresponding power is used.

The time taken for the water temperature to rise by 75 K is measured.

The test is performed three times and the average value of the results is determined.

The time is stated in min and s, rounded to 10 s.

8 Ability to control the temperature of a load

8.1 Lower control position

8.1.1 Purpose

The purpose of this test is to check the function of a **control** for a lower setting, like melting chocolate.

NOTE For increasing the repeatability, oil is used instead of chocolate. In pre-tests it was proven that the behaviour of melting chocolate can be reflected by warming up a quantity of oil.

8.1.2 Cookware, positioning and ingredients

For reproducible results, the **standardized cookware** shall be used.

For comparative testing, **alternative cookware** may be used.

A piece of **standardized cookware** with a bottom of a diameter (outside) of $(150 \pm 0,5)$ mm is used. When selecting a piece of **alternative cookware**, the diameter of this cookware shall be 150^{+20}_{-10} mm.

If the hob has no **cooking zone** ≥ 130 mm and < 160 mm, the test is carried out with a piece of **standardized cookware** that has a bottom of a diameter (outside) of $(180 \pm 0,5)$ mm. For comparative testing, a piece of **alternative cookware** can be used with a diameter of 180^{+20}_{-10} mm.

The cookware is used without a lid.

On **cooking areas**, the cookware is positioned in accordance with the manufacturer's instructions for positioning this diameter. If no instruction is given, it is positioned in accordance with the requirements for this cookware size stated for measuring the energy consumption (see Annex A). On a **hob** with **cooking zones**, the cookware is placed centrally on a fitting **cooking zone**.

The **standardized cookware** is filled with fresh sunflower oil at room temperature using the amounts stated in Table 5. For **alternative cookware**, the amount of oil has to be adapted accordingly, so that the filling height is approximately 30 mm.

NOTE Sunflower oil is considered to be fresh if it has not been used more than three times.

Table 5 – Amount of oil

Diameter of the standardized cookware bottom (outside) mm	Amount of sunflower oil g	Cooking zone size category mm
$150 \pm 0,5$	450 ± 5	≥ 130 and < 160
$180 \pm 0,5$	650 ± 5	≥ 160 and < 190

8.1.3 Procedure

The **cooking zone** or **cooking area** is heated in accordance with the manufacturer's instructions for melting chocolate. If no instructions are given, the **control** is set at the lowest possible setting. The temperature at the centre of the oil is recorded continuously by means of a thermocouple in accordance with 5.3, which is located 15 mm above the inner cookware bottom centrally.

The oil is not stirred and is heated up:

- 1) If the temperature reaches $(50 \pm 0,5) ^\circ\text{C}$ in ≤ 30 min, the oil is further heated for 15 min with an unchanged setting. Then the **control** is set to off.
- 2) If $(50 \pm 0,5) ^\circ\text{C}$ is reached after > 30 min and ≤ 45 min, the oil is further heated with an unchanged setting until the test reaches a total duration of 45 min.
- 3) If $(50 \pm 0,5) ^\circ\text{C}$ is not reached within 45 min, the **control** is set to off after 45 min.

In any case, the total test duration of 45 min shall not be exceeded.

8.1.4 Assessment

The recorded temperature during the heating phase is analyzed.

Certain temperature requirements – the same for both cookware sizes – have to be fulfilled so that the lower setting of the **control** is adequate for melting processes. These requirements take into account the following steps:

- an increase in temperature not too high at the beginning in order, for example, not to burn the chocolate before it is melted;
- a sufficient temperature after a certain time, adequate, for example, for melting the chocolate in an appropriate time;
- a limited temperature after a certain time, which, for example, keeps the chocolate melted for a certain time.

An example for the analysis of the temperature curve is given in Annex G that is based on the **standardized cookware**, which allows an exact assessment.

8.2 Temperature overshoot of hotplates

8.2.1 Purpose

The purpose of this test is to assess the heat retention of the **hotplate**.

NOTE This test is applicable for comparative testing only.

8.2.2 Ingredients and cookware

For reproducible results, the **standardized cookware** shall be used.

For comparative testing, **alternative cookware** may be used.

The cookware is used without a lid.

The cookware is selected and filled with fresh sunflower oil at room temperature following the requirements in 8.1.2 and it is placed on the **hotplate**.

8.2.3 Procedure

The **hotplate** is heated with the control set at the maximum position. The temperature at the centre of the oil is recorded continuously by means of a thermocouple. The oil is not stirred.

When the oil temperature reaches $(80 \pm 0,5) ^\circ\text{C}$, the supply is switched off. The temperature in the oil is recorded continuously until the temperature starts declining.

8.2.4 Assessment

The temperature overshoot is the difference between the highest recorded temperature and the temperature of the oil and the temperature of 80 °C.

The temperature increase from 80 °C to the highest measured temperature is stated in K.

9 Heat distribution and heat supply

9.1 Measuring the heat distribution

9.1.1 Test purpose

The purpose of this test is to measure the heat distribution of **cooking zones** and **cooking areas**. Therefore, a steel disc is spread with a thin layer of fat and flour, positioned on the **cooking zone** or **cooking area** and heated up. The browned surface of the disc after a certain time is representative for the heat distribution of a **cooking zone** or **cooking area**.

The test is applicable to cooking zones with a diameter ≤ 330 mm and ≥ 100 mm or where one of the sides' lengths is ≤ 330 mm and ≥ 100 mm.

For **multiple zones** that include a circular and an elliptical or rectangular part, only the circular part is tested.

9.1.2 Discs

The material of the disc is stainless steel AISI type 430 of thickness $(6 \pm 0,2)$ mm. To guarantee a sufficient permeability of the cookware bottom, the disc has to be annealed.

NOTE 1 The annealing is done for approximately 2 h at approximately 650 °C in a nitriding-furnace.

The flatness of the disc is specified in Table 6 for different sizes.

Top and bottom surfaces of the discs shall be sandblasted in the following conditions:

- pressure of 3 bar;
- high-class corundum type 054;
- particle size: 0,25 mm to 0,36 mm.

NOTE 2 This treatment is required to guarantee that enough flour is attached.

NOTE 3 A possible supplier is indicated in Clause F.5.

The sandblasting process can be repeated if tenacious stains caused by fat and flour occur which cannot be removed by cleaning or bleaching.

The discs are specified in Table 6.

Table 6 – Specifications for discs used for measuring the heat distribution

Cooking zone size category	Diameter of the discs (outside)	Flatness of discs
mm	mm	mm
≥ 100 < 130	$120 \pm 0,5$	≥ 0 < 0,2
≥ 130 < 160	$150 \pm 0,5$	≥ 0 < 0,2
≥ 160 < 190	$180 \pm 0,5$	≥ 0 < 0,2
≥ 190 < 220	$210 \pm 0,5$	≥ 0 < 0,5
≥ 220 < 250	$240 \pm 0,5$	≥ 0 < 0,5
≥ 250 < 280	$270 \pm 0,5$	≥ 0 < 0,5
≥ 280 < 310	$300 \pm 0,5$	≥ 0 < 0,7
≥ 310 ≤ 330	$330 \pm 0,5$	≥ 0 < 0,7

To select the best-fitting disc, the **cooking zone** diameter is determined in accordance with 6.3 and the determined diameter is assigned to the adequate **cooking zone** size category in accordance with Table 6. The second column of Table 6 indicates the appropriate disc diameter. The third column specifies the allowed tolerances for the flatness.

For circular, elliptical or rectangular **multiple zones**, always the biggest possible diameter according to 6.3 is tested.

For **cooking areas** the discs are selected and positioned according to Annex A.

If, on an induction **hob**, a disc is not detected, the next biggest disc diameter is chosen.

If a selected disc size is out of the range of the cookware sizes allowed by the user manual, then the closest diameter compatible with the defined range shall be chosen.

9.1.3 Pre-test for determining the setting

The heat distribution test shall be conducted with a power density q , where q is defined as the heat capacity per area unit of the disc in W/cm^2 . The power density shall be $0,9 \text{ W}/\text{cm}^2 \leq q \leq 1,2 \text{ W}/\text{cm}^2$. For an adequate setting, a preliminary test is carried out by following these steps:

- place the disc (without greasing and flouring) selected according to Table 6 centrally on the cooking zone; for cooking areas, follow the selecting and positioning procedure described in Annex A;
- switch on the cooking zone or cooking area with a setting where the power density $0,9 \text{ W}/\text{cm}^2 \leq q \leq 1,2 \text{ W}/\text{cm}^2$ is expected;
- measure the mean energy consumption (EC_m) of the **cooking zone** or **cooking area** within 10 min;
- switch off the cooking zone or cooking area and note the energy consumption EC_m in Wh;
- calculate the mean power $\bar{P}$ with Formula (4):

$$\bar{P} = \frac{6 \times EC_m}{1h} \quad (4)$$

- calculate the power density q with Formula (5):

$$q = \frac{\bar{P}}{a_d} \quad (5)$$

where:

- $\bar{P}$ is the mean power in W;
- EC_m is the energy consumption in Wh within 10 min;
- q is the power density in W/cm²;
- a_d is the surface area of the disc in cm².

If the determined power density q is not in range of $0,9 \text{ W/cm}^2 \leq q \leq 1,2 \text{ W/cm}^2$, the pre-test is repeated with an adapted setting of the **control**.

If no setting can be determined in the range of $0,9 \text{ W/cm}^2 \leq q \leq 1,2 \text{ W/cm}^2$, the setting next to the upper limit of the range is determined.

NOTE If the determined power density is close to $0,9 \text{ W/cm}^2$, within the main test the power density can drop below the limit for those technologies which show an unsteady power input.

9.1.4 Preparation of the disc for the main test

9.1.4.1 Ingredients

The following ingredients are used for preparing the disc:

- flour: wheat flour without raising agent, unbleached, mineral content: maximum 0,5 % (dry substance);
- fat: coconut fat with a fat content of 100 %.

9.1.4.2 Procedure

For the main test, the disc is greased and floured according to following procedure:

- Temper the disc at $40 \pm 5^\circ \text{C}$ for at least 20 min. A preheated oven may be used if the required temperature can be maintained.
- Take the disc out of the oven and grease the upper surface with fat by using a cosmetic sponge. First spread the fat radially and afterwards vertically along the whole surface. The fat film shall be very thin.
- Put the disc back into the oven with the greased surface facing up and warm at $40 \pm 5^\circ \text{C}$ at least for a further 15 min, so the fat layer becomes very even.
- Remove the disc again.
- Fix a suction lifter on the lower surface of the disc for better handling.
- Sieve the flour on the upper surface of the disc using a sieve with a mesh size between 300 µm and 800 µm (diameter).
- Beat the edge of the floured disc twice onto a wooden board to remove the surplus flour.

NOTE 1 Take care that the edge of the floured disc doesn't touch the flour knocked off before. If the disc dip into this pile of flour knocked off before the even layer can be affected.

- Flour the disc again, rotate it by 90 °C and beat it on the wooden board twice. Repeat the flouring until the layer of flour is very even.

NOTE 2 Normally 4 times flouring is enough to reach a thin even layer of flour.

- Check if the flour achieves a smooth, even and thin layer. Otherwise clean the disc and repeat the procedure.
- The suction lifter is removed.

9.1.5 Main test

The **cooking zone** or **cooking area** shall be at ambient temperature.

Place the evenly floured disc centred on the **cooking zone**. Switch on the **cooking zone** with the appropriate setting determined in 9.1.3. For **cooking areas** place the disc according Annex A.

Heat up the disc without any change of setting until the main part of the flour is browned up to NCS level 10 to 12 according to Annex D. The browning is checked visually by the shade charts according to Annex F.

When the required browning matching NCS 10 – 12 according to Annex D is reached, the **cooking zone** or **cooking area** is switched off and the disc is shifted from the hot **cooking zone** or **cooking area** immediately.

Stop the test in advance if the first parts of the disc have match NCS 15 according to Annex D before the required average browning of NCS 10 – 12 according to Annex D is reached.

The time t from switch on the **control** up to switch off is stated in s.

The energy consumption during the time t is stated in Wh.

The position of the disc used on the **cooking area** is stated.

9.1.6 Assessment

9.1.6.1 General

Start the assessment after the disc has cooled down to approximately ambient temperature, at the latest within 24 h.

Take care not to damage the sensitive flour layer. In case the surface is damaged, the test has to be discarded.

For the assessment, only the part of the disc, which covers the cooking zone, is defined as the area to be assessed.

EXAMPLE 1 A cooking zone with a diameter of 130 mm is tested using a disc with a diameter of 150 mm (see Table 6), so the diameter of both differs by 20 mm. For the assessment, these 20 mm of the disc are not considered.

For **cooking areas**, not the entire area of the used disc is relevant but only the area of the used disc minus 15 mm of the outer radius. In this way, the impact of an active rim of a pan is considered, which can influence the activation of coils.

EXAMPLE 2 A disc with a diameter of 180 mm is positioned on a cooking area according Annex A. In a pre-test, the power density is calculated taking into account the area of 180 mm in diameter. For the assessment, only the inner 150 mm diameter is considered.

Alternatively the floured disc can be evaluated visually, but for comparative testing only. By using the shade charts described in Annex D, the assessment can be made based on the criteria in 9.1.6.3 and 9.1.6.4.

9.1.6.2 Requirements to the digital measurement system

For reproducible results of the evaluation of browning, any digital measurement system shall be used that meets the following requirements when the measurements are taken.

NOTE 1 The requirements to the digital measurement system correspond to those described in IEC 60350-1.

a) Evenness of light distribution on the measurement area

The reflection value R_Y of a uniform coloured shade chart shall be measured over the entire surface to be analysed, for example, the size of the biggest disc.

The shade chart shall be coloured in shade number 10, which is defined in Annex D.

The mean value of the reflection value R_Y over the entire surface is determined. More than 90 % of the entire surface may deviate from the mean value by up to ± 5 %. Less than 10 % of the entire surface may deviate by up to ± 8 %.

The entire surface is divided into sections of 1 cm². None of the mean values of the 1 cm² sections shall deviate by more than ± 5 % of the mean value of the entire surface.

b) Recognition of the shade numbers

The shade numbers defined in Table D.1 shall be confirmed in all positions of the surface to be assessed.

This is ensured using the following check: flat circular calibrated colour samples with a diameter of 70 mm in every shade number defined in Annex D are placed at a height of 28 mm. The reflection value R_Y of the calibrated colour samples shall be measured in the outermost points of the area to be assessed, as well as in the centre.

The reflection value R_Y of the calibrated colour samples shall be measured with the tolerances given in Table D.1.

The H values of the limiting samples H_{limit} and H_{lower} which are specified in Table D.2 are measured in the outermost points of the area to be assessed, as well as in the centre. Therefore, flat circular colour samples with a diameter of 70 mm in shade numbers 5 and 6 (defined in Annex D) are placed at a height of 28 mm. H_{limit} and H_{lower} shall be distinguishable from each other concerning their H values in all positions of the surface to be assessed.

NOTE 2 Squared colour samples with a length of 70 mm and width of 70 mm could be used as well.

NOTE 3 Technical details are not fixed in order to be open for technical progress (e.g. camera, software).

NOTE 4 The hue value refers to the HSL colour model.

c) Definition of the illuminance

The measurement is taken under a full spectral fluorescent triband or equivalent from 5 700 K to 7 000 K, with a colour rendering index $R_a > 90$ % of illumination.

NOTE 5 Suppliers for suitable lamps are indicated in Clause F.6.

NOTE 6 Suppliers of colour measuring systems, which meet these requirements, are given in Clause F.7.

d) Minimum requirement to the resolution of the digital measurement system

To ensure a sufficient resolution use a test chart showing at least three pairs of black and white lines with a thickness of 1 mm each. The black lines shall show a reflection value R_Y of maximum 10 %, the white lines shall show a reflection value R_Y of at least 90 %. The reflection value of each single line is to be measured and stated once in horizontal direction and once under an angle of 45°. The resolution is sufficient if the measured reflection value R_Y of each black line doesn't exceed 20 % and the measured reflection value R_Y of each white line exceeds 80 %.

NOTE 7 If the resolution is not sufficient, it can be helpful to use a higher zoom resolution.

NOTE 8 A possible supplier for adequate test charts is indicated in Clause F.7.

9.1.6.3 Criteria of validity

Criteria of validity ensure an adequate comparison of different main tests.

Results of the main test according to 9.1.5 are valid and shall only be accepted if following criteria are fulfilled.

- Time $t \leq t_{\max}$ according to Table 7;
- Table 7 shows $t_{\max}$ for each diameter of the disc.

Table 7 – maximum time $t_{\max}$ for each size of disc

Cooking zone size category	Diameter of the discs (outside)	$t_{\max}$
mm	mm	min
≥ 100 < 130	$120 \pm 0,5$	42
≥ 130 < 160	$150 \pm 0,5$	42
≥ 160 < 190	$180 \pm 0,5$	37
≥ 190 < 220	$210 \pm 0,5$	34
≥ 220 < 250	$240 \pm 0,5$	32
≥ 250 < 280	$270 \pm 0,5$	32
≥ 280 < 310	$300 \pm 0,5$	30
≥ 310 ≤ 330	$330 \pm 0,5$	30

- Used setting

For checking the setting the actually used setting is calculated by the energy consumption and time stated in 9.1.5. The actual setting shall work with the power density $0,9 \text{ W/cm}^2 \leq q \leq 1,2 \text{ W/cm}^2$.

- Browning intensity

For checking the browning intensity the average lightness is determined using a digital evaluation system according to 9.1.6.2. The browning intensity shall show an average reflection value within R_y 16,4 and 26,5.

NOTE For visual check, NCS 10 -12 according to Annex D is required. The stated ranges for the digital evaluation and the visual assessment differ due to the fact that the shade charts and the floured discs have different spectral radiation characteristics.

If one of these three criteria is not fulfilled, the main test shall be repeated depending on the unfilled criteria with an increase of time or an adaption of the setting.

9.1.6.4 Criteria for assessment

- Change of browning along diametral lines

Divide the floured disc diameter into 128 sections and determine the average shade numbers $\overline{SN}_i$ for each section according to Annex D. Consider the represented area of each line section by weighing the average shade numbers $\overline{SN}_i$ with the distance to the centre section, plus one. As a measure for the change of browning along this line calculate the gradient sum square $GS_{\text{line } j}$ according to Formula (6).

$$GS_{\text{line } j} = \sqrt{\frac{\sum_{i=1}^{127} (\overline{SN}_i - \overline{SN}_{i+1})^2 \cdot (|64 - i| + 1)}{127}} \quad (6)$$

where

i is the respective section per line;

j is the number of rotations of the line (see below), here $j = 1$;

$\overline{SN}_i$ is the average shade number of each section;

$GS_{\text{line } j}$ is the gradient sum square, line j .

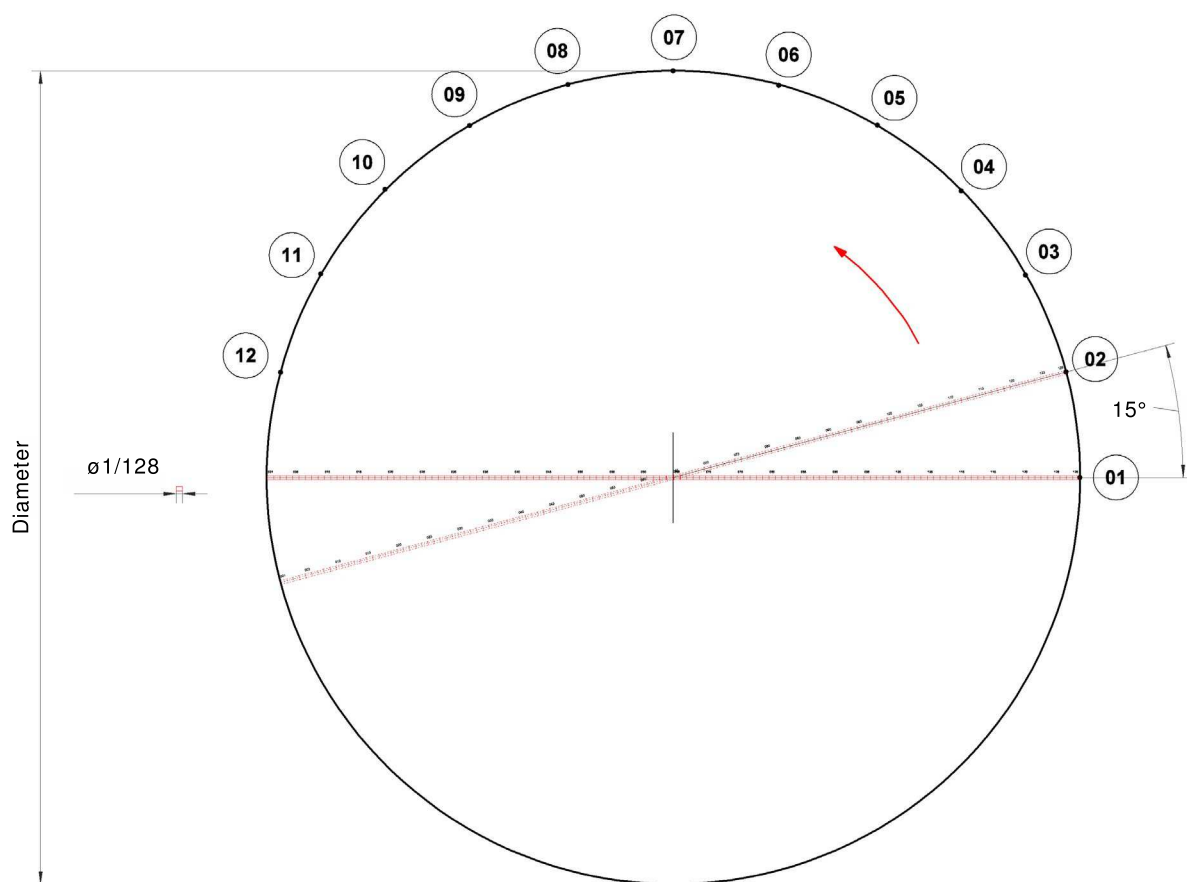
Rotate the line by 15° eleven times and calculate $GS_{\text{line } j}$ for each line as shown in Figure 7.

As a measure of the change of browning of the whole disc, calculate the overall gradient sum square of all twelve lines using Formula (7).

$$GS = \frac{\sum_{j=1}^{12} GS_{\text{line } j}}{\sqrt[12]{12}} \quad (7)$$

where

GS is the overall gradient sum square.



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Figure 7 – Diametral lines

- **Rotation symmetry**
Determine the distance between the geometrical centre of the area to be assessed and the centre of mass of the image.
- **Standard deviation**
Determine the standard deviation of the area to be assessed using the shade numbers according to Annex D of the smallest detectable area.
- **Browning difference**
The browning difference within the area to be assessed is calculated by the 95th percentile minus the 5th percentile of occurring shade numbers for the smallest detectable areas.
- **Not browned areas**
Determine the percentage of not browned areas. Areas with a hue value $H \leq H_{\text{limit}}$ (specified in Table D.2) may be considered as not browned areas.
- **Dark centre**
Determine if the floured disc shows a dark centre. The diameter of the centre is calculated by 0,3 times the diameter of the area to be assessed. The centre is considered as too dark if the average browning intensity is at least 2 shade numbers higher than the average browning intensity of the area to be assessed.

9.2 Measuring the Continuous frying

9.2.1 Purpose

~~The purpose of this test is to determine whether the cooking zone can steadily maintain a moderately high temperature when frying continuously.~~

~~NOTE 1 This test is applicable for comparative testing only.~~

~~NOTE 2 Currently this test is only applicable for cooking zones. Necessary adoptions for **cooking areas** are under consideration.~~

~~9.2.2 Specification of the frying pan~~

~~The assessment is made by frying a batch of pancakes in a frying pan.~~

- ~~— Material: stainless steel bottom clad with several layers, which typically clad a stainless steel layer (e.g. AISI 430 or AISI 439 steel), an aluminium layer and a ferromagnetic layer — often also called "sandwich layer bottom" or "aluminium clad".~~
- ~~— Flatness: $< 0,003 \cdot a$ at ambient temperature, where a is the outer diameter of the pan bottom. A convex shaped bottom plate is not allowed. The flatness of the base has to be checked before starting a measurement.~~
- ~~— Thickness of the bottom: > 3 mm.~~
- ~~— No aluminium or copper spots on the surface and without an aluminium ring on the outside.~~
- ~~— No ferromagnetic disc bottom, ferromagnetic coating or sputtering.~~
- ~~— Without reliefs and stamps, except one smaller stamp with a diameter less than 30 % from the flat bottom diameter in the centre.~~
- ~~— No magnetic sidewall.~~
- ~~— Inner surface of the pan with non-stick surface coating, e.g. polytetrafluoroethylene (PTFE)~~
- ~~— Dimension: the size of pan shall match the size of the **cooking zone** (see 6.2) as well as possible. However, it may vary by a maximum of $+20$ mm and -10 mm.~~

~~For determining the size of cookware, the outer diameter (a) of the flat bottom of the pan is measured.~~

~~The used frying pan is stated. For comparative results, always the same design shall be used, even if different sizes are tested.~~

~~9.2.3 Recipe for pancakes~~

~~The quantities of ingredients and approximate cooking durations corresponding to the diameter of the cooking zone are given in Table 8.~~

Table 8 — Ingredients and cooking durations

Ingredients	Diameter of the cooking zone mm			
	≥ 130 and < 160	≥ 160 and < 190	≥ 190 and ≤ 220	> 220 and ≤ 280
White wheat flour, without raising agent	140 g	140 g	200 g	280 g
Fresh milk, fat content 3 % to 4 %	270 g	270 g	400 g	540 g
Egg (without shell)	110 g	110 g	160 g	220 g
Salt	3 g	3 g	4 g	6 g
Batter quantity for each pancake	45 ml	55 ml	85 ml	140 ml
Cooking duration for the first side	40 s to 60 s	50 s to 70 s	60 s to 80 s	70 s to 90 s

9.2.4 Procedure

~~Whisk milk and egg together, sieve the flour and salt together and add to the milk and egg mixture.~~

~~Leave the batter to rest for one hour at room temperature before baking the pancakes.~~

~~For the first pancake grease the frying pan only with a thin layer of vegetable oil. Heat the pan until the centre of the base has reached a temperature of (200 ± 5) °C measured by a contact probe. Pour the relevant quantity of batter into the pan.~~

~~Fry the pancake until bubbles appear in the upper surface and the batter has set (approximate times are shown in Table 8). Turn the pancake and fry until the second side is golden brown. Fry a total of eight pancakes, maintaining the same setting and the same orientation between the frying pan and the cooking zone.~~

~~A preliminary test may be necessary to determine the setting in order to achieve the specified range of cooking duration for each pancake stated (see Table 8).~~

9.2.5 Assessment

~~The evenness of browning of the side which is fried first is evaluated for each pancake except the first one by using the shade chart of Annex D.~~

~~The average browning of each pancake is determined. The maximum difference between these average values is stated.~~

9.2.1 Purpose

The purpose of this test is to determine if the **cooking zone** or **cooking area** can steadily maintain a medium-high temperature when frying pancakes continuously.

For **cooking zones**, the test is specified for sizes that are typically used for frying, i.e. the following diameters of **cooking zones**:

- diameter of ≥ 160 mm to < 190 mm;
- diameter of ≥ 190 mm to ≤ 220 mm.

For **cooking areas**, one frying pan is used that corresponds to the diameter given for **cooking zones**.

The test is applicable for **open loop controlled** and **closed loop controlled cooking zones** and **cooking areas**.

NOTE 1 This test is applicable for comparative testing only.

NOTE 2 Owing to the pan's construction (specified in 9.2.2), the test is not suitable for assessing the heat distribution.

9.2.2 Specification of the frying pan

- Material: stainless steel bottom clad with several layers, which typically clad a stainless steel layer (e.g. AISI 430 or AISI 439 steel), an aluminium layer and a ferromagnetic layer – often also called "sandwich layer bottom" or "aluminium clad".
- Flatness: $< 0,003 d$ at ambient temperature, where d is the bottom diameter of the pan. A convex-shaped bottom plate is not allowed. The flatness of the base shall be checked before starting a measurement.
- Thickness of the bottom: > 3 mm.

- No aluminium or copper spots on the surface and without an aluminium ring on the outside.
- No ferromagnetic disc bottom, ferromagnetic coating or sputtering.
- Without reliefs and stamps, except for one smaller stamp with a diameter less than 30 % of the flat bottom diameter in the centre.
- No magnetic sidewall.
- Inner surface of the pan with non-stick surface coating, e.g. polytetrafluoroethylene (PTFE).
- Dimension: the size of pan shall match the size of the cooking zone (see 6.3.2 or 6.3.3) as much as possible. However, it may vary by a maximum of +20 mm and minimum of -10 mm.

The diameter of the inner bottom of the frying pan is relevant. The inner bottom diameter corresponds to the usable surface of the inner base. Follow the instruction of the cookware manufacturer regarding the inner bottom diameter of the cookware. If no instructions are given, measure the inner diameter with a flexible tape. For this, position the flexible tape on the inner bottom surface, searching the maximum measureable diameter.

For **cooking zones** and **cooking areas** that work exclusively with a supplied frying pan, the supplied pan shall be used.

Use the same frying pan for the pre-test and the main test. Use the frying pan without greasing.

Record the frying pan used and its measured inner bottom diameter.

9.2.3 Recipe and amounts

The quantities of ingredients for one batch of pancakes are specified in Table 8. Always prepare the same amount and discard any surplus mixture. Ingredients and amounts, as defined in Table 8, shall be used.

Table 8 – Ingredients

Ingredients	Frying pan, inner bottom diameter	
	≥ 150 mm and < 195 mm in g	≥ 195 mm and ≤ 240 mm in g
White wheat flour, without raising agent	280 ± 2	365 ± 2
Fresh milk, fat content 3 % to 4 %	540 ± 2	705 ± 2
Egg (without shell) / whole egg	220 ± 2	290 ± 2
Salt	6 ± 0,5	8 ± 0,5
Baking powder Phosphate baking powder, (double acting), Diphosphate (E450 46,7 %); Natriumcarbonat (E500 33,3 %); wheat starch	8 ± 0,5	11 ± 0,5

Sieve the flour and baking powder to the other ingredients. Stir all components for (300 ± 10) s using a food processor. Make sure that all ingredients are thoroughly mixed and that there are no lumps in the batter.

Cover and store the batter at room temperature for 60 min to 120 min. Then, skim off any foam from the surface and sieve it.

Table 11 – Quantity of batter per pancake

Inner bottom diameter mm	Quantity of batter g
150 to 165	45 ± 2
166 to 180	55 ± 2
181 to 195	65 ± 2
196 to 210	75 ± 2
211 to 225	85 ± 2
226 to 240	100 ± 2

Use a ladle or measure the portions of batter according to the values in Table 11 with measuring cups. If cups are used, fill and empty the cups first in order to coat the cups before the final amount is weighed.

9.2.4 Pre-test

In order to define the heating up phase for the pan, determine the hottest area of the pan.

For **radiant cooking zones**, **induction cooking zones** and for **cooking areas**, the outer diameter of the frying pan is marked on the glass ceramic to simplify keeping the same position during the frying process.

For **cooking zones**, ensure that the frying pan is centred.

For **cooking areas**, position the frying pan in accordance with Annex A.

For **hobs with closed loop controls**, the manufacturer's instructions regarding the positioning of the cookware shall be followed.

Always position the frying pan empty.

Heat the empty frying pan with the highest setting. However, a boost function shall not be used. If the inner bottom of the pan has reached a medium-high temperature, determine the hottest area of the bottom. A contact probe or thermography may be used.

Record the position/location of the hottest area as the area where the temperature is measured in the main test.

9.2.5 Main test

The **hob** and the frying pan shall be at ambient temperature.

Position the frying pan by following the procedure described in the pre-test.

– For **open loop controlled cooking zones** and **cooking areas**:

Switch the control to the highest setting. A boost function shall not be used.

Take a contact temperature probe and control the temperature rise at the hottest area determined in the pre-test.

For **solid hotplates**, **radiant cooking zones** and **tubular hotplates**, switch the power to continuous setting recommended by the manufacturer's instructions when the temperature reaches a temperature of $(190 \pm 5) ^\circ\text{C}$. For **induction cooking zones** and **cooking areas**,

switch the power to the continuous setting recommended by the manufacturer's instructions when the temperature reaches $(220 \pm 5) ^\circ\text{C}$.

If no recommendation is given, then set the control to a setting slightly higher than the medium one.

EXAMPLE For a control with 9 possible settings, setting 6 is chosen.

Pour the quantity of batter into the pan not later than 15 s after switching the power to the continuous setting and distribute it by using a batter spreader. Always ensure that the batter is poured and spread with similar handling, for example, pouring into the centre of the pan and spreading clockwise. Start measuring the frying time after filling but before distributing the batter in the pan.

Fry the first pancake until the batter dries to the point that it no longer drips when turning. Record the frying time in s. If necessary, adjust the frying time when baking the second pancake. Then, turn the pancake and fry the second side for approximately 20 s.

Fry ten pancakes. Keep the setting unchanged. Fry all pancakes exactly with the time determined for the second pancake, first side. The time in between frying the pancakes shall not exceed 20 s.

– For **closed loop controlled cooking zones** and **cooking areas**:

Regarding heating up and the continuous setting, follow the recommendations given in the manufacturer's instructions.

If no recommendation is given and a temperature setting is available, choose a setting as close as possible to $200 ^\circ\text{C}$.

Pour the quantity of batter into the pan no later than 15 s after switching the power to continuous setting and distribute it by using a batter spreader. Always ensure that the batter is poured and spread with similar handling, for example, pouring into the centre of the pan and spreading clockwise. Start measuring the frying time after filling, but before distributing the batter in the pan.

Fry the first pancake until the batter dries to the point that it no longer drips when turning. Record the frying time in s. Then, turn the pancake and fry the second side for approximately 20 s.

Fry ten pancakes. Keep the setting unchanged. Fry all pancakes exactly with the time determined for the second pancake, first side. The time in between frying the pancakes shall not exceed 20 s.

9.2.6 Assessment

9.2.6.1 General

For all pancakes, assess the first side fried, not the side after turning the pancake.

The outer circle of the pancake (= rim) is not considered (approximately 10 mm). However, neglect the two pancakes fried first. Only the pancakes number 3 to 10 are included in the assessment. Dark and light spots that have formed on the pancake surface, for example by bubbles, are not taken into account.

For **cooking zones** tested with a bigger frying pan, only this area of each pancake is assessed which corresponds to the diameter of the cooking zone.

The browning intensity for each pancake is determined using the shade chart described in Annex D. The browning intensity per pancake is defined by the predominant shade chart.

If more than one cooking zone is tested, only the results achieved with the same frying pan can be compared with each other and classified.

9.2.6.2 Criteria of validity

Results of the main test in accordance with 9.2.5 are valid and shall only be accepted if the following criteria are fulfilled:

- Target browning intensity

The browning intensity of the pancake assessed firstly (= 3rd pancake) shall be in the range of NCS 10 ± 2 .

- Frying time

The frying time for the first side of all pancakes shall be within 50 s to 85 s.

If one of these criteria is not fulfilled, the main test shall be repeated with an adapted setting or varying the time.

9.2.6.3 Criterion of assessment

The difference of the browning intensity Δ NCS between all pancakes assessed is calculated and stated.

Owing to the influence of the frying pan chosen for the comparative test series, a deviation of maximum 4 steps of the NCS grades is allowed.

Table 12 shows an example for the assessment of pancakes.

Table 12 – Example for the assessment of pancakes

Pancakes	1 ^a	2 ^a	3	4	5	6	7	8	9	10
Browning intensity per pancake (predominant NCS shade chart)	10	11	12	11	12	12	13	13	13	13
Criterion of validity			NCS 10 ± 2							
Criterion of assessment			Δ NCS = 11 – 13 = –2 This difference can be caused by the frying pan and is neglected. The tested cooking zone can steadily maintain a medium-high temperature when frying pancakes continuously.							
a Pancakes 1 and 2 are ignored for the calculation of browning intensity.										

10 Heat performance of cooking zones

10.1 Purpose

Electronic components in **hobs** are used for thermal protection. Temperature sensors are integrated into the **hob**. The power to the **cooking zones** can be cut off when temperatures reach critical limits. Also, the electronic **control** system itself can require thermal protection. This design characteristic can alter the ability to heat food. The purpose of the test method is to determine the heating performance of **hobs** that have thermal protection.