



BSI Standards Publication

**Household and similar electric appliances –
Methods for measuring the performance of clothes
washing machines intended for commercial use**

National foreword

This British Standard is the UK implementation of EN 50640:2018. It supersedes PD CLC/TS 50640:2015, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CPL/59/1, Dishwashers and washing machines.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

**Household and similar electric appliances - Methods for
measuring the performance of clothes washing machines
intended for commercial use**

Appareils électrodomestiques et analogues - Méthodes de
mesure de l'aptitude à la fonction pour les machines à laver
le linge à usage commercial

Waschmaschinen für den gewerblichen Gebrauch -
Verfahren zur Messung der Gebrauchseigenschaften

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European foreword

This document (EN 50640:2018) has been prepared by CLC/TC 59X "Performance of household and similar electrical appliances".

The following dates are fixed:

- latest date by which this document has (dop) 2019-04-23
to be implemented at national level by
publication of an identical national
standard or by endorsement
- latest date by which the national (dow) 2021-04-23
standards conflicting with this document
have to be withdrawn

This document supersedes CLC/TS 50640:2015.

This European Standard is a new standard, but it is based on portions from EN 60456:2011.

The procedures described in this European Standard are modified substantially compared to the procedures described in EN 60456. Therefore results of tests according to this European Standard cannot and are bound not to be compared to results of similar procedures of EN 60456.

Significant technical differences from EN 60456 are:

- a) the method includes procedures for measuring steam heated and gas heated **washing machines**;
- b) the introduction of a new type of **base load**;
- c) a new reference **programme**;
- d) a new formulation of the standard detergent.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association.

1 Scope

This European Standard deals with the performance of clothes **washing machines** intended to be used by trained users e.g. in hotels, hospitals, factories, in light industry and on farms. It also covers **washing machines** declared for commercial use in public areas and operated by lay persons e.g. in launderettes, apartment houses and communal laundry rooms. The clothes **washing machines** can be utilizing cold and/or hot water supply and without heating or with heating devices for electricity, steam or gas. This European Standard covers top, front and side loaded clothes **washing machines** with horizontal or vertical axis and with one or more wash compartments. It also deals with appliances for both washing and drying textiles (**washer-dryers**) with respect to their washing related functions and to separate **spin extractors** related to their dewatering capabilities.

NOTE 1 Performance of tumble dryers declared for commercial use is assessed in EN 50594.

NOTE 2 The object is to state and define the principal performance characteristics of clothes **washing machines** declared for commercial use and to describe the test methods for measuring these characteristics.

NOTE 3 This European Standard does not apply to continuous batch **washing machines** (e.g. tunnel washers) or **washing machines** only possible to operate with automatic loading and unloading.

NOTE 4 This European Standard does not specify safety requirements for **clothes washing machines declared for commercial use**. Safety requirements are specified in EN 50571 and the EN ISO 10472- series.

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.

EN 437:2003+A1:2009, *Test gases — Test pressures — Appliance categories*

CEN/TR 1749:2014, *European scheme for the classification of gas appliances according to the method of evacuation of the combustion products (types)*

EN 12953-10, *Shell boilers — Part 10: Requirements for feedwater and boiler water quality*

EN 50571, *Household and similar electrical appliances — Safety — Particular requirements for commercial electric washing machines*

EN 60456, *Clothes washing machines for household use — Methods for measuring the performance (IEC 60456)*

EN 60734, *Household electrical appliances — Performance — Water for testing (IEC 60734)*

EN ISO 80000-1:2013, *Quantities and units — Part 1: General (ISO 80000-1:2009 + Cor 1:2011)*

IAPWS-IF97, *IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam* [International Association for the Properties of Water and Steam]

3 Terms, definitions and symbols

3.1 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>

3.1.1

washing machine

appliance for cleaning and rinsing of textiles using water which may also have a means of extracting excess water from the textiles

3.1.2

test washing machine

washing machine that is subjected to part or all of the requirements in this European Standard in order to determine its performance

Note 1 to entry: **Test washing machine** can include **washing machines** according to 3.1.6, 3.1.7.

3.1.3

reference machine

specially constructed **washing machine** of known performance which is used to increase repeatability and reproducibility of results

Note 1 to entry: It can be used to provide a known performance level within a laboratory against which to compare selected performance parameters on **test washing machines** as defined in this European Standard – refer to 5.5.2.

3.1.4

washer-dryer

washing machine which includes means for drying the textiles, usually by heating and tumbling

Note 1 to entry: This European Standard only covers the **operations** which relate to the **washing machine** function – see Clause 1.

3.1.5

spin extractor

separate water-extracting appliance in which water is removed from textiles by centrifugal action (**spin extraction**)

3.1.6

horizontal axis washing machine

washing machine in which the load is placed in a drum which rotates around an axis with an angle less than 45° to horizontal

Note 1 to entry: The classification of vertical axis or horizontal axis in this European Standard is only used to define the placement of the load into the drum.

3.1.7

vertical axis washing machine

washing machine in which the load is placed in a drum which rotates around an axis which rotates with an angle of 45° or more related to horizontal

Note 1 to entry: The classification of vertical axis or horizontal axis in this European Standard is only used to define the placement of the load into the drum.

3.1.8

automatic machine

washing machine where the load is fully treated by the machine without the need for user intervention at any point during the **cycle** prior to its completion

3.1.9**top loaded machine**

washing machine where the load is placed in the wash compartment from the top, and which may be of a horizontal or vertical axis type

3.1.10**side loaded machine**

washing machine where the load is placed in the wash compartment from the side, and which is of a horizontal axis type

3.1.11**pullman machine**

washing machine where the wash compartment is divided in two compartments

3.1.12**Y-pocket machine**

washing machine where the wash compartment is divided in three compartments

3.1.13**test run**

single performance assessment as specified in Clause 8 of this European Standard

3.1.14**test series**

group of **test runs** on a **test washing machine** which, collectively, are used to assess the performance of a **washing machine**

3.1.15**operation**

each performance of a function that occurs during the **washing machine programme** such as pre-wash, washing, rinsing, draining or spinning

3.1.16**programme**

series of **operations** which are pre-defined within the **washing machine** and which are declared by the manufacturer as suitable for washing certain textile types

3.1.17**cycle**

complete washing process until the load is accessible to the user, as defined by the **programme** selected, consisting of a series of **operations** (wash, rinse, spin, etc.)

3.1.18**spin extraction**

water-extracting function by which water is removed from textiles by centrifugal action, which is included as a function (built in **operation**) of an **automatic washing machine** but may also be performed in a **spin extractor**

3.1.19**spin speed**

rotational frequency of a drum during **spin extraction**

Note 1 to entry: A method for determination of **spin speed** is not defined in this European Standard.

3.1.20**base load**

unsoiled textiles used for testing

3.1.21

test load

base load used for testing plus stain test strips

3.1.22

test load mass

actual mass of the **base load** including stain test strips

3.1.23

nominal test load mass

mass of dry textiles of a particular type for which the performance of the **test washing machine** shall be tested (**rated capacity** or part load)

Note 1 to entry: Target value for the conditioned **test load mass**.

3.1.24

rated capacity

maximum mass in kilograms of dry textiles of a particular type which the manufacturer declares can be treated in the **washing machine** on the selected **programme**

3.1.25

end of cycle

when the load is accessible to the user and next programme can be started

3.1.26

cycle time

time from the initiation of the **programme** (excluding any user programmed delay) until the **end of cycle**

3.1.27

main wash duration

time from the commencement of the initial water intake for the main wash until the commencement of the initial water intake for the first rinse

Note 1 to entry: Variations in the laboratory water supply pressure can affect the **main wash duration**. This definition is only applicable to **test washing machines**. The **reference machine** wash time used for calibration of the **reference machine** is defined differently. Refer to Table E.1.

3.1.28

remaining moisture content

measure of the additional amount of moisture that is contained in the **base load** in relation to the equilibrium condition for **base load** items which have been conditioned in a controlled space (refer to 6.4.5.2)

Note 1 to entry: This equilibrium condition is defined as 0 % **remaining moisture content** in this European Standard. Hence it is possible for a **base load** or load items to have a negative **remaining moisture content** when treated with a tumble drier. Refer also to Annex F.

3.1.29

rated voltage

voltage assigned to the appliance by the manufacturer

3.1.30

cycle energy

energy consumed during the **cycle time** in one **test run**

3.1.31**programme time**

time from the initiation of the programme (excluding any user programmed delay) until the load is accessible

3.2 Symbols**3.2.1 Symbols relating to 9.2 – washing performance**

C_k	the sum of the average reflectance values (Y-values) for each test run
$\overline{C}$	the average sum of the reflectance values (Y-values) for each of the five types of soils, for all valid test runs
$C_{k\ test}$	the sum of the reflectance values in each test run of the test washing machine
$\overline{C}_{test}$	the average sum of the reflectance values of the test washing machine
$\overline{C}_{ref}$	the average sum of the reflectance values in each test run of the reference machine
m	the number of soil types per stain test strip
n	the number of stain test strips in each test run
p	confidence interval for q
q	ratio between the test washing machine , $\overline{C}_{test}$, and the reference machine , $\overline{C}_{ref}$
s_q	standard deviation of the ratio q
s_C	the standard deviation of C_k
s_i	the standard deviation of the reflectance values for each soil type within a given test run
$t_{w-1, 0,05}$	the “Student T” factor for $(w-1)$ degrees of freedom for a confidence of 95 % (i.e. 2,776 for five test runs equals four degrees of freedom, two sided test)
w	the number of test runs in the test series
$\overline{x}_i$	the average reflectance values for each soil type
x_{ij}	the average reflectance value of the 4 individual readings for each of the 5 soil types on a stain test strip

3.2.2 Symbols relating to 9.3 – water extraction (spinning)

RMC	remaining moisture content
$\overline{RMC}$	average remaining moisture content
M	the mass of the conditioned base load (g)
M_r	the mass of base load at the end of the test run (g)

3.2.3 Symbols relating to 9.4 – energy, water and time

T_c	the measured average cold water inlet temperature (°C)
T_h	the measured average hot water inlet temperature (°C)
V_c	the volume of the cold water used during an operation (l)

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V_h	the volume of external hot water used during operation (l)
W_c	the cold water energy correction for the operation (kWh)
W_{ct}	the total cold water energy correction determined during the test (kWh)
W_{et}	the total electrical energy metered during the test (kWh)
W_{gt}	the total gas energy metered during the operation (kWh)
W_h	the calculated hot water energy for the operation (kWh)
W_{ht}	the calculated total hot water energy determined during the test (kWh)
W_{st}	the total steam energy metered during the operation (kWh)
W_{total}	total energy (kWh)

3.2.4 Symbols relating to Annex F

M_{bd}	the mass of base load at the end of the bone dry run (g)
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3.2.5 Symbols relating to Annex G

M_T	the total test load mass (kg)
M_S	the mass of a small sheet (kg)
M_{ST}	the mass of a stain test strip (kg)
M_{S+ST}	the mass of a small sheet with a stain test strip attached (kg)
M_L	the mass of a large sheet (kg)
X_S	number of small sheets
X_{S+ST}	number of small sheets with stain test strips attached
X_{SF}	fixed number of small sheets
X_A	additional number of small sheets
X_L	number of large sheets

4 Requirements

4.1 General

This European Standard describes test methods for the measurement of the following performance parameters:

- washing performance;
- rinsing performance (under consideration);
- water extraction performance;
- water consumption;
- energy consumption;

- wash bath temperature;
- **cycle time**.

Any claims of performance referring to this European Standard for these parameters shall be measured in accordance with the requirements of this European Standard (refer to Clause 8 for details).

This European Standard does not specify minimum performance requirements for clothes **washing machines**.

4.2 Rated Capacity

Either the manufacturer or supplier shall declare the **rated capacity** at 0,5 kg intervals.

NOTE For different textile types the **rated capacity** of a **washing machine** is usually different.

The **rated capacity** shall not exceed the maximum mass of dry laundry, in kilograms, to be used in the **test washing machine** in accordance with EN 50571.

When the manufacturer or supplier gives a range of values for the **rated capacity** for a particular textile type, the highest value shall be used.

Where information on the **rated capacity** is not available, the **test load mass** shall be determined according to Annex K.

4.3 Dimensions

Where a manufacturer declares dimensions, these shall be in accordance with the following requirements, as applicable. The dimensions shall be given in mm and shall be rounded up to the nearest whole mm.

- | | | |
|------------------|---|--|
| Height a_1/a_2 | = | vertical dimension measured from the floor to a horizontal plane at the maximum height of the washing machine , with the door/lid closed. If adjustable levelling feet are provided, they shall be moved up and down to determine minimum (a_1) and maximum (a_2) possible heights. |
| Height a_3/a_4 | = | maximum vertical dimension measured from the floor to a horizontal plane at the maximum height of the washing machine with the door/lid open (generally when at right angles to the machine top). If adjustable levelling feet are provided, they shall be moved up and down to determine minimum (a_3) and maximum (a_4) possible heights. |
| Width b_1 | = | horizontal dimension, between the sides, as measured between two parallel vertical planes against the sides of the washing machine including all projections. |
| Width b_2 | = | horizontal dimension, between the sides, as measured between two parallel vertical planes against the sides of the washing machine including all projections including an open side mounted door/lid. |
| Depth c_1 | = | horizontal dimension as measured from a vertical rear plane against the back of the washing machine and the most prominent part of the front fascia, with the door/lid closed. For this measurement, the door thickness, knobs and handles are generally not included in the measurement. |
| Depth c_2 | = | horizontal dimension as measured from a vertical rear plane against the back of the washing machine and the most prominent part of the front fascia, with the door/lid closed. For this measurement, the door thickness, knobs and handles are included in the measurement. |
| Depth c_3 | = | horizontal dimension as measured from a vertical rear plane against the washing machine and the most prominent part of the front, knobs and handles also being taken into account, with the door/lid open (generally when at right angles to the |

machine front).

Drum volume = the volume of a **washing machine**, where required, shall be determined in accordance with Annex K.

NOTE 1 Dimension α_3/a_4 is generally only applicable to top loaded **washing machines** while dimension c_2 is generally only applicable to front loaded **washing machines**.

NOTE 2 Width b_2 is referring to **washing machines** with a loading door at the side of the machine.

NOTE 3 Dimension c_1 is intended to provide an indication of the required depth for the **washing machine** where the fascia is intended to be flush with adjacent furniture or appliances.

5 Test conditions, materials, equipment and instrumentation

5.1 General

The tolerances specified for parameters within this European Standard, using the symbol “±”, indicate the allowable limits of variation from the specified parameter outside which the test or results shall be invalid. The statement of tolerance does not permit the deliberate variation of these specified parameters.

Rounding shall only be applied to reported values in Annex N. If numbers have to be rounded, they shall be rounded to the nearest number according to EN ISO 80000-1:2013, B.3, Rule B. If the rounding takes place to the right of the comma, the omitted places shall not be filled with zeros. If a value to be reported is an intermediate required for use in the calculation of other values then rounding shall only apply to the format of the intermediate in the report; the rounding shall not apply prior to its use in subsequent calculations.

5.2 Reference machine

Unless otherwise specified, the **reference machine** shall be considered a **test washing machine** with respect to conditions, materials and equipment specified.

5.3 Ambient conditions

5.3.1 Electricity supply

The supply voltage to each **test washing machine** shall be 230 V or 400 V as defined by the manufacturer's installation guide. If more than one option for installation is available and no clear indication for testing is given, the supply voltage shall be 400 V. The supply voltages shall be maintained throughout the test within ± 2 %. For **washing machines** with a drum volume equal or larger than 400 l the voltage tolerance is allowed to be ± 3 %. The supply voltage measured during the tests shall be recorded.

The electric supply cable shall not exceed 4 m of length unless a longer supply cable is delivered together with the **washing machine** from the manufacturer. The plug (or the end of the cable furthest from the **washing machine**) is the reference point at which the supply voltage shall be maintained.

The supply frequency to each **test washing machine** shall be maintained at 50 Hz ± 1 % throughout the test.

Voltage stabilizers should be designed such that the normal **operation** of the **test washing machine** does not cause undue distortion of the voltage waveform during the whole test.

5.3.2 Water supply

5.3.2.1 General

The measured total water hardness, water temperature and water pressure of water supplied to **test washing machines** shall comply with the following requirements and shall be reported. This water is generally referred to as laboratory supply water in this European Standard.

5.3.2.2 Water hardness

For all treatments of the **base load** prior to a **test series** and all **washing machine test runs** in accordance with this European Standard soft water shall be used. The soft water shall have a total water hardness of $(0,5 \pm 0,2)$ mmol/l.

Normalization of a **base load** prior to use in a **test series** (refer to 6.4.4) shall always be done using laboratory supply water with the same total water hardness as that used for the subsequent **test series**.

Total water hardness is determined and expressed in mmol/l of CaCO_3 equivalent.

If total water hardness needs to be adjusted, it shall be prepared according to EN 60734.

Measurements of total water hardness shall be undertaken on water that is representative of the laboratory supply water used for tests.

5.3.2.3 Water temperature

The temperature of the laboratory supply water to each **test washing machine** shall be measured and recorded to the nearest $0,1^\circ\text{C}$. It shall be:

- for cold water $(15 \pm 2)^\circ\text{C}$;
- for hot water the temperature indicated by the manufacturer $\pm 2\text{ K}$, or $(60 \pm 2)^\circ\text{C}$, if no value is given.

For **washing machines** with a drum volume equal or larger than 400 l the cold and hot water temperature tolerance can be increased to $\pm 5\text{ K}$.

When the manufacturer specifies a hot water temperature range, which includes $(60 \pm 2)^\circ\text{C}$, the hot water temperature shall be set at $(60 \pm 2)^\circ\text{C}$.

When the manufacturer specifies a hot water temperature range, which does not include $(60 \pm 2)^\circ\text{C}$, the hot water temperature shall be set at the end of the temperature range which is closest to $(60 \pm 2)^\circ\text{C}$.

However the supplied hot water temperature shall never be allowed to be higher than 60°C .

The water supply system shall be configured so that the temperature of all water entering the inlet hose of the **test washing machine** is within specified tolerance with the exception of up to 500 ml of each increment up to a **test load mass** of 10 kg and up to 1000 ml of each increment up to and equal to a **test load** of 50 kg.

For larger **test load masses** the exception for each increment is 2000 ml. A temperature recording system shall record inlet water temperature at intervals of no less than once per second.

NOTE Clause 8 requires water temperatures and volumes to be recorded on a continuous basis during filling in order to determine weighted average temperature.

5.3.2.4 Water pressure

The static (gauge) pressure of the laboratory supply water at the inlet to each **test washing machine** shall be maintained at (240 ± 50) kPa during filling **operations**. The water supply to the **reference machine** shall be in accordance with D.3.1.

The hot and cold water pressure (as applicable) shall be determined as close as practicable to the point of connection of each **test washing machine** to the laboratory water supply system. The pressure measurement shall be made downstream of the last reduction in the supply pipe diameter before the **test washing machine** and less than 3 m from the **washing machine** inlet. The measured pressure shall be rounded up to the nearest whole 10 kPa to compare with the allowed range. If connecting inlet hoses are placed between the point of pressure measurement and the washing machine water inlet these hoses shall not contribute in large extent to a reduction of water flow and or water pressure. If water inlet hoses are delivered with the washing machine these hoses shall be used throughout the test.

5.3.3 Ambient temperature and humidity

5.3.3.1 Ambient temperature and humidity for washing machine testing

The ambient temperature of the test room shall be (23 ± 2) °C at the start of the **test washing machine** test. The ambient temperature shall not rise more than 4 K during the **test run**. The measured ambient temperature for **washing machine** testing shall be reported. It shall be rounded to the nearest 0,5 °C. The maximum and minimum ambient temperature during the **test run** shall be recorded. The measurement location shall be in the vicinity of machine under test. For **washing machines** with a drum volume equal or larger than 400 l the ambient temperature tolerance can be increased to $(23\text{ °C} + 6\text{ °C} / - 2\text{ °C})$.

The ambient humidity is not specified for **washing machine** testing.

5.3.3.2 Ambient temperature and ambient relative humidity for conditioning of base load items

Where an ambient controlled room or chamber is used for conditioning the **base load**, the following conditions shall be maintained:

- ambient temperature: (20 ± 2) °C;
- ambient relative humidity: (65 ± 5) %.

The measured ambient temperature and relative humidity for conditioning base load items shall be reported. The ambient temperature shall be rounded to the nearest 0,5 °C. The ambient relative humidity shall be rounded to the nearest whole percentage. Specific requirements regarding conditioning of the base load are specified in 6.4.5.2. As an alternative to using a controlled room or chamber for conditioning the base load, the bone dry method may be used. Refer to 6.4.5.3.

5.4 Test materials

5.4.1 General

This section sets out the specifications for test materials required for **washing machine** testing to this European Standard, including:

- **base load** (load items);
- stain test strips;
- detergent.

5.4.2 Base load

The **base load** shall consist of 2 sizes of sheets as specified in Annex C. The size and mass of each of the **base load** items are given in Table 1:

Table 1 — Size and mass of the different base load items

Base load item	Size mm	Nominal mass g
Small sheet		155 ± 10
Width	720 ± 20	
Length	900 ± 20	
Large sheet		750 ± 20
Width	1 480 ± 20	
Length	2 200 ± 20	

5.4.3 Stain test strips

Stain test strips shall be attached to the **base load** prior to testing to assess the washing performance of a **test washing machine**. Different soil types are used in order to assess the following washing characteristics:

- the scouring effect, chiefly due to mechanical action, the first test piece used being soiled with sebum and the second with a mixture of carbon black and mineral oil,
- the removal of protein pigments, the test piece used being soiled with blood;
- the removal of organic pigments, the test piece used being soiled with cocoa;
- the bleaching effect, the test piece used being soiled with red wine.

Stain test strips consist of square pieces with individual soil types measuring (120 ± 5) mm × (120 ± 5) mm each which are joined together into a strip with the different kinds of soil in the following order:

- unsoiled piece;
- sebum;
- carbon black/mineral oil;
- blood;
- cocoa;
- red wine.

The specifications of test pieces with standardized soiling for each soil type which are used to make a stain test strip are given in Annex A.

NOTE Information about the compliance of stains used in stain test strips with respect to importation regulations of particular countries can be obtained from the supplier.

5.4.4 Detergents

The detergent to be used throughout the test shall be IEC Standard Powder Detergent 2016 (IEC-P). The specification of the detergent is given in Annex B.

The IEC Standard Powder Detergent 2016 (IEC-P) is distributed in three separate components:

- base powder (with enzyme and foam inhibitor);
- sodium percarbonate;

- bleach activator (TAED).

The three components shall be stored separately. The date of manufacture for each component shall be marked by the supplier on the container. The lifetime of each component for IEC Standard Powder Detergent 2016 (IEC-P) and the storage conditions shall be as specified by the manufacturer. If no expiry date for the detergent components is specified by the manufacturer, the expiry date is deemed to be one and a half year from the date of manufacture.

Mixing of detergent components, lifetime after mixing, dosage and placement of detergent is specified in 6.3.

5.5 Equipment

5.5.1 General

This section sets out the specifications for specialized test equipment required for **washing machine** testing to this European Standard including:

- **reference machine**;
- spectrophotometer;
- equipment for conditioning the **base load**;
- iron.

A checklist of other laboratory equipment which may be required for **washing machine** testing is provided in 5.5.6.

5.5.2 Reference machine

A **reference machine** shall be run in parallel with the **test washing machine**, applying the same procedure to both machines to provide a measure of relative performance and reproducible results.

Specifications for the **reference machine** are given in Annex D.

For the purposes of this European Standard, the **test load mass** used in the **reference machine** shall always be 5,0 kg for the reference test **programme**.

5.5.3 Spectrophotometer

5.5.3.1 General

Optical measurements of each of the different stain test strip pieces after washing are performed using a spectrophotometer.

The minimum instrument specification is provided below:

- Measuring instrument: spectrophotometer that provides reflectance data at a minimum of 16 wavelengths spaced at 20 nm intervals, or closer, between 400 nm and 700 nm;
- Parameter: tristimulus value Y (CIE 015:2004);
- Illuminant / observer: D65 / 10° – EN ISO 11664-2;
- Measuring geometry: d / 8°;
- UV-filter: The ultraviolet filter shall have a spectral transmittance of $\leq 0,01$ at wavelengths of 400 nm and less, and a spectral transmittance of $\geq 0,80$ at wavelengths in the range 450 nm to 700 nm;
- Measurement aperture: minimum 20 mm diameter;

NOTE Where a measurement aperture is not circular, an aperture area of not less than 314 mm² is acceptable.

- Gloss / specular excluded, i.e. measurement with open gloss / specular trap.

5.5.3.2 Calibration

The calibration process shall be performed at least once a day during continuous use or after any restart of the device using:

- white standard: barium sulfate tablet or certified white ceramic tile;
- and black standard: black body or light trap or certified black ceramic tile;
- or using procedures as specified by the instrument manufacturer.

The spectrophotometer shall be checked for its spectral performance and measurement accuracy at least once a year.

General handling of the spectrophotometer and its use and calibration shall be in accordance with the supplier operating instructions.

5.5.4 Equipment for conditioning the base load

This European Standard requires **base load** items to be treated in a controlled manner prior to their use in performance tests in order to determine their mass under standardized ambient conditions. The alternative methods of conditioning the **base load** items are:

- leaving the **base load** items in a room or chamber with a controlled ambient temperature and humidity (refer to 5.3.3.2) until their **remaining moisture content** is in equilibrium. Refer to 6.4.5.2 for details;
- treating the **base load** items in a clothes dryer of specified performance to ensure that the **base load** items are in a “bone dry” state. Refer to 6.4.5.3 for details. Annex F sets out the method and the specifications for a tumble dryer which is used for this method.

5.5.5 Iron for preparation of stain test strips after washing

Where an iron or ironing appliance is used to prepare stain test strips after washing and prior to reflectance readings, it shall have a surface temperature between 130 °C and 150 °C.

5.5.6 Other equipment

Testing of **washing machines** according to this European Standard requires equipment for the measurement of a range of parameters. These parameters include the following:

- mass;
- volume of water and other liquids;
- length and dimensions;
- electrical parameters (voltage, energy, frequency);
- temperature of water and air and humidity of air;
- water pressure supplied to the **washing machine**;
- total water hardness of the laboratory supply water supplied to the **washing machine**;
- pH of the laboratory supply water;

— time.

For some of the above measurements, the specifications of instruments used to take these measurements are not explicitly defined in this European Standard, except that the accuracy of measurement as specified in the following section shall be achieved.

Note that several different instruments for the measurement of mass are likely to be required for determining mass of load items and the whole **base load** and mass of detergent (refer to 5.6.2).

5.6 Instrumentation and accuracy

5.6.1 General

Instruments used and measurements made for this European Standard shall comply with the specifications for instruments in 5.6.2 and for measurements in 5.6.3.

5.6.2 Instruments

Parameter	Unit	Minimum resolution	Minimum accuracy	Additional requirements
Mass				
Masses in the range up to 100 g	g	0,05 g	$\pm 0,1$ g	-
Masses in the range between 100 g and 2 000 g	g	0,5 g	± 1 g	-
Masses in the range from 2 kg to 50 kg	g	10 g	± 20 g	-
Masses in the range above 50 kg	g	50 g	± 100 g	-
Temperature				
Ambient temperature	°C	0,1 °C	± 1 K	-
Water temperature	°C	0,1 °C	$\pm 0,6$ K	See Annex L
Ambient humidity	% (RH)	1 % (RH)	± 3 % (RH)	The specifications shall be met over a temperature range of 15 °C to 30 °C
Water volume (water inlet)				Separate metering for hot and cold inlets, where applicable. Devices using viscosity should be calibrated at the actual nominal temperature ± 5 °C, and the nominal flow rate.
Water volumes up and equal to 100 l	l	0,1 l	± 2 %	
Water volumes above 100 l	l	0,5 l	± 2 %	
Water pressure	kPa	10 kPa	± 5 %	-
Time	s	5 s	± 1 %	-
Spin speed	r/min	1 r/min	± 1 %	-

5.6.3 Measurements

Parameter	Unit	Minimum accuracy	Additional requirements
Total water hardness	mmol/l	$\pm 2 \%$	-
Energy			
Electrical energy	kWh	$\pm 1 \%$	Due to distortion of the voltage and current wave forms caused by inductive devices such as motor controls specific requirements for energy meters are necessary. See e.g. EN 62053-21 for more information.
Gas energy	kWh	$\pm 2 \%$	See Annex I.
Steam energy	kWh	$\pm 2 \%$	See Annex J.

6 Preparation for testing

6.1 General

This section sets out the requirements for the preparation of the **test washing machine** and **reference machine** prior to testing. It also specifies the requirements for the preparation of **test loads** for **test washing machine** and the **reference machine**.

6.2 Test washing machine and reference machine preparation

6.2.1 Test washing machine

6.2.1.1 General

The measurements shall generally be carried out on a new **washing machine** which is installed and used in accordance with the manufacturer's instructions, except as required by this European Standard. Where there is more than one option for installation, the option chosen for testing shall be documented in the test report.

6.2.1.2 Preparation of the test washing machine after installation

After installation, the **test washing machine** shall be run for two complete cleaning runs on a cotton **programme** with the maximum wash temperature set and setting maximum main wash water level if applicable, the first run without load and with 1 g per litre of drum volume of the IEC-P base powder and the second run without load and without detergent. No additional runs or **cycles** of any type (loaded or empty) shall be undertaken on the **test washing machine** between **test runs** within a **test series**.

6.2.1.3 Preparation of the test washing machine for a test series

Before a **test series** is commenced the **test washing machine** shall be checked to confirm that it has no operating defects that may affect the **operation** of the unit. Where separate inlets are used for both hot and cold water, they shall each be connected to an appropriate laboratory water supply system for testing (refer to 5.3.2).

Any filters shall be thoroughly cleaned before each **test series**. Prior to the **test series** (not less than one day in advance but not more than two weeks in advance and without any other run before the **test series** is started) a cleaning run shall be undertaken on a **programme** with the maximum wash temperature set and setting maximum main wash water level if applicable without load and without

detergent. After the cleaning run the machine shall stay standing at the stable laboratory ambient temperature until the **test series** is finished.

6.2.1.4 Preparation of the test machine for a test run

The **test washing machine** shall be at laboratory ambient temperature at the beginning of each **test run**. It shall be accepted that this requirement has been met if the internal surface temperature of the **test washing machine** drum is within 2 °C of the ambient air temperature for at least 15 min, or if the **test washing machine** has been left fully open and standing at the stable laboratory ambient temperature for not less than 2 h. Observe that no machine **operation** is allowed between the completion of one **test run** until start of the next **test run** with the following exception: If a **test run** has been aborted before the end of the test **cycle** a rinsing sequence shall be performed using the test **programme** but without load and detergent. The machine shall be at ambient temperature for not less than 2 h before being loaded for the next run.

Where the **test washing machine** is equipped with a temperature sensor to determine the water temperature in the sump during the wash **operation**, the temperature measured by this sensor may be taken as an alternative to the drum temperature to assess whether the **test washing machine** is at ambient temperature. The temperature measured by the sensor shall be within 2 °C of the ambient air temperature for at least 15 min. Before each **test run**, any detergent dispenser shall be clean and dry prior to the addition of detergent. Observe that after the **automatic washing machine** is started no action shall be taken to help dispensing the detergent.

It shall be checked for the specific machine under test if 2 h with the door fully open is enough or if longer time is necessary to reach within 2 °C from the ambient temperature.

6.2.2 Reference machine

The **reference machine** shall be checked in accordance with the requirements of Annex E prior to a **test series**.

The **reference machine** start up **programme** shall be run immediately (not more than 30 min) prior to the commencement of any **test run** (refer to E.4).

The **reference machine** shall meet the requirements of 6.2.1.4 before the start up **programme** is started prior to the commencement of each **test run**.

Lint blocking the drain valve shall be removed completely before starting a **test series**. The water filter of the supply valve shall be cleaned. The reference **programme** without load and detergent shall be run to remove residues.

It is recommended not to use the **reference machine** for any other purpose (e.g. rinsing loads) between the **test runs** of a **test series**.

Before each **test run**, the detergent dispenser shall be clean and dry prior to the addition of detergent.

At each **test run** it shall be checked that no detergent remains in the detergent dispenser. It shall be ensured that in the **reference machine** the detergent is totally dispensed during the water intake for the main wash. If detergent remains in the dispenser after the initial fill, then that **test run** shall not be valid.

6.3 Detergent

6.3.1 General

The detergent used for all **test runs** shall be as specified in 5.4.4. The **reference machine** and all **test washing machines** run in parallel shall use detergent from the same batch for every **test run** in the **test series**.

This European Standard may also be used for assessment of all performance measures (except rinsing) on **test washing machines** where the manufacturer recommends the use of no detergent and where no other consumable material is added by the user during normal use. In such cases tests on the **test washing machine** shall be performed without the addition of any consumable material (i.e.

detergent) and with a connection to an electricity supply (refer to 5.3.1) and a standard laboratory water supply system (refer 5.3.2).

NOTE In all cases the **reference machine** is tested using the detergent dose specified in 6.3.2 irrespective of whether detergent is used in the **test washing machine** or not.

6.3.2 Detergent dose

The detergent dose for the **reference machine** and the **test washing machine** shall be determined from the selected reference **programme** and the **test load** as set out in Table 2:

Table 2 — Detergent Dose

Test washing machine dose	Reference washing machine dose
4,7 g/kg of rated capacity + 8 g/kg of nominal test load mass	70 g

NOTE 1 g/kg is grams of detergent per kg of **nominal test load mass**. Dosage for **reference machine** is fixed by **programme** and is a different dose compared to the **test washing machine**. The **reference machine** is always operated at a fixed load size; refer to 5.5.2.

If a pre-wash is to be included, the total quantity of detergent used shall be the same as the figures above. The total detergent quantity is to be split between pre-wash and main wash in accordance with the manufacturer's instructions. If there are no instructions, the split shall be 1:2 for pre-wash: main wash.

NOTE 2 The quantity of detergent specified in this European Standard is fixed by the **nominal test load mass**. The IEC Standard Powder Detergent 2016 (IEC-P) and the quantity specified cannot be reflective of some commercial detergents.

6.3.3 Mixing detergent

Weigh the quantity of detergent components specified in Annex B to make up the detergent dose required for each single **test run**. The components shall be thoroughly mixed together prior to use. Mixed detergent shall be stored in a sealed container if not used immediately.

The maximum storage time prior to use of IEC-P after mixing of detergent components shall be 14 d. All detergent components shall be within their expiry date at the time of use.

6.3.4 Detergent placement

Where a detergent dispenser is present, the detergent dose specified in 6.3.2 shall be placed as follows:

- where dispenser is large enough to hold the whole dose, place all detergent in the dispenser; or
- where the dispenser is not large enough to hold the whole dose, fill the dispenser to the maximum level indicated and place any excess detergent for the **test run** into the base of the drum according to 6.3.5 before the load is added.

Only in the case of **vertical axis washing machines**, where the manufacturer recommends in the user guide that the detergent dispenser only be used when using a delay start option on the machine (e.g. to avoid damage to fabrics which are in contact with the detergent), then the detergent shall be placed in the base of the drum according to 6.3.5 as if the dispenser is not present.

- Where there is no detergent dispenser, follow the manufacturer's instructions for detergent placement. If no instructions are given, all of the detergent is added to the base of the drum according to 6.3.5 before the load is added.

6.3.5 Placing detergent into the drum base

If the dispenser is too small for the amount of detergent or no dispenser exists place the detergent into base of the drum according to following procedure:

- Clean and dry the bottom of the drum so no water remains on the drum surface. Cover the bottom of the drum with one small sheet from the **base load**. Place the detergent on the small sheet and cover the detergent with another small sheet from the **base load** prior to the loading of the other **base load** items.

6.4 Test loads

6.4.1 General

This section sets out requirements for the preparation of the **test loads** used in the **test washing machine** and the **reference machine**. Refer to Clause 7 regarding the selection of the required **test load mass** and requirements for tests at **rated capacity**. This section sets out:

- determination of **test load mass**;
- maximum age requirements for **base load** items used in a **test series**;
- pre-treatment of new **base load** items prior to use in testing;
- normalization of the **base load** items between **test series**;
- conditioning of **base load** items to determine the **base load** mass at a known **remaining moisture content** prior to the commencement of a **test series**;
- fixing stain test strips to the **base load** to make up the appropriate **test load** prior to each **test run**.

The same **base load** shall be used exclusively for a single **test washing machine** for all **test runs** in a **test series**. No normalization runs shall occur between **test runs** in a **test series**. The **base load** is dried in a dryer between **test runs** within a **test series** but the **base load** does not have to be conditioned prior to the next **test run**. Sub-clause 8.2.5 specifies requirements for checking the **base load** between **test runs** in a **test series**.

A schematic flow diagram showing the preparation of load items prior to a **test series** is shown in Figure 1.

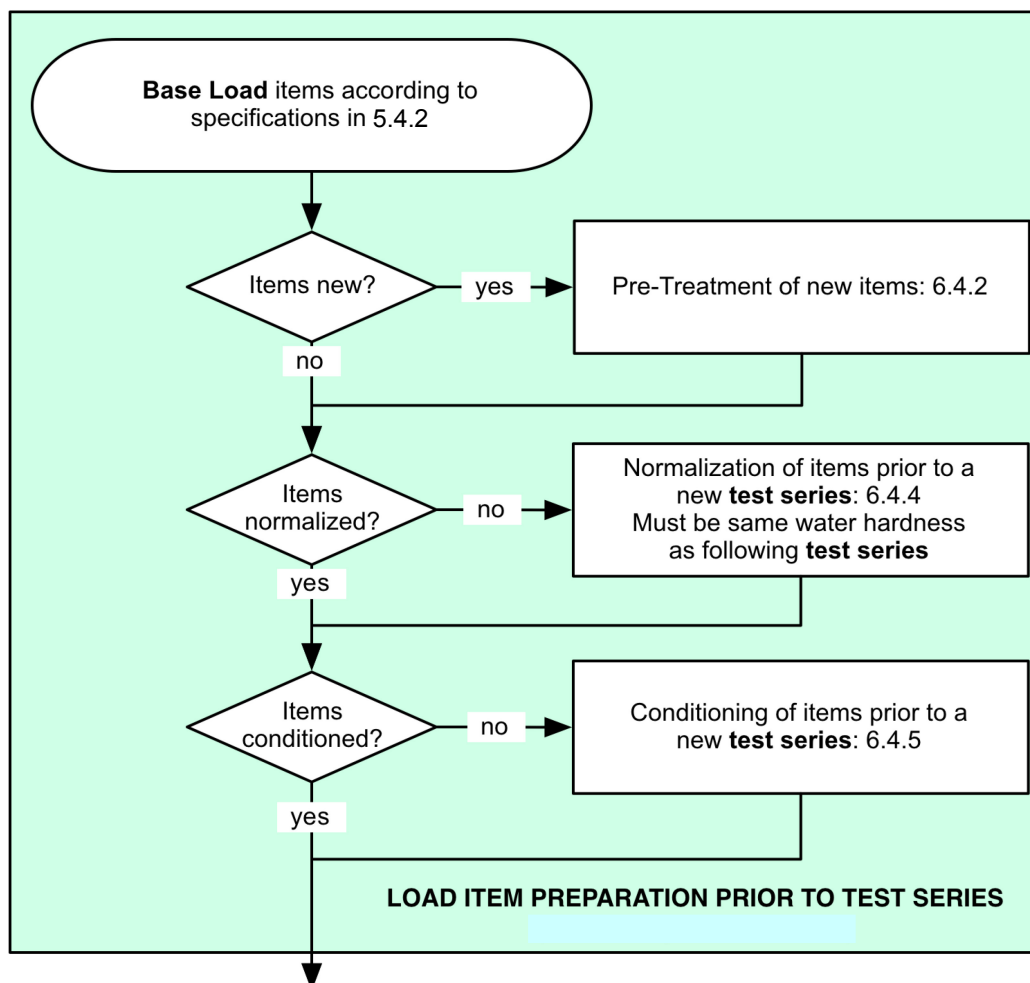


Figure 1 — Load item preparation prior to a test series

6.4.2 Pre-treatment of new base load items prior to use

The **base load** items shall be treated before their first use by undergoing a normalization wash process five times, as defined in 6.4.4 but without intermediate drying and using 14 g /kg of the IEC-P. This shall be followed by normalization according to 6.4.4 and by conditioning according to 6.4.5.

6.4.3 Requirements regarding the maximum age of base load items

Any individual **base load** item shall not be used for more than 100 **test runs**, excluding pre-treatment runs prior to initial use (refer to 6.4.2) and the normalization runs between each **test series** (refer to 6.4.4).

To meet the age requirements specified in this European Standard, a system of tracking the number of **test runs** for each load item is recommended.

6.4.4 Normalization of base load items before a new test series

6.4.4.1 General

Normalization is the process of washing the **base load** using a specified **programme** in order to bring the **base load** back into a standardized state prior to commencing the next **test series**.

Before a new **test series** the **base load** shall be normalized as specified below. Normalization of the **base load** is followed by conditioning according to 6.4.5 in order to determine the load mass in a standardized state prior to commencement of the next **test series**. Normalization of a **base load** prior

to use in a **test series** shall always be done using a laboratory supply water with the same total water hardness (refer to 5.3.2.2) as that is to be used for the subsequent **test series**.

NOTE Typical laboratory practice would be to normalize the **base load** at the completion of a **test series** and then dry the **base load** as specified and place it in a conditioning room/chamber until the next **test series**.

6.4.4.2 Normalization of base load items before a new test series

All **base load** items shall be treated once without detergent in a **washing machine** with a loading capacity that is equal or larger than the **test load** and using a 60 °C **programme** with a mechanical action similar to a cotton **programme** and with one main wash and 4 rinses. The water quantity in the process shall be approximately 5 l/kg load in main wash and 5 l/kg load in each rinse. The normalization **programme** shall contain an intermediate spin between main wash and 1st rinse and between rinses to 50 % $\pm$ 5 % residual moisture and a final spin to 35 % $\pm$ 5 % residual moisture. On completion of the **cycle** the **base load** items shall then be dried in a tumble dryer. The tumble dryer shall have an exhaust temperature not exceeding 90 °C.

If the **base load** is to be conditioned in a room/chamber in accordance with 6.4.5.2 after normalization, then the **remaining moisture content** on removal from the dryer shall be less than 0 %.

6.4.5 Conditioning of base load items before a new test series

6.4.5.1 General

Conditioning is the process of bringing the **base load** to reach a known **remaining moisture content** after normalization and drying at the completion of a **test series** in order to check the standardized mass of each load prior to commencing the next **test series**.

Conditioning may be done in an ambient controlled room/chamber or using the bone dry method. The method used shall be reported.

The **base load** does not have to be conditioned between **test runs** within a **test series**. However, the **base load** is to be dried in a tumble dryer and some checks on the **base load** mass between **test runs** are specified in 8.2.5.

6.4.5.2 Conditioning of base load items in an ambient controlled room/chamber

In this method, the **base load** items are dried in a tumble dryer to a **remaining moisture content** of each single item of less than 0 % and are then stretched or flattened by hand before conditioning. They are then allowed to reach an equilibrium **remaining moisture content** when placed in a room/chamber with an ambient temperature and humidity which is maintained in accordance with 5.3.3.2. Under this method, two options are available as follows:

- The **base load** items shall be hung singly and separately so that air can freely circulate between individual load items. The load is left for a period of not less than 15 h;
- The **base load** items shall be left until their mass has changed by less than 0,5 % for two successive measurements which are taken at intervals of 2 h or more.

6.4.5.3 Conditioning of base load items using the bone dry method

In this method, the **base load** items are dried continually in a tumble dryer of known performance until the **remaining moisture content** has been reduced to a level that is known as the “bone dry” condition, where very little free moisture is present. The conditioned mass of the load shall then be determined by taking the bone dry mass and multiplying it by factor which is determined by the dryer performance characteristics.

The specification for the tumble dryer used and the method to prepare the **base load** to the bone dry condition prior to a **test series** and the calculation of conditioned mass is specified in Annex F.

6.4.6 Test load composition

6.4.6.1 Test load composition

The **test load** consists of the **base load** as specified in Annex C and 5.4.2 and the stain test strips as specified in 5.4.3. Affixing stain test strips is specified in 6.4.8. 6.4.2 to 6.4.5 set out requirements regarding the preparation and maintenance for a **test series**.

6.4.6.2 Determination of the test load mass

The **test load mass** shall be determined to nearest 0,5 kg of **rated capacity**. The **test load mass** shall be adjusted so that it corresponds to the required **test load mass** for the specified **programme** of the test machine. The numbers of small and large sheets in the **base load** for various required **test load masses** are specified in Table 3. Final adjustment of the **test load mass**, which includes the mass of the stain test strips shall be made by adding or removing small sheets so that the total mass is as close as possible (± 100 g) to the nominal required **test load mass** for **test loads** up to and equal to 40 kg and ± 200 g for **test loads** above 40 kg.

Table 3 — Number of different load items in the test load for various test load masses

Required test load mass	Number of small sheets with stain test strips attached	Number of small sheets ^a	Number of large sheets
2,0	2	11	0
2,5	3	13	0
3,0	3	11	1
3,5	4	13	1
4,0	4	11	2
4,5	5	14	2
5,0	5	12	3
5,5	6	14	3
6,0	6	17	3
6,5	7	19	3
7,0	7	18	4
7,5	8	20	4
8,0	8	18	5
8,5	9	20	5
9,0	9	19	6
9,5	10	21	6
10	10	24	6
15	10	22	13
20	10	21	20
25	10	24	26
30	10	22	33
40	10	24	46
50	10	21	60

Required test load mass	Number of small sheets with stain test strips attached	Number of small sheets ^a	Number of large sheets
60	10	22	73
70	10	24	86
80	10	21	100
90	10	22	113
100	10	24	126
150	10	22	193
200	10	21	260
250	10	24	326
300	10	22	393
^a The actual number of small sheets may differ from the number indicated above (which is intended to be indicative)			

6.4.7 Calculation of loads not shown in Table 3

A description how to calculate the number of different load items for **test load masses** between or above the **test load masses** shown in the table is given in G.8.

6.4.8 Addition of stain test strips to the base load

6.4.8.1 General

Stain test strips shall be attached to the **base load** in order to assess washing performance as set out in 6.4.8.2.

6.4.8.2 Attachment of stain test strips to base load

Stain test strips specified in 5.4.3 shall be affixed to **base load** as follows:

Stain test strips are attached to small sheets.

The number of stain test strips used for a performance test for different **base loads** shall be as shown in Table 3.

The orientations described in the following text refer to a plan view of the small sheet and stain test strip in Figure 2.

Small sheets to which stain test strips are attached for a washing performance test shall be flattened by hand or by iron prior to the attachment.

Attach the stain test strips to the small sheet as follows:

- Place the stain test strip on top of the upper side of the small sheet as shown in Figure 2 so that the unsoiled piece of the strip is at the top and with serial number or other manufacturers marking facing up;
- Move the stain test strip so that the right hand edge of the strip aligns with the right hand edge of the small sheet without overlap and that the strip is located centrally from top to bottom;
- Sew or fasten the right-hand edge of the stain test strip onto the right-hand edge of the small sheet in this position along a line that is a distance of (10 ± 5) mm from the right-hand edge of the small sheet and strip. Where non-metallic fasteners are used at least 2 fasteners per soiled piece shall be used to ensure that the strip is adequately secured along its length. Metallic fasteners of any type shall not be used.

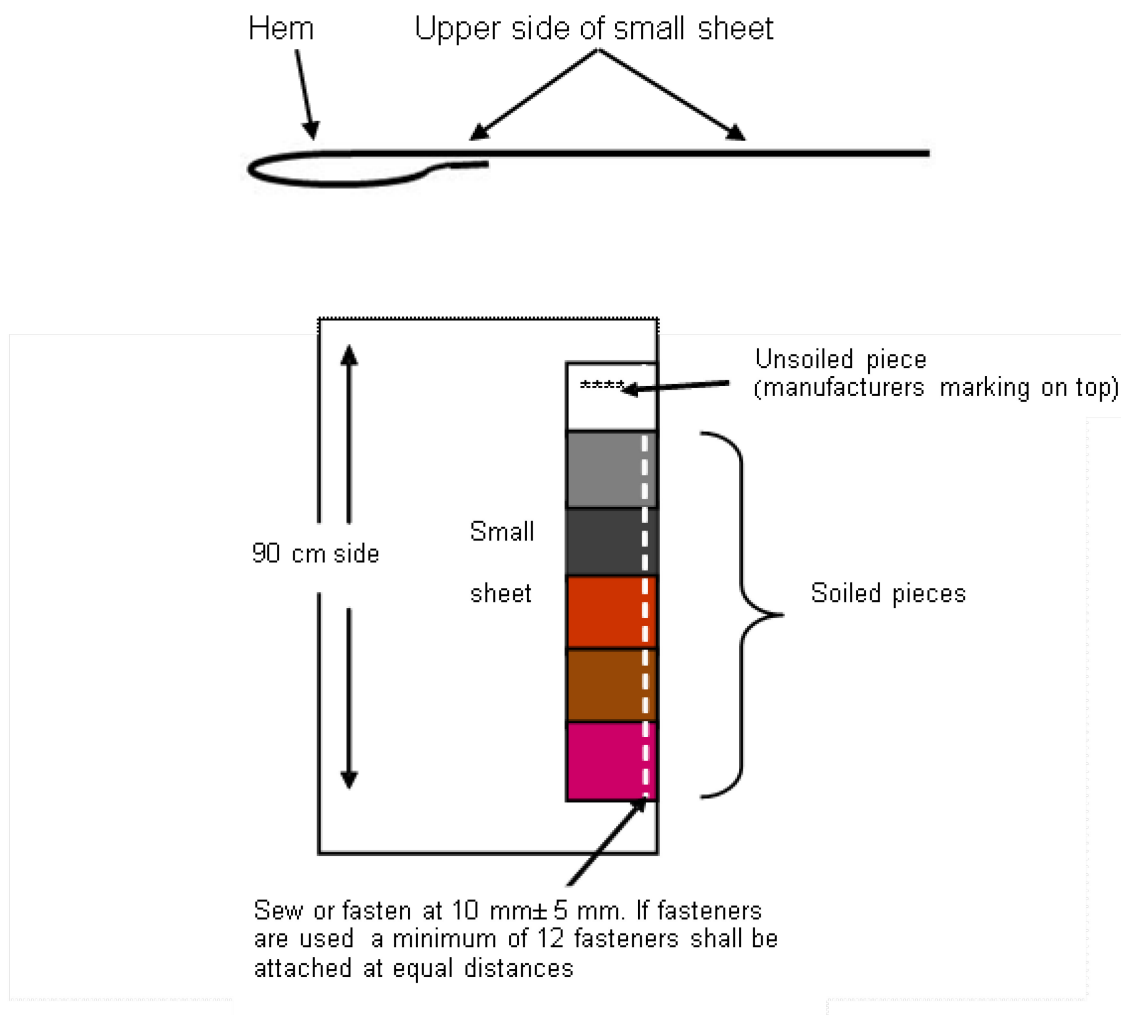


Figure 2 — Attachment of soil test strip

7 Performance measurements – general requirements

This clause sets out the main performance test methods specified in this European Standard.

The following performance parameters are intended to be measured using a common single **test series** as set out in Clause 8:

- washing performance;
- water extraction performance;
- total energy consumption;
- bath temperature;
- water consumption;
- **cycle time**.

The evaluation of these measured parameters is specified in Clause 9.

NOTE A method for the assessment of rinse performance is under consideration.

Prior to performing a **test series**, the following parameters need to be selected:

- performance tests required (washing performance, water extraction performance, water and energy consumption, bath temperature and **cycle time**);
- **programme** to be tested on the **test washing machine**;
- **test load mass** (**rated capacity** or part load). See G.7.

The primary requirement of this European Standard is for the determination of performance at **rated capacity** for each set of test conditions. Any claim of performance to this European Standard without a statement of load size shall be determined on the basis of tests at **rated capacity**. However, additional tests may be conducted at other capacities. Any claims of performance for such test results shall be qualified with the **test load mass** used.

8 Tests for performance

8.1 General

This section sets out the test procedure for the determination of the following parameters:

- washing performance;
- water extraction performance;
- energy consumption;
- wash temperature;
- water consumption;
- **cycle time**.

For the assessment of washing performance the result from the **test washing machine** is compared to the result from the **reference machine** which is operated in parallel.

While the text in this European Standard is written from the perspective of a single **test washing machine** operating in parallel with the **reference machine**, more than one **test washing machine** may be operated in parallel with the **reference machine** during a **test run** or **test series**.

8.2 Test procedure for performance tests

8.2.1 Test conditions, materials and preparation for testing

For each **test run** the **reference machine** and **test washing machine** shall be conducted as follows:

- connected to an electricity supply specified in 5.3.1;
- connected to a laboratory water supply system specified in 5.3.2;
- in ambient conditions as specified in 5.3.3;
- with the **test washing machine** and the **reference machine** prepared in accordance with 6.2;
- using a **base load** specified in 5.4.2 and a **test load** that has been prepared in accordance with the requirements of 6.4;
- using the detergent specified in 5.4.4 and with the detergent dose and placement specified in 6.3.

Stain test strips and detergent (as applicable) used in the **test washing machine** and the **reference machine** shall be from the same batch for all **test runs** within a **test series**. **Test loads** shall have new stain test strips attached for each **test run** irrespective of whether a washing performance test is being conducted. Detergent shall be used in all performance tests except where otherwise specified (refer to 6.3).

8.2.2 Test load and loading

The **nominal test load mass** shall be selected for each **test series**.

Prior to a **test series**, separate conditioned **base loads** to achieve the required **test load mass** (see 6.4.6) shall be prepared for the **reference machine** and the **test washing machine**. The same **base load** shall be used in each **test washing machine** for all **test runs** in a **test series**.

Each **test washing machine** and the **reference machine** shall be loaded in accordance with the requirements of Annex G.

8.2.3 Programme

The **programme** selected on the **test washing machine** and any associated settings shall be in accordance with the manufacturer's instructions. In the case of a **programmable washing machine**, the manufacturer's instructions regarding the settings of the **washing machine** and **programme** description shall be followed. The **programme** selected on the **test washing machine** (with any associated settings) shall be reported.

8.2.4 Test procedure

This procedure applies to the **test washing machine** and the **reference machine** which shall be run in parallel.

Test procedures specific for gas and steam heated **washing machines** can be found in Annex I and Annex J.

The intent of "parallel" is to ensure that **test washing machines** are subjected to comparable variations in normal laboratory conditions as the **reference machine**.

Operate the **test washing machine** and the **reference machine** in parallel on the relevant **programmes** ensuring that no user selected delay is incorporated. Monitor and record all required parameters during the **cycle**.

Any adverse warning indicators (e.g. warnings or faults) shall be noted and considered when assessing **test run** validity.

Within 10 min of the **end of cycle**, remove the **test load**. The stain test strips shall be carefully removed as quickly as possible. Proceed to follow the relevant requirements of each of the performance tests being performed in the **test series**. Assessment of water extraction performance can be affected by delays in subsequent measurements, so specific requirements regarding measurement (and where necessary, storage) of the **base load** after the completion of the **cycle** and timing of measurements are specified for these tests.

8.2.5 Test series

A **test series** of five tests is carried out on the **test washing machine** and the **reference machine** in parallel. The first **test run** in a **test series** shall be done with a normalized and conditioned **base load** (see 6.4.4 and 6.4.5).

At the completion of measurements for a **test run**, the **base load** shall be dried in a tumble dryer to a **remaining moisture content** of $(0 \pm 3) \%$. The tumble dryer shall have an exhaust temperature not exceeding 90 °C. Do not adjust number of items during a **test series**. Care is required to ensure that no **base load** items are lost or gained between **test runs**, so a system of accounting for all **base load** items shall be used. After the last **test run** of a **test series** the **base load** may be normalized directly without drying in between.

In circumstances where one of the five **test runs** on either the **test washing machine** or the **reference machine** is invalid (e.g. power failure, **test washing machine** or **reference machine** breaks down, instrumentation or control gear fault or failure), it is permitted to conduct a sixth **test run** on the **test washing machine(s)** and the **reference machine** (as required) in the **test series** under identical conditions. Similarly if evidence is provided that one of the **test runs** in the **test series** had problems due to abnormal conditions, a sixth **test run** may be added under identical conditions. The reason for the extra **test run** shall be reported. The invalid **test run** is eliminated completely from any subsequent evaluation.

Where an additional **test run** is required on a **test washing machine**, only the **test washing machine** of interest and the **reference machine** need to be operated for a sixth **test run**. Where an additional **test run** is required on the **reference machine**, the **reference machine** and all **test washing machines** which were operated in parallel for the **test series** shall be subjected to a sixth **test run**. Only washing performance requires results from both the **test washing machine** and the **reference machine**.

If more than one **test run** is invalid in a **test series**, then the whole **test series** is invalid, irrespective of the reason. In that case, the **test runs** completed shall be counted on load life and then the load is normalized as per 6.4.4 for use in the next **test series**.

8.3 Measurements to determine washing performance

8.3.1 General

This clause contains specific requirements for the measurement of washing performance. Evaluation of the measurements performed in this clause are set out in 9.2.

8.3.2 Removal and drying of stain test strips

After completion of each **test run** in accordance with 8.2, the stain test strips shall be removed from the **test load** at the completion of the **cycle**.

Before taking reflectance measurements (8.3.3), the test strips shall be dried and flattened. Any method of drying and flattening may be used provided it can be shown to produce the same reflectance result as one of the following options:

- air dry and flatten by placing the wet stain test strip under tension at ambient temperature in the dark; or
- air dry at ambient temperature in the dark, then flatten by ironing; or
- dry and flatten by ironing the wet stain test strip.

If an ironing appliance is used it shall comply with 5.5.5 and it shall be used in such a way that it does not cause a surface shine on the test strip. This can be achieved by placing a piece of fabric between the hot plate and the stain test strip.

Once dry, the stain test strips shall be stored in a dry dark place until the reflectance measurement is undertaken (refer to 8.3.3).

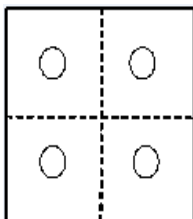
Residual humidity in the stain test strips will influence the measurement results, as will overheating during ironing. Exposure of the stain test strips to direct daylight at any time shall be avoided as far as possible.

8.3.3 Assessment of stain test strips

To assess washing performance, tristimulus Y reflectance measurements are carried out on each of the individual soil types and the unsoiled test piece which make up the stain test strip. Reflectance measurements shall be taken with a spectrophotometer as specified in 5.5.3.

For any complete set of tests, the reflectance of all stain test strips (**reference machine** and **test washing machines**) shall be measured under the same ambient conditions. The stain test strips shall be allowed to stabilize at these conditions before the reflectance measurements are undertaken.

Reflectance measurements shall be taken with not less than four layers of the same washed soil type as backing for the piece being measured. Every washed piece of soil shall be measured in four locations on the top side, at the positions indicated in Figure 3. Each of the 4 individual readings shall be recorded. The average value of the four readings for each soil type shall be used in the subsequent evaluation for that soil type.



Positions for measuring each soil type are in the centre of the four square quadrants.

Figure 3 — Positions for measuring soiled test pieces

8.4 Measurements to determine maximum spin speed

Maximum **spin speed** shall be tested during the same **test runs** in which washing performance, spinning extraction, time and water and energy consumption are tested. During the test, **spin speed** shall be recorded at intervals of 1 s or less. The maximum **spin speed** of each **test run** shall be determined during a period of 60 s when the highest **spin speed** values are reached. The maximum **spin speed** shall be recorded as the lowest speed measured during this period.

If it is necessary to remove or modify any parts of the **washing machine** in order to install a sensor for the measurement of **spin speed**, then all such parts and modifications shall be replaced as far as possible in their original position so that the installation does not significantly affect the performance of the **washing machine** in any way pertinent to the tests being carried out. The type, installation and accuracy of the instrument used shall be reported.

8.5 Measurements to determine water extraction performance

8.5.1 General

This clause contains specific requirements for the assessment of water extraction performance, which is a measure of the residual water in the **base load**. Evaluation of the measurements performed in this clause are set out in 9.3.

The water extraction performance is expressed as the amount of remaining moisture in the **base load** after the final spinning **operation** at the end of the **cycle** relative to the conditioned mass of the same **base load**.

This method is intended for the assessment of **automatic washing machines** that have spin **operation** at the end of the **cycle**. It is also intended to be used to assess the performance of separate **spin extractors**.

8.5.2 Washing Machines

The **test load** shall be subjected to the performance test procedure specified in 8.2.

At the end of the test **cycle** as set out in 8.5.1, without delay, remove the soiled **test strips** and weigh the **base load**. The mass of the moist **base load** at the end of the **cycle** is recorded.

8.5.3 Spin Extractors

For the measurement of water extraction performance of separate **spin extractors** the washing and rinsing **operations** are performed in accordance with 8.2 but without a final spin **operation**. The **programme** selected shall be suitable for the **base load** to ensure repeatable conditions. At the completion of the **cycle**, without delay, weigh the **base load**.

The **spin extractor** shall be loaded evenly, with the items placed along the drum wall of the **spin extractor**. When the items reach about one-third of the height of the drum, the items are pushed from the circumference to the centre so as to fill the hollow in the centre of the drum. This is repeated once or twice as the drum gets filled further. The **base load** is finally covered at the top with the last **base load** item, which is folded over double for this purpose.

The water is extracted from the **base load** for the time recommended by the manufacturer or for 4 min if instructions are not given.

8.6 Measurement to determine the bath temperature

Procedure for measuring the bath temperature is described in Annex H.

8.7 Measurements to determine water and energy consumption and cycle time

8.7.1 General

This clause specifies the procedure and measurements required for the determination of water and energy consumption during typical **operations** such as washing, rinsing and **spin extraction**. It also specifies the method for determination of the duration of the complete **cycle** and total water and energy consumption.

The purpose is to obtain reproducible data for the calculation of environmental impacts and cost of **operation** based on water and energy consumption.

Evaluation of the measurements performed in this clause are set out in 9.4.

NOTE This clause is applicable also to **washing machines** without **spin extraction**.

8.7.2 Procedure

The **test load** shall be subjected to the performance test procedure specified in 8.2. During these tests instrumentation for the measurement of water volume, water temperature and electrical energy shall record the required parameters. It is recommended that data for all parameters be recorded at regular intervals throughout the test using a data logger or computer. Data collection should commence well before the **programme** is initiated and continue after the **end of cycle**.

Commence the measurements when the **programme** is initiated (without any user programmed delay). Stop the measurement at the **end of cycle**.

A **test series** consisting of five complete **test runs** shall be carried out using the selected **programme**.

8.7.3 Measurement of energy supplied by electricity

The energy supplied to the machine under test via electricity shall be measured on the main electrical supply lines to the machine during the full **cycle time** as defined in 3.1.26.

8.7.4 Measurement of energy supplied by gas

Measurement of energy supplied by gas is described in Annex I.

8.7.5 Measurement of energy supplied by steam

Measurement of steam energy is described in Annex J.

8.7.6 Measurement of energy consumed via compressed air

If the machine under test needs compressed air for the normal **operation** the energy consumed via the compressed air shall be measured as follows:

Use a separate air compressor with a compressed air tank large enough to hold all necessary air for one **test run**.

Immediately before the start of a **test run** load the compressed air tank until the compressor stops and shut of the compressor from the electrical supplies.

At the end of the **test run** when no more machine **operation** remains restart the compressor again and measure the amount of electrical energy consumed by the compressor until the compressed air tank is full again.

9 Assessment of performance

9.1 General

This section sets out the primary evaluation methods for the assessment of **washing machine** performance under this European Standard. This section includes the evaluation of:

- washing performance;
- water extraction performance;
- energy consumption;
- wash temperature;
- water consumption;
- **cycle time**.

For the evaluation of washing performance (9.2) the result from the **test washing machine** shall be compared to the result from the **reference machine** which is operated in parallel. In case of an invalid **test run** (in either the **test washing machine** or the **reference machine**) neither the **test run** result in the **test washing machine** nor the corresponding **test run** result from the **reference machine** shall be used for any evaluation of that **test washing machine** within the **test series**.

9.2 Evaluation of washing performance

The washing performance shall be evaluated below using the reflectance values (Y-values) measurements determined in 8.3.3.

Steps a) to d) below are calculated for both the **test washing machine** and the **reference machine** which have been operated in parallel.

- a) The average reflectance values $\bar{x}_i$ for each soil type i is given as the mean value per **test run** of the readings for each of the n stain test strips used in the test, calculated as follows:

$$\bar{x}_i = \frac{\sum_{j=1}^n x_{ij}}{n}$$