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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electric dishwasher for commercial use – Test methods for measuring the performance

Lave-vaisselle électriques à usage collectif – Méthodes d'essai et de mesure de l'aptitude à la fonction

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ELECTRIC DISHWASHER FOR COMMERCIAL USE – TEST METHODS FOR MEASURING THE PERFORMANCE

FOREWORD

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EN 50593:2017 has served as a basis for the elaboration of this standard.

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

CDV	Report on voting
59A/223/CDV	59A/226/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

In this standard, the following print types are used:

- terms used throughout this standard which have been defined in Clause 3: **in bold type**

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INTRODUCTION

This first edition has been developed to provide a globally applicable and agreed method to test the performance of electric dishwashers for commercial use.

ELECTRIC DISHWASHER FOR COMMERCIAL USE – TEST METHODS FOR MEASURING THE PERFORMANCE

1 Scope

This document applies to manually loaded under-counter one-tank and one-tank hood-type electrically heated dishwashing machines for washing plates, dishes, glassware, cutlery and similar articles.

These machines are used in commercial kitchens, such as restaurants, canteens, hospitals and in businesses such as bakeries, butchers' shops, etc.

This document does not apply to commercial dishwashers with transport systems (flight-type and rack conveyor dishwashers) and utensil washers.

This document does not apply to undercounter water-change dishwashers.

This document does not apply to appliances designed exclusively for industrial purposes.

The object is to state and define the principal performance characteristics of electric dishwashers for commercial use and to describe the standard methods of measuring these characteristics.

The characteristics are measured by washing plates.

This document is concerned neither with safety nor with minimum performance requirements.

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.

ISO 15510, *Stainless steels – Chemical composition*

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
commercial dishwasher
electric dishwasher that is specially designed for use in commercial environments and that cleans and rinses dishes, glasses, cutlery, and, in some cases, cooking utensils by chemical, mechanical, thermal and electrical treatment

Note 1 to entry: Commercial dishwashers evaluated with a specific drying operation at the end of the programme should be declared as such in the test report.

3.1.1
under-counter one-tank dishwasher
manually loaded, programmable, undercounter front loader with typically one detergent-circulating zone and a fresh-water rinsing process

Note 1 to entry: The washware is cleaned using a detergent solution that is regenerated. The technical equipment is geared to the performance that is required in the specific application.

3.1.2
hood-type dishwasher
manually loaded, programmable, hood-type, pass-through machine with typically one detergent-circulating zone and a fresh-water rinsing process

3.2
operation
event that occurs during the dishwasher's programme, such as cleaning, rinsing or drying

3.3
programme
series of operations that are pre-defined within the dishwasher and that are declared by the manufacturer as suitable for cleaning certain washware

3.4
cycle
complete cleaning process, as defined by the programme selected, consisting of a series of operations (washing, rinsing, drying, etc.) and including any operations that occur after the completion of the programme

Note 1 to entry: Examples of **operations** that can occur after the completion of the **programme** are refilling of the boiler, heating, operation of pumps and fans.

3.5
programme time
time that is measured from the initiation of the programme (excluding any user-programmed delay) until an end of programme indicator is showing the end of the programme

Note 1 to entry: If there is no end of programme indicator, the programme time is equal to the cycle time.

3.6
cycle time
time that is measured from the initiation of the programme (excluding any user-programmed delay) until all activity ceases (i.e. the end of the cycle)

3.7
automatic dispenser
device activated automatically that injects or dispenses detergent or rinse agent one or more times into the dishwasher at predetermined points in the dishwasher cycle

3.8
ready-to-use mode
mode after which the dishwasher has been filled with water, the water has been heated (ready for operation) and the machine is ready to start the cycle as indicated in the instructions for use

3.9
rack
removable support for holding washware in the dishwasher

3.10
energy-consuming element
electrical consumer (e.g. heaters, fans, pumps) in the dishwasher

Note 1 to entry: The control system is not considered as an energy-consuming element.

3.11
washware
materials and utensils that come into contact with foodstuffs and re-usable crates/containers that are cleaned in a commercial dishwasher

Note 1 to entry: Examples of washware are plates, crockery, cutlery, kitchen equipment, glasses, pots, containers, crates and trays made of materials such as porcelain, plastic, glass, stainless steel and silver as well as coated materials.

3.12
treating agents
chemical products used to clean or rinse, as rinse aids or descalers, when treating washware in dishwashers

3.12.1
detergent
chemical product used to remove soiling from washware, and which counteracts resoiling from the detergent solution

3.12.2
detergent solution
water mixed with detergent in the detergent circulation tank

3.12.3
rinse aid
chemical agent added to the water in the final rinsing operation, which decreases the interfacial tension of the rinse aid solution

Note 1 to entry: It improves the drying effect and reduces water marks.

3.12.4
rinse aid solution
supply water mixed with rinse aid used for fresh-water rinsing

3.13
pre-cleaning
removal of loose waste and leftover food on the washware and the emptying of hollow vessels

Note 1 to entry: Pre-cleaning is generally implemented by pushing the residue into waste containers and, if possible, by rinsing the washware with water. Pre-cleaning reduces the soiling of the dishwasher and improves the cleaning result.

3.14
ballast soil
artificial soil for testing certain machine characteristics

3.15
fresh-water rinsing
process after cleaning during which the washware is sprayed with a rinse aid solution to remove residues of detergent solution, dissolved and undissolved dirt particles

3.16
drying
process in which the moisture drips, vaporises or evaporates from the surface of the washware

3.17
cleaning
removal of soiling

3.18
re-soiling
soiling of the washware (e.g. on the rear side of the washware) by the cleaning process, which causes a deterioration of the cleaning result

3.19
cleaning process
process including at least one washing process and one fresh-water rinsing process

3.20
operating time
period during which the dishwasher is operational

3.21
spray system
sum of all pipelines, jets and spray pipes required to circulate and spray detergent and rinse aid solutions

3.22
water softener
device which reduces the hardness of water

3.23
start-up time
time needed for the initial fill

3.24
initial fill
first water filling process between activation of the machine and reaching the ready-to-use mode

4 List of measurements

The performance and consumption characteristics are determined as follows:

– **cleaning** and **resoiling** performance test in accordance with Clause 6;
– energy, water consumption and time measurement in accordance with Clause 7.

5 General conditions for measurements

5.1 General

The dishwasher manufacturer's instructions regarding installation and use of the **commercial dishwashe**r shall be followed, except if they stand in conflict. In this case, this document shall prevail.

The **cleaning** and **resoiling** performance test in accordance with Clause 6 and the energy and water consumption and time measurement in accordance with Clause 7 are done together.

Deactivate the automatic start for appliances with automatic start **cycle** when the door/hood is closed.

No chemical agents other than the ones mentioned in 5.7 and 5.8 shall be used.

All testing shall be performed on the same machine.

Before commencing measurements, the **commercial dishwasher** shall be checked to ensure that it is operating properly.

All tests shall be started with the appliances at the ambient conditions in accordance with 5.5.

For all tests, the appliance shall be free-standing in the room without any excess coverage other than originally equipped. All protective surface cover foils shall be removed.

Test materials for laboratories are specified in Annex A.

5.2 Conditioning of the machine under test and sequence of test procedures

Before conducting the performance tests, the dishwasher shall be initially filled and dosed with reference detergent (specified in 5.7) and reference **rinse aid** (specified in 5.8). No additional **cycles** shall be carried out on the machine under test between the consecutive steps of the procedures specified in Clauses 6 and 7. All parts of the machine shall be inspected, and any residues shall be removed.

5.3 Electricity supply

The appliance is supplied at rated voltage ±2 % and shall be maintained at the appliance's terminal throughout the test.

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.

The supply frequency shall be at the rated frequency ±1 %

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.

The voltage and frequency shall be measured and recorded during the test.

5.4 Test programme

The **programme** to be tested shall be the one that cleans normally soiled **washware** (standard **cleaning cycle**).

The manufacturer shall declare the **programme** to be used for testing.

5.5 Ambient conditions

The following ambient conditions shall be maintained throughout the measurements.

– ambient temperature of the room: (23 ± 2) °C;
– relative humidity: (55 ± 5) % RH;
– air velocity max: 1 m/s.

The limit value for the air velocity shall only apply to the room area where the drying of the soiled plates is carried out (see 6.2.3).

The ambient temperature and the relative humidity shall be measured and recorded during the test.

5.6 Water supply

5.6.1 General

The actual water temperature and pressure maintained during the tests shall be measured and recorded. The maintained water hardness shall be measured.

5.6.2 Water supply – Temperature

The temperature of the supply water shall be (15 ± 2) °C.

5.6.3 Hardness

If the dishwasher is fitted with an integrated water softening unit, it shall be deactivated (set to soft water supply). During testing, soft water shall have a total hardness of $(Ca^{2+} + Mg^{2+}) < 0{,}54$ mmol/l .

NOTE Procedures to reach a defined hardness of water are described, for example, in IEC 60734.

5.6.4 Water Pressure

The flow pressure of the water supply shall be set to 240 kPa and shall be maintained within the range ±20 kPa. If it is not possible to maintain the pressure within this range, a flow rate of (15 ± 2) l/min shall be maintained.

5.7 Detergent

For the tests, solely the reference detergent shall be used (see Clause A.1).

The concentration shall be (3 ± 0,3) g/l for the tests.

The amount of detergent shall be calculated by the given concentration and the measured water consumption of the previous **operation**.

The detergent shall be added by hand directly into the wash chamber.

Detergent from the same batch shall be used for the dishwasher under test.

The detergent manufacturer's specifications regarding storage and handling shall be observed.

5.8 Rinse aid

For the tests solely the reference **rinse aid** shall be used (see Clause A.2).

The dosing is done in accordance with the manufacturer’s instructions.

The concentration shall be set in accordance with the manufacturer’s instructions.

Rinse aid from the same batch shall be used for the dishwasher under test.

The **rinse aid** manufacturer's specifications regarding storage and handling shall be observed.

5.9 Load

The load is a **rack** for the appliance under test defined in Clause A.4.

The **rack** is loaded in accordance with the manufacturer’s instructions. The **washware** used for test purposes is defined in Clause A.4.

Only **washware** with no visible damage on the surface, e.g. scratches or similar damage, and free of any residues shall be used.

5.10 Temperature measurement

The temperature shall be measured every second and recorded during the **cycle** and reported.

The last **rack** used in the conditioning **cycles** with **ballast soil** (7.2.4) is equipped with a temperature probe (with an accuracy of ±2 K) positioned in the centre of the upper surface of the stainless-steel support fixed on the holder (see Clause A.6), whose exact position is the first row on the left-hand side, at the front of the **rack**.

6 Cleaning and resoiling performance test

6.1 Purpose and general description

The purpose of this test is to evaluate the **cleaning** and **resoiling** performance and is performed together with the energy and water consumption and time measurement, as described in 7.2.4.

The procedure consists of the removal of the test soiling, applied in the form of 33 soil dots per plate. After the dots are applied, the plates are air-dried under ambient conditions as defined in 5.5.

To evaluate performance degradation during continuous **operation**, particles in accordance with 6.2.2.3 are added directly into the wash tank before the machine **cycle** starts. For statistical plausibility, in total five **cycles** shall be done in the preconditioned dishwasher using the described cleaning solution and the standard settings of the dishwasher manufacturer. The plates are evaluated by visual inspection at the end of the procedure. The number of not completely removed soil dots, as well as the number of remaining sesame seed particles on the plates, are counted and statistically analysed as described in the procedure specified in 6.2.

If more than one **rack** is cleaned in one **cycle**, parameters referring to the number of **racks** involved shall be considered accordingly.

6.2 Description of the cleaning performance test procedure

6.2.1 Preparation

6.2.1.1 Basic cleaning of plates

If new plates are used, follow the procedure in 6.2.1.2.

Before each test, all plates need to be pre-treated with the basic cleaning procedure. Plates are pre-soaked using the basic cleaning **detergent** (see Clause A.3) with a dosage of 300 g ± 15 g per 10 l of fresh water at a temperature of 50 °C to 65 °C. The plates shall be pre-soaked for at least 20 min followed by manual pre-scrapping, if needed, so that the soil or other residues are completely removed from the plates' surfaces. In order to ensure a complete removal of the basic **detergent** after basic plate cleaning, all plates shall be rinsed with fresh water and washed in a dishwasher for two **cycles**. Only demineralized water with conductivity < 80 µS (no chemicals) shall be used for the dishwasher to avoid any residuals on the plates' surfaces.

After basic cleaning, the plates need to be completely air-dried and cooled down to ambient temperature.

An alternative procedure can be applied if the same result is obtained (see 6.2.3).

Only completely dry plates at ambient conditions shall be used for the test.

6.2.1.2 Basic cleaning of new plates

If new plates are used for the test, the following procedure shall be applied. The basic cleaning **detergent** (see Clause A.3) with a dosage of 300 g ± 15 g per 10 l tank volume shall be used. The **detergent** is directly added into the wash tank. The new plates shall then be washed for 10 subsequent **cycles** in the dishwasher with a wash temperature of 60 °C to 65°C and a rinse temperature of 80 °C to 85 °C. Load the **rack** with new plates, put it into the dishwasher and start the subsequent **cycles**. When the 10 **cycles** are finished, drain the dishwasher and refill it with fresh demineralized water. In order to remove any **detergent** residues, the dishwasher shall then be run for one complete **cycle** with a **cycle time** ≥ 180 s without the use of any chemicals.

6.2.1.3 Dishwasher

The dishwasher shall be preconditioned in accordance with the standard measuring procedure described in 7.2.4.

6.2.1.4 Template for dot application

Figure 1 and Figure 2 show the template for the application of the dots.

Dimensions in millimetres

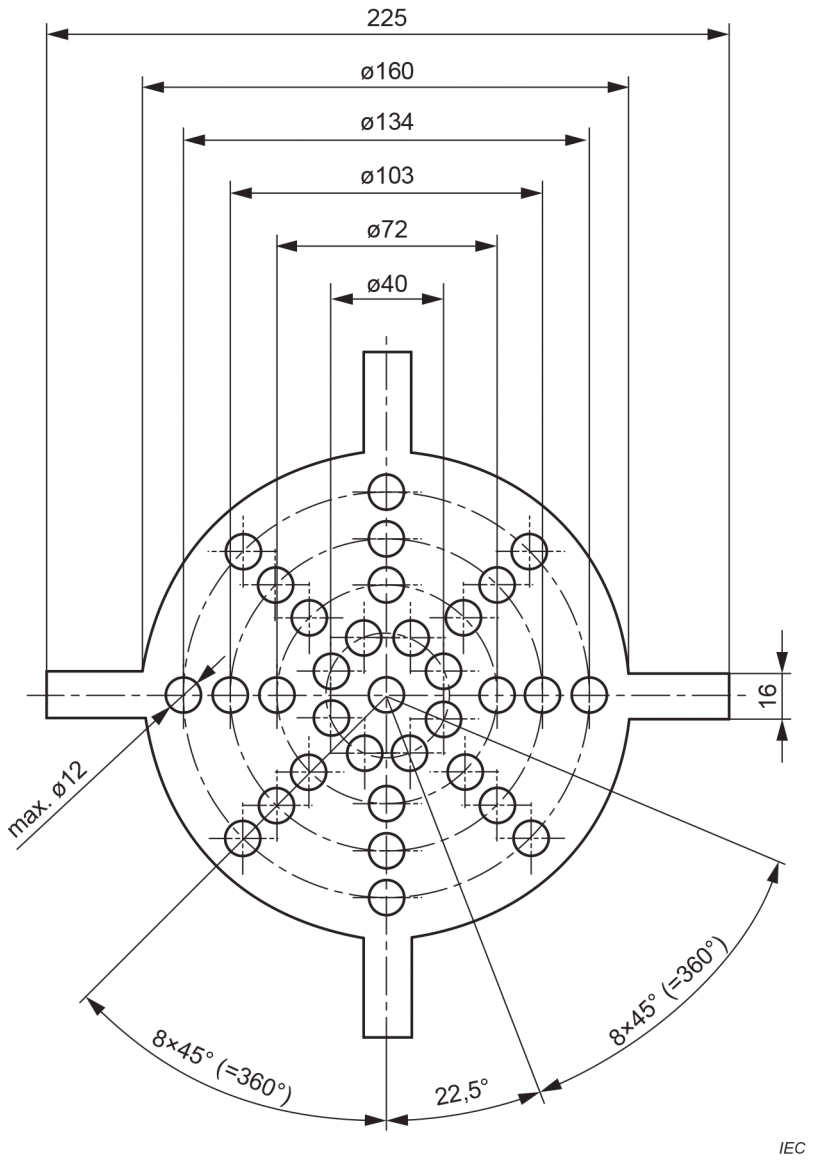

Figure 1 – Template with dot test pattern

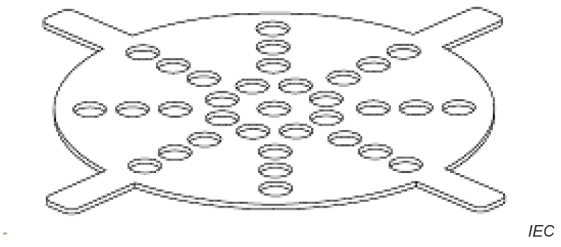

Figure 2 – Template – 3D view

The thickness of the template should be between 1 mm and 3 mm.

The maximum diameter of the holes shall be 12 mm.

Recommended materials are stainless steel or rubber. A centralized position of the template on the plate shall be ensured.

If a stiff material is used for the template, the flaps shall be bent upwards to allow the template to hover at a maximum of 5 mm above the surface of the plate. The template shall not come in contact with the test soil. One template should be sufficient for the preparation of all plates.

6.2.1.5 Pipette/dispenser used for dot application

For application of the dots to the plate's surface, a repeater pipette with the required accuracy shall be used (see Clause A.5).

6.2.2 Formulation of test soil

6.2.2.1 Ingredients

290 g cow's milk (3,5 % fat, pasteurized, homogenized)

0,2 g Nigrosin (CAS number 101357–32–8) (C.I. 50420)

80 g white and yellow egg mixed

NOTE 1 Example of egg: class M according to European egg labelling.

80 g white (granulated) table sugar

210 g wheat flour for pastry with 0,5 % mineral content in dry form

NOTE 2 Examples of white flour: in Germany, Type 405, Austria: Type 480; in Switzerland, "Weissmehl"; in Italy, Tipo 00.

Use eggs of good quality with a mass of 50 g to 65 g at ambient condition. The eggs shall be at least 7 days old, but not having passed their best before or use-by date. The eggs shall be kept refrigerated until use. At least 3 eggs shall be used for the whisked egg.

The egg white and the egg yolk are mixed with a stick blender for 10 s in a bowl.

Any U.H.T. milk with 3,5 % fat content may be used. U.H.T. milk shall have a use-by or expiry date of at least 1,5 months from the date of the test. U.H.T milk shall be refrigerated after opening and shall be used within 2 days of opening.

6.2.2.2 Formulation

The coarse Nigrosin kernels are ground in a chemical mortar to a fine powder (Figure 3).

180 g of cow milk is poured into an 800 ml beaker.

The milk shall be added at a temperature of 6 °C to 8 °C.

The ingredients 0,2 g of Nigrosin, 80 g of sugar, 80 g of egg and 210 g of wheat flour are added to the 180 g of cow's milk.

Blend together with a stick blender for 2 min. After completion, 110 g of additional cow's milk is added. The mixture is manually stirred with a whisk or spatula to suspend residual ingredients from the beaker walls. Afterwards the mixture is blended for another 2 min and set aside for 30 min to remove air enclosures (Figure 4).

The created test soil can be used for a maximum of 3 h. If the test soiling is not used for a while, plastic foil shall be used as a cover to minimize film build-up due to dehydration. If a thin film exists, it can be mixed under to rehydrate the film fragments.

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Figure 3 – Coarse Nigrosin kernels are ground in a chemical mortar

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Figure 4 – Mixed test soil

6.2.2.3 Particles

To each **rack,** 10 g of white sesame seeds (see Clause A.7) are added directly into the machine chamber/on top of the wash tank.

The sesame seeds are added immediately before the insertion of the **rack** containing the soiled plates. The sesame seeds are prepared by sieving, using an upper mesh size of 2 mm and a lower mesh size of 1 mm.

6.2.3 Application of test soil

The application and the drying process shall occur at ambient conditions as defined in 5.5. The test soiling dots are applied on the front side of the plates only.

Centre the template in the middle of the plate. Use the repeater pipette to apply the 33 dots in the middle of the given areas. Each dot shall have a weight between 0,024 g and 0,030 g, corresponding to an average volume of about 25 µl. The total soil amount per plate shall be 0,9 g ± 0,1 g. Total drying time per **rack** shall be 2h and 20 min from commencing the soiling process (application of the first dot). The soiling process per **rack** shall not exceed 20 min.

After application, the plates shall be stored in their serving orientation to dry, not covered or stacked.

At the end of the 2 h drying period, the dots have dehydrated to dot sizes of 6,75 mm ± 1,00 mm. A soiled plate is shown in Figure 5.

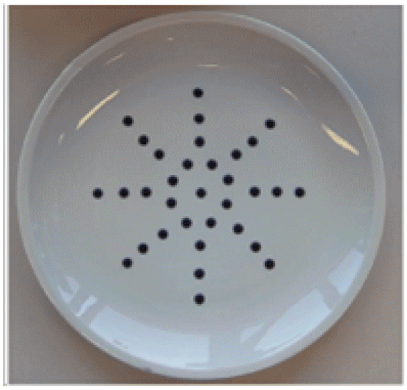

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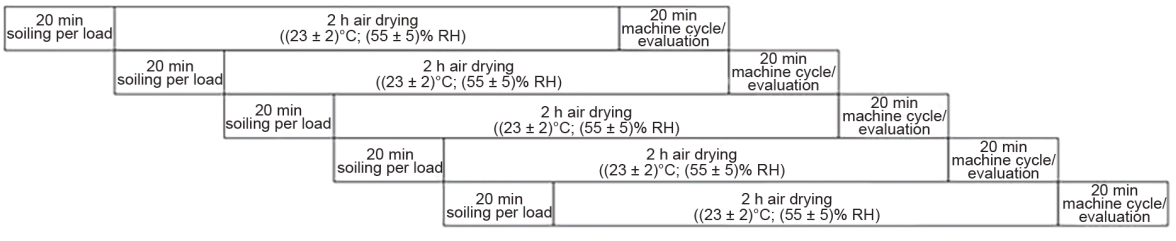
Figure 5 – Plate with 33 dots after drying

If the specified sizes of the dots are not reached, the basic cleaning process of the plate surface was not successful and thus there are still remaining residues on the plate surface, or other parameters were not in range. This leads to altered cleaning performance behaviour and therefore shall be avoided.

In total, 5 **racks** with soiled plates shall be prepared in series as described in Figure 6. At the end of the 2 h drying time, the first **rack** is ready for the **cleaning** and **resoiling** performance test, which is combined with the energy and water consumption and time measurement. The test sequence defined under 7.2.4 and shown in the flow chart in Annex B shall be followed. To each machine **cycle,** 10 g of sesame seeds are added directly into the machine chamber/on top of the wash tank before a new **rack** is loaded.

A water meter complying with 7.2.1 shall be installed in the feed line of the dishwasher in order to measure the water consumption.

Time schedule for test procedure is shown in Figure 6.



IEC

Figure 6 – Time schedule for test procedure

In order to calculate average **cleaning** results, each test consists of five repetitions. The supply water volume refilled by the machine during the **cycle** shall be measured in order to compensate for tank water discharge. In accordance with this volume, the **detergent** (3 g/l) is manually added after each **cycle** in order to ensure a constant **detergent** concentration.

6.3 Evaluation

6.3.1 General

After each **cycle**, the **rack** containing the plates is immediately removed from the machine. After the plates are dried, all plates are visually inspected for remaining dot soil residues and sesame seed particles. The remaining dots and particles per plate are counted.

A remaining dot is counted if there are any traces visible after the **cycle**. Any remaining sesame seed particles or fractions thereof are counted.

The evaluation time per plate is 10 s.

For the evaluation, the light conditions shall be as follows:

– colour temperature of 3 500 K to 4 500 K ("daylight" or "cool white" lamp);
– intensity of illumination measured at the position of evaluation shall be 1 000 lx to 1 500 lx.

For dot evaluation purposes, only the front side of the plate is considered.

For the evaluation of sesame seed particles, both the front and rear sides of the plate are considered.

The found total numbers of sesame seed particles from both sides of the plate are added. See Table 4.

6.3.2 Calculation of performance results

For statistical plausibility, the average results of the five **cycles** are considered to generate the final result.

The **cleaning** performance is calculated using Formula (1):

$$X_{\mathrm{c}} = \frac{T_{\mathrm{NRD}}}{T_{\mathrm{NAD}}} \cdot 100 \ \text{ in \%} \tag{1}$$

where:

T_{NRD} total number of remaining dots
T_{NAD} total number of applied dots

The **resoiling** performance is calculated using Formula (2):

$$X_{\mathrm{r}} = \frac{T_{\mathrm{NPF}}}{T_{\mathrm{NEP}}} \tag{2}$$

where:

T_{NPF} total number of particles found
T_{NEP} total number of evaluated plates

7 Energy, water consumption and time measurement

7.1 General information

The purpose of this measurement is to determine the electrical energy and water quantity as used by the dishwasher for filling, running and the required time for completion of a particular **programme** that is used for measuring the **cleaning** performance.

Furthermore, the **start-up time** and the electrical power of the **ready-to-use mode** are measured.

All test sequences are presented in the flow chart in Annex B.

If more than one **rack** is cleaned in one **cycle**, parameters referring to the number of **racks** involved shall be considered accordingly.

7.2 Measurement method

7.2.1 General

Energy consumption is measured in kWh to three decimal places, water consumption in litres to one decimal place and time in seconds.

The energy and water consumption is measured in total for 5 **cycles**. The total value is then divided by 5 (see 7.2.4).

The **programme** and **cycle time** is measured for each **cycle** (see 7.2.4) and the arithmetic mean of the values shall be calculated.

7.2.2 Preparation

The dishwasher is cleaned by running one normal **cleaning cycle** as defined for the performance test, but without load.

Then it is emptied as described in the instruction manual and cooled down to ambient temperature (see 5.5), with the hood/door open for at least 12 h.

The fill level of the dishwasher boiler is at the same height as after the standard draining process (see instruction manual of the manufacturer). All parts of the machine shall be inspected, and any residues shall be thoroughly removed.

The appropriate **racks** and plates in accordance with 5.9 are provided.

Before each test procedure, the required amount of **racks** shall be prepared.

All plates and **racks** shall be dry and at ambient temperature (see 5.5).

7.2.3 Initial fill and Start-up time

Start recording.

Switch on the dishwasher and wait until it has reached the **ready-to-use mode** and all **energy-consuming elements** are inactive.

Open door/hood and keep it open for 30 s to load the machine in accordance with 5.9. Close the door/hood and start one **cycle** immediately.

Wait until all **energy-consuming elements** are inactive.

Stop recording.

The **start-up time** (T_S) shall be measured from switching on the dishwasher until it has reached the **ready-to-use mode** and all **energy consuming elements** are inactive.

The energy (E_F) and water consumption (V_F) are measured from switching on the dishwasher until one **cycle** is finished and all **energy consuming elements** are inactive.

The energy (E_S) and water (V_S) consumption for the **initial fill** process is calculated by subtracting the average consumption of one **cycle** (E_C resp. V_C) calculated in accordance with 7.2.4.

$$E_S = E_F - E_C \quad (3)$$

$$V_S = V_F - V_C \quad (4)$$

7.2.4 Energy, water consumption and programme/cycle time

This test is done together with the **cleaning** and **resoiling** performance test (Clause 6).

The machine shall be conditioned in accordance with 5.2.

The machine is in **ready-to-use mode**.

For temperature conditioning of the entire machine and for turbidity conditioning in the wash tank, three **racks** loaded with plates shall be washed consecutively. To each conditioning **cycle,** a defined quantity of **ballast soil** shall be added into the centre of the wash chamber of the dishwasher before the filter (if available). The **ballast soil** needs to be added before the **cycle** is started.

For each plate to be tested, 0,9 g of test soil shall be added.

For each **rack** to be tested, 10 g of sesame seeds shall be added.

Both the test soil and the sesame seeds are described in 6.2.2.

NOTE For example, if the **rack** is loaded with 18 plates, 18 × 0,9 g = 16,2 g of test soil and 10 g of sesame seeds shall be added into the wash chamber for each conditioning **cycle**.

Load the machine, close the door/hood and start the first **programme cycle**.

After the machine is indicating the end of the **programme**, wait until all **energy-consuming elements** are inactive.

Open door/hood and keep it open for 30 s to unload and load again with the next **rack** and add **detergent** and **ballast soil**.

Close door/hood and start the next conditioning **cycle** immediately.

The load for the 3rd conditioning **cycle** shall be equipped with a temperature probe, in accordance with 5.10.

After the 3rd conditioning **cycle,** unload the machine and close the door/hood.

Wait until the dishwasher is in the **ready-to-use mode** and all **energy-consuming elements** are inactive.

The energy, water consumption and **programme/cycle time** measurement combined with the **cleaning** and **resoiling** performance test shall now be started within 15 min.

Five **cycles** loaded with **racks** with soiled plates shall be washed. For each **rack,** 10 g of sesame seeds, in accordance with 6.2.2.3, shall be added into the centre of the wash chamber of the dishwasher before the filter (if available).

Start recording.

Open door/hood and keep it open for 30 s to load the machine with a **rack** with soiled plates.

Close the door/hood and start the **programme cycle** immediately.

After the machine indicates the end of the programme, wait until all **energy-consuming elements** are inactive.

Open door/hood and keep it open for 30 s to unload the machine.

Close door/hood until the next **rack** containing soiled plates in accordance with 6.2.3 is ready for use.

Open door/hood and keep it open for 30 s to load the next **rack** and add **detergent**.

Close door/hood and start the next **programme cycle** immediately.

After the 5th **programme cycle**, when the machine is indicating the end of the wash **cycle**, wait until all **energy-consuming elements** are inactive.

Open door/hood and keep it open for 30 s to unload the machine.

Close the door/hood.

Stop recording 20 min after the start of 5th **cycle**.

Now, the total water consumption (V_T) and the total energy consumption (E_T) of 5 **cycles** and each individual **programme/cycle time** (T_{PR1} until T_{PR5} and T_{C1} until T_{C5}) shall be reported.

The total energy consumption (E_T) is then divided by 5 to determine the energy consumption per **cycle** (E_C)

$$E_C = E_T / 5 \quad (5)$$

The water consumption (V_T) is then divided by 5 to determine the water consumption per **cycle** V_C.

$$V_C = V_T / 5 \quad (6)$$

The energy (E_P) and water (V_P) consumption per plate shall be calculated by dividing E_C and V_C by the number of plates per **rack**:

$$E_P = E_C \,/\, \text{plates per rack} \tag{7}$$

$$V_P = V_C \,/\, \text{plates per rack} \tag{8}$$

The **programme time** (T_{PR}) is calculated as follows:

$$T_{PR} = \left(T_{PR1} + T_{PR2} + T_{PR3} + T_{PR4} + T_{PR5}\right) / 5 \tag{9}$$

The **cycle time** (T_C) is calculated as follows:

$$T_C = (T_{C1} + T_{C2} + T_{C3} + T_{C4} + T_{C5}) / 5 \tag{10}$$

7.2.5 Power consumption – Ready-to-use mode

The machine shall be conditioned in accordance with 5.2.

Load the machine in accordance with 5.9, close the door/hood and start one **cycle**.

Keep door/hood closed and wait until all **energy-consuming elements** are inactive.

Start the power consumption measurement (E_U) over the period of time (T_U). The measurement shall be carried out for at least 3 h.

Data shall be recorded at regular intervals of 5 s.

At the end of the minimum 3 h period, open door/hood and keep it open for 30 s to unload and again load the machine. Start a **programme cycle** immediately. After the machine indicates the end of the **programme**, wait until all **energy-consuming elements** are inactive.

Stop recording data.

The **ready-to-use mode** power consumption (E_{RTU}) is calculated by subtracting the average power consumption of one **cycle** (E_C) evaluated in accordance with 7.2.4.

$$E_{RTU} = E_U - E_C \text{ in kWh} \tag{11}$$

The **ready-to-use mode** time (T_{RTU}) is calculated by subtracting the average **cycle time** (T_C) as evaluated in accordance with 7.2.4.

$$T_{RTU} = T_U - T_C \text{ in s} \tag{12}$$

The power of the **ready-to-use mode** is calculated as follows:

$$P_U = \left(E_{RTU} \times 3\,600\right) / T_{RTU} \text{ in kW} \tag{13}$$

8 Data to be reported

8.1 Laboratory and test data

Laboratory data shall be reported in accordance with Table 1.

Table 1 – Laboratory data

Company/address:	
Test person:	
Date:	
Room temperature [°C]:	
Air humidity [%]	
Water hardness [mmol/l]:	
Water temperature [°C]	
Water pressure [kPa]	
Detergent, Type:	Batch number:
Rinse agent, type:	Batch number:

Dishwasher data shall be reported in accordance with Table 2

Table 2 – Dishwasher data

Manufacturer/provider:	
Model name:	
Serial number:	
Supply voltage [V, Hz]	
P_{max} [kW]	
I_{max} [A]	
Programme used:	
Manufacturer’s setting of tank temperature	
Manufacturer’s setting of boiler temperature	
Features	
Detergent solution concentration [g/l]	
Rinse aid solution concentration [g/l]	

Measured data shall be reported in accordance with Table 3

Table 3 – Measured data

Energy consumption for initial fill (E_S)		kWh
Water consumption for initial fill (V_S)		l
Start-up time (T_S)		s
Number of plates per rack		
Cleaning performance (x_{clean})		%
Resoiling performance (x_{res})		
Energy consumption per cycle (E_C)		kWh
Water consumption per cycle (V_C)		l
Energy consumption per plate (E_P)		kWh
Water consumption per plate (V_P)		l
Average programme time (T_{PR})		s
Average cycle time (T_C)		s
Power ready-to-use mode (P_U)		kW

8.2 Evaluation sheet for cleaning performance calculation

During the cleaning performance evaluation, the data shall be recorded in accordance with Table 4.

Table 4 – Evaluation sheet

		Rack 1		Rack 2		Rack 3		Rack 4		Rack 5	
Plate surface		Front	Front and rear	Front	Front and rear	Front	Front and rear	Front	Front and rear	Front	Front and rear
Amount of		Remaining dots	Particles found	Remaining dots	Particles found	Remaining dots	Particles found	Remaining dots	Particles found	Remaining dots	Particles found
Plate	1										
	2										
	3										
	4										
	5										
	6										
	7										
	8										
	9										
	10										
	11										
	12										
	13										
	14										
	15										
	16										
	17										
	18										
Quantity											

In Figure 7, an example is shown of remaining dots and particles.

On that plate, 14 dots (numbered) and 4 sesame seed particles (red circles) are still visible after the finished machine **cycle**.

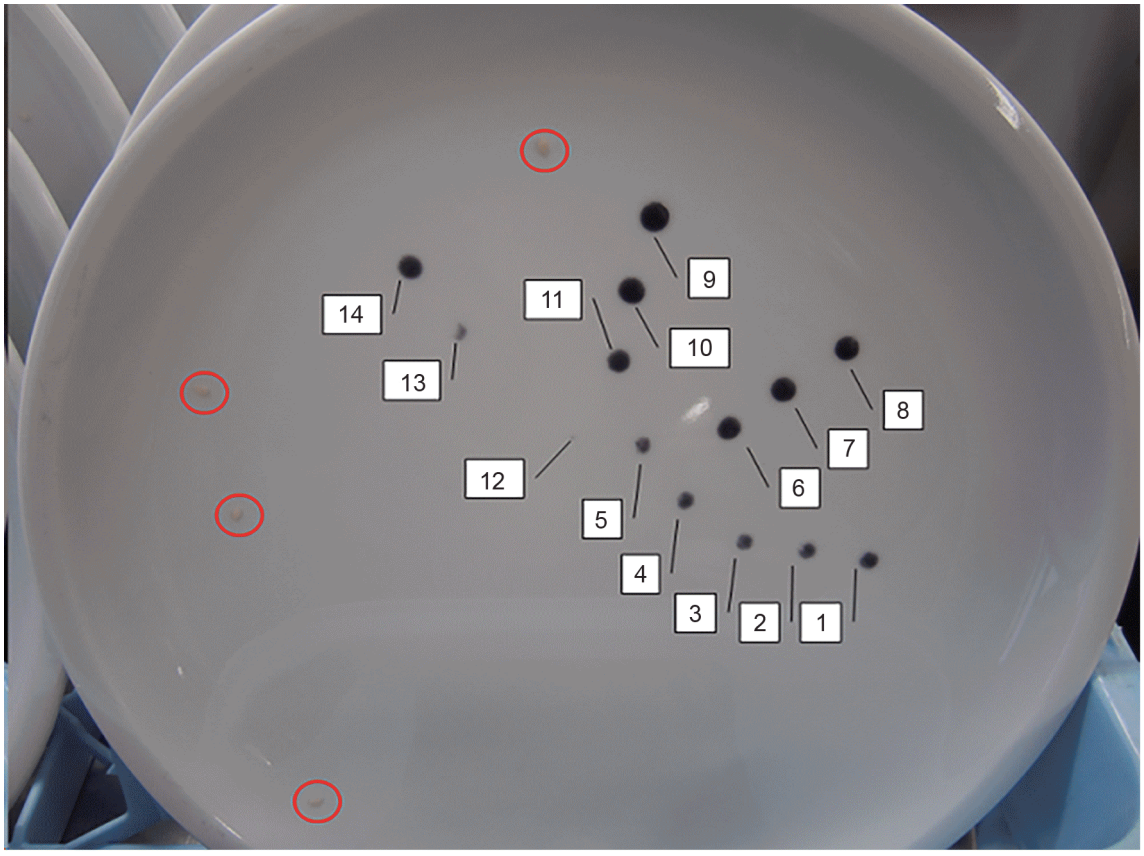


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Figure 7 – Evaluation example

Annex A
(normative)

Test materials for laboratories

A.1 Reference detergent

The detergent is prepared in accordance with the formula specified in Table A.1.

While stirring the fully demineralized water, the potassium tripolyphosphate solution and the potassium hydroxide are added. Finally, the sodium silicate is also added while stirring, and thoroughly mixed. After one or two days, a deposit precipitates out of the initially clear solution. This sediment is removed by decanting.

Table A.1 – Detergent

Raw material	Percentage of mass [%]	Quantity for 1 kg
Fully demineralized water	21,6	216,0 g
Potassium tripolyphosphate solution, 50 % (percentage of mass)	20,0	200,0 g
Potassium hydroxide, 45 % (percentage of mass)	35,5	335,0 g
Sodium silicate, material quantity proportion r (SiO2/Na2O) = 3,41 to 3,51; mass of solid is approximately 35 %	22,9	229,0 g
Total	100,0	1 000,0 g

NOTE Density of reference detergent: 1,35g/ml.

Examples of detergents that comply with this specification:

302633 DIN Testreiniger REGSM (5 l)[1]

20 000 951 DIN Detergent REGSM (12 kg)[2]

A.2 Reference rinse aid

The rinse aid is prepared in accordance with the formula specified in Table A.2.

While stirring the fully demineralized water, the crystalline citric acid is added and fully dissolved.

Subsequently, the two following liquid raw materials are added while continuously stirring.

---

1 DIN Testreiniger REGSM (5 l) is the tradename of a product supplied by Chemische Fabrik Dr. Weigert GmbH and Co.KG. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

2 DIN Detergent REGSM (12 kg) is the tradename of a product supplied by Winterhalter Gastronom GmbH. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Table A.2 – Rinse aid

Raw material	Percentage of mass [%]	Quantity for 1 kg
Fully demineralized water	70,0	700,0 g
Citric acid, monohydrate, crystalline	5,0	50,0 g
Niotensid, fatty alcohol C12/C14 + 5 EO + 4 PO	20,0	200,0 g
Sodium cumenesulfonate 40 % (percentage of mass)	5,0	50,0 g
Total	100,0	1 000,0 g

Examples of rinse aids that comply with this specification:

302833 DIN Testklarspüler KEGSM (5 l)[3]

20 000 952 DIN Rinse Aid KEGSM (10 l)[4]

A.3 Basic cleaning detergent

The basic cleaning detergent is prepared in accordance with the formula specified in Table A.3.

All ingredients are thoroughly mixed.

Table A.3 – Basic cleaning detergent

Raw material	Percentage of mass [%]	Quantity for 1 kg
Sodium hydroxide	30,0	300,0 g
Pentasodium tripolyphosphate	30,0	300,0 g
Sodium percarbonate	20,0	200,0 g
Disodium metasilicate	20,0	200,0 g
Total	100,0	1 000,0 g

Examples of basic cleaning detergent that comply with this specification:

Etolit Geschirrblitz[5]

A.4 Load

If the dishwasher is supplied with a rack, this rack shall be used for the test.

If no rack is supplied with the dishwasher, an available standard rack shall be used.

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[3] DIN Testklarspüler KEGSM (5 l) is the tradename of a product supplied by Chemische Fabrik Dr. Weigert GmbH and Co.KG. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

[4] DIN Rinse Aid KEGSM (10 l) is the tradename of a product supplied by Winterhalter Gastronom GmbH. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

[5] Etolit Geschirrblitz is the tradename of a product supplied by Etol-Werk Eberhard Tripp GmbH and Co. OHG. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

In the case of dishwashers with rack dimensions of 500 mm × 500 mm, the racks shall be loaded with 18 plates, and for dishwashers with a rack size of 400 mm × 400 mm, the racks shall be loaded with 10 plates.

The plates are porcelain plates.

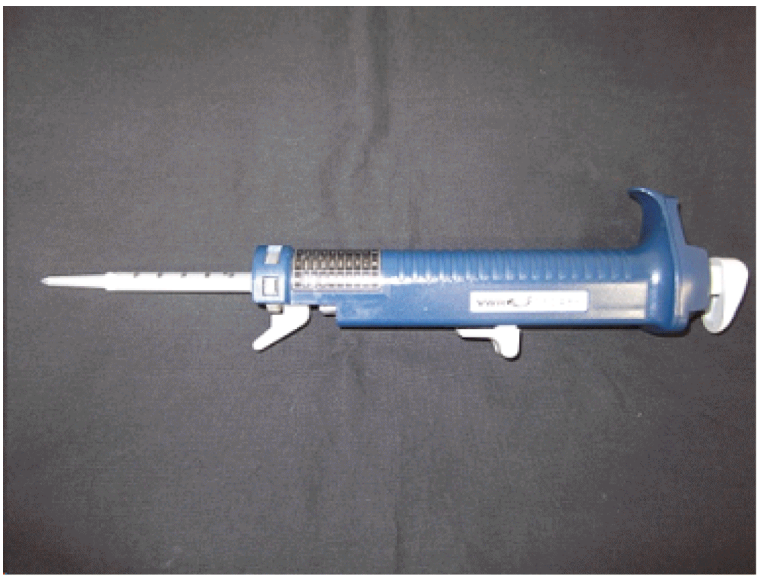
Example of a plate that complies with this specification:

Plate flat coupe diameter 240mm, item No. 9051224[6].

It is recommended to place paper between the plates to stack them without scratching them.

A.5 Test pipette/dispenser

EXAMPLE Pipette VWR (Figure A.1) and VWR Dispenser tip 1,25ml (Figure A.2).



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VWR order no. VWRI613-0964[7]

Figure A.1 – Pipette

6 Plate flat coupe diameter 240 mm, Item No. 9051224 is the tradename of a product supplied by Schönwald. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

7 VWR order no. VWRI613-0964 is the tradename of a product supplied by VWR International GmbH. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

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VWR order no. 613-1002[8]

Figure A.2 – VWR Dispenser tip 1,25ml

The pipette shall be suitable for a dosing volume of 25 µl.

A.6 Stainless steel holder and support[9]

The stainless-steel holder is shown in Figure A.3.

8 VWR order no. 613-1002 is the tradename of a product supplied by VWR International GmbH. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

9 Stainless steel holder and support are examples of products supplied by Milchwirtschaftliches Institut Dr. Huefner. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Dimensions in millimetres

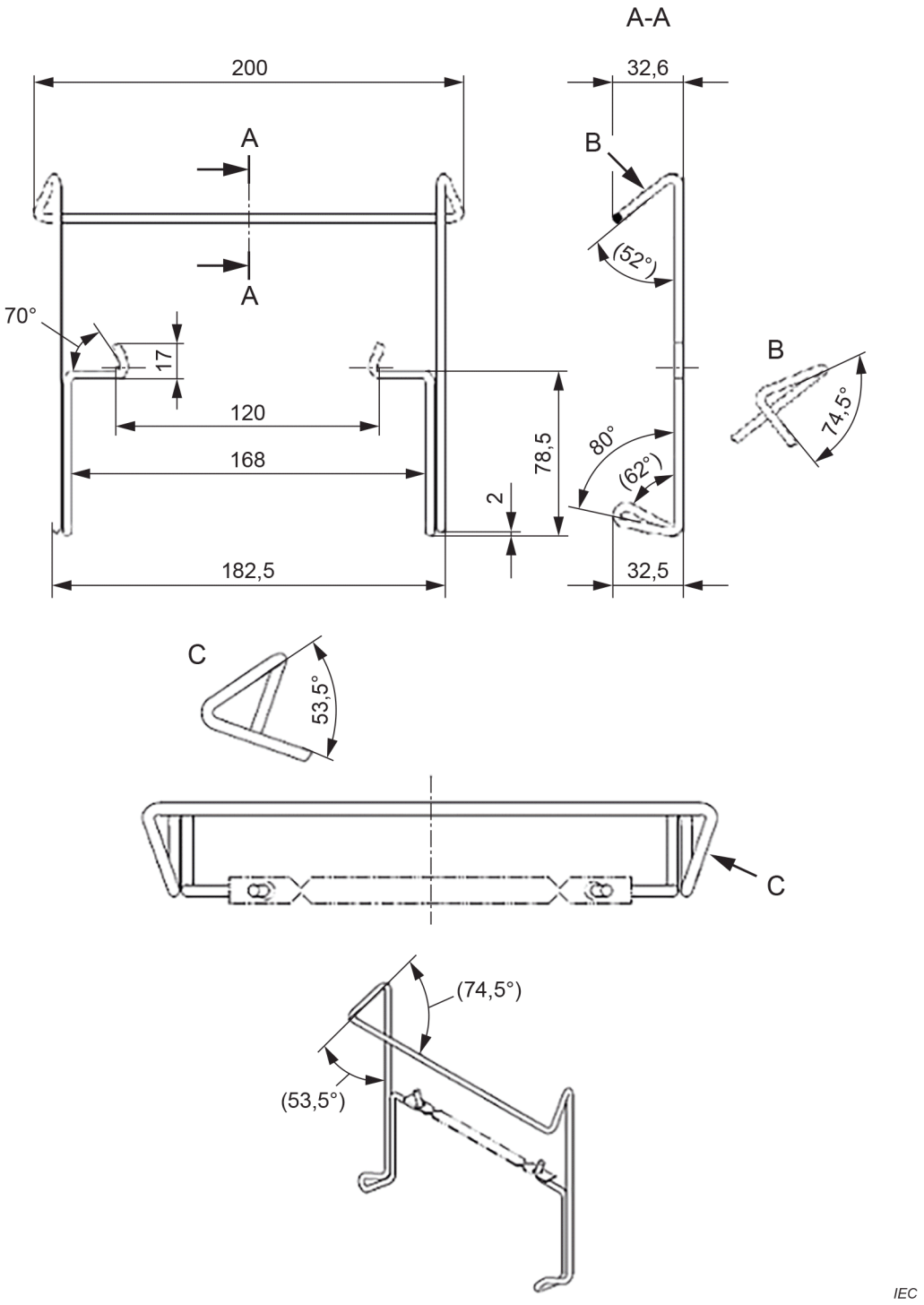

Figure A.3 – Holder for stainless steel support

The stainless-steel support as shown in Figure A.4 is made of the following stainless-steel material:

Austenitic steel, material no. 1.4301 as specified in ISO 15510.

Dimensions in millimetres.

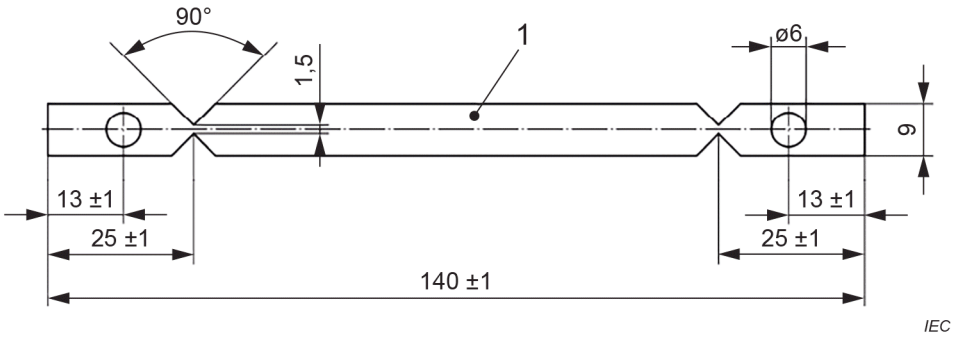

Figure A.4 – Stainless steel support

The temperature probe is fixed on the support as shown in Figure A.5.

Dimensions in millimetres.

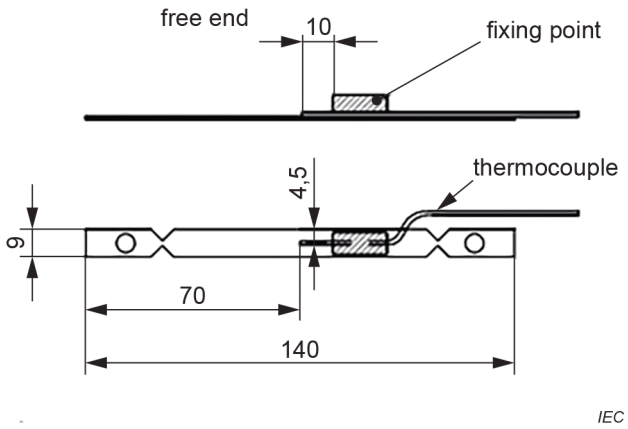

Figure A.5 – Temperature probe positioning

A.7 Sesame seeds

Sizes between 1 mm and 2 mm

With shell

White colour

Not roasted

Examples of sesame seeds: Sesame natur[10].

[10] Sesame natur is the tradename of a product supplied by Schapfenmühle. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Annex B
(informative)

Flowchart – Test sequence

Figure B.1 shows test sequences

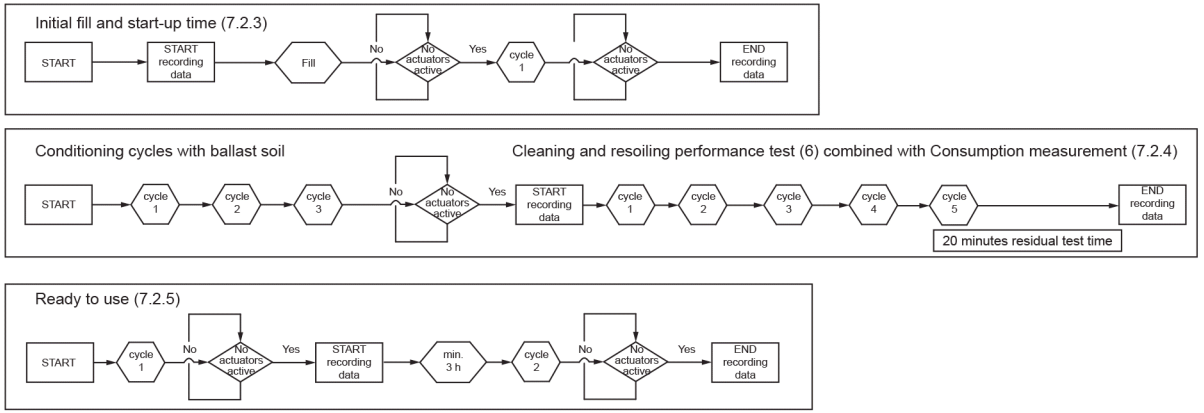

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Figure B.1 – Flowchart for test sequence

Bibliography

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IEC 60335-2-58, *Household and similar electrical appliances – Safety – Part 2-58: Particular requirements for commercial electric dishwashing machines*

IEC 60734, *Household electrical appliances – Performance – Water for testing*

IEC 62053-21, *Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)*

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