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PAKISTAN STANDARD

CLOTHES WASHING MACHINES FOR HOUSEHOLD USE – METHODS FOR MEASURING THE PERFORMANCE

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PAKISTAN STANDARD SPECIFICATION
FOR
CLOTHES WASHING MACHINE FOR HOUSEHOLD USE- METHODS FOR MEASURING THE PERFORMANCE

0. FOREWORD

0.1 This Pakistan Standard was adopted by the authority of the Board of Directors after the draft prepared by the technical committee for "Electrical Appliances and Accessories (ENSC-3)" and approved and endorsed by the Electro-technical National Standards Committee on_____.

0.2 This Pakistan standard No. 2188, was prepared in 2001. This standard was directly adopted in 2011 on the bases of IEC: 60456 which was subsequently revised. Hence it was deem necessary revised this standard on the bases of latest IEC: 60456/2010 alongwith corrigendum in order to keep abreast with the latest development in technology.

0.3 This standard is based on IEC 60456/2010 "Clothes Washing Machine for Household Use- Methods for Measuring the performance" and its hereby acknowledge with thanks

0.4 This standard is subject to periodical review in order to keep pace with changing requirements and test development in the industry. Any suggestions for improvement will be recorded and placed before the revising committee in due course.

0.5 This standard covers technical provisions and it does not purport to include all necessary provision of a contract.

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CLOTHES WASHING MACHINES FOR HOUSEHOLD USE – METHODS FOR MEASURING THE PERFORMANCE

1 Scope

This International Standard specifies methods for measuring the performance of clothes **washing machines** for household use, with or without heating devices utilising cold and/or hot water supply. It also deals with appliances for water extraction by centrifugal force (**spin extractors**) and is applicable to appliances for both washing and drying textiles (**washer-dryers**) with respect to their washing related functions. This International Standard also covers **washing machines** which specify the use of no detergent for normal use.

NOTE 1 Tumble dryer performance is assessed to IEC 61121.

The object is to state and define the principal performance characteristics of electric household **washing machines** and **spin extractors** and to describe the test methods for measuring these characteristics.

NOTE 2 This international standard applies also to **washing machines** for communal use in blocks of flats or in launderettes. It does not apply to **washing machines** for commercial laundries. This International Standard is not intended to be used for the comparative evaluation of detergents.

NOTE 3 This International Standard does not specify acoustical noise requirements for **washing machines**. Acoustical noise measurements are specified in IEC 60704-1 and IEC 60704-2-4.

NOTE 4 This International Standard does not specify safety requirements for **washing machines**. Safety requirements are specified in IEC 60335-2-7.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60335-2-7, *Household and similar electrical appliances – Safety – Part 2-7: Particular requirements for washing machines*

IEC 60734, *Household electrical appliances – Performance – Hard water for testing*

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

IEC 62301, *Household electrical appliances – Measurement of standby power*

IEC Guide 109, *Environmental aspects – Inclusion in electrotechnical product standards*

ISO 31-0:1992, *Quantities and units – Part 0: General principles*

ISO 2060, *Textiles – Yarn from packages – Determination of linear density (mass per unit length) by the skein method*

ISO 2061, *Textiles – Determination of twist in yarns – Direct counting method*

ISO 7211-2, *Textiles – Woven fabrics – Construction – Methods of analysis – Part 2: Determination of number of threads per unit length*

EN 12127*, Textiles – Fabrics – Determination of mass per unit area using small samples*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

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 document in order to determine its performance

NOTE T**est washing machine** may include washing machines according to 3.1.7, 3.1.8, 3.1.9 and/or 3.1.10.

3.1.3
reference machine
specially constructed **washing machine** of known performance which is used to increase repeatability and reproducibility of results

NOTE It may 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 document – refer 5.4.2.

3.1.4
washer-dryer
washing machine which includes both a **spin extraction** function and also a means for drying the textiles, usually by heating and tumbling

NOTE This document only covers the operations which relate to the **washing machine** function – see Scope.

3.1.5
spin extractor
separate water-extracting appliance in which water is removed from textiles by centrifugal action (**spin extraction**)

3.1.6
standard extractor
spin extractor used to remove water remaining in the base load at the completion of the programme where a rinse performance measurement is required

3.1.7
vertical axis washing machine
w**ashing machine** in which the load is placed in a drum which rotates around an axis which is vertical or close to vertical. For the purposes of this document, vertical axis is where the angle of the axis of rotation is more than 45 degrees to horizontal. Where the drum does not rotate, the washing machine shall be classified as a vertical axis washing machine.

NOTE The classification of vertical axis or horizontal axis in this document is only used to define the placement of the load into the drum.

3.1.8
horizontal axis washing machine
washing machine in which the load is placed in a drum which rotates around an axis which is horizontal or close to horizontal. For the purposes of this document, horizontal axis is where the angle of the axis is less than or equal to 45 degrees to horizontal.

NOTE The classification of vertical axis or horizontal axis in this document is only used to define the placement of the load into the drum.

3.1.9
manual washing machine
washing machine where the machine requires user intervention at one or more points during the programme to enable the machine to proceed to the next **operation**

NOTE Examples of user intervention could include manual fill (non automatic water level), transfer of the load between a washing drum and a **spin extractor** drum or manual draining. **Manual washing machines** have special requirements regarding the **programme** which is tested for this document; see Annex M.

3.1.10
automatic machine
washing machine where the load is fully treated by the machine without the need for user intervention at any point during the **programme** prior to its completion

3.1.11
test run
single performance assessment as specified in Clause 7 of this document

3.1.12
test series
group of **test runs** on a **test washing machine** which, collectively, are used to assess the performance of a **washing machine**

3.1.13
operation
each performance of a function that occurs during the **washing machine programme** such as pre-wash, washing, rinsing, draining or spinning

3.1.14
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

3.1.15
cycle
complete washing process, as defined by the **programme** selected, consisting of a series of **operations** (wash, rinse, spin, etc.) and including any **operations** that occur after the completion of the **programme**

NOTE Examples of **operations** that may occur after the completion of the **programme** are pumping, monitoring and anti-creasing (where applicable).

3.1.16
spin extraction
water-extracting function by which water is removed from textiles by centrifugal action. This is included as a function (built in **operation**) of an **automatic washing machine** but may also be performed in a **spin extractor**

3.1.17
spin speed
rotational frequency of a drum during **spin extraction**

NOTE A method for determination of **spin speed** is not defined in this standard.

3.1.18
base load
textile load used for testing without stain test strips or wool shrinkage specimens

3.1.19
test load
base load used for testing plus stain test strips or wool shrinkage specimens

3.1.20
test load mass
actual mass of the base load plus stain test strips or wool specimen

3.1.21
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). Target value for the conditioned **test load mass**

3.1.22
rated capacity
maximum mass in kg of dry textiles of a particular type which the manufacturer declares can be treated in the **washing machine** on the **programme** selected

3.1.23
programme time
programme time is the time from the initiation of the **programme** (excluding any user programmed delay) until the completion of the **programme**. If the end of **programme** is not indicated, the **programme time** is equal to the **cycle time**.

3.1.24
end of programme
the **programme** is complete when the **washing machine** indicates the end of the **programme** and the load is accessible to the user. Where there is no end of **programme** indicator and the door is locked during operation, the **programme** is complete when the load is accessible to the user. Where there is no end of **programme** indicator and the door is not locked during operation, the **programme** is complete when the power consumption of the appliance drops to some steady state condition and is not performing any function.

NOTE An indication of the end of the **programme** may be in the form of a light (on or off), a sound, an indicator shown on a display or the release of a door or latch. In some **washing machines** there may be a short delay from an end of **programme** indicator until the load is accessible by the user.

3.1.25
cycle time
time from the initiation of the **programme** (excluding any user programmed delay) until all activity ceases. Activity is considered to have ceased when the power consumption reverts to a steady state condition that persists indefinitely without user intervention. If there is no activity after the end of the **programme**, the **cycle time** is equal to the **programme time**

NOTE **Cycle time** includes any activity that may occur after the **programme** is completed. This could include any electronic activity or any additional mechanical activity that occurs for a limited period after any end of **programme** indicator. Any cyclic event that occurs indefinitely is considered to be steady state.

3.1.26
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 Variations in the laboratory water supply pressure may 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.

3.1.27
remaining moisture content
measure for 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 This equilibrium condition is defined as 0 % **remaining moisture content** in this document. 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 G.

3.1.28
off mode
condition where the product is switched off using appliance controls or switches that are accessible and intended for operation by the user during normal use to attain the lowest power consumption that may persist for an indefinite time while connected to a mains power source and used in accordance with the manufacturer's instructions. Where there are no controls, the washing machine is left to revert to a steady state power consumption of its own accord.

3.1.29
left on mode
lowest power consumption mode that may persist for an indefinite time after the completion of the programme and unloading of the machine without any further intervention of the user

NOTE In some products this mode may be an equivalent power to **off mode**.

3.1.30
rated voltage
voltage assigned to the appliance by the manufacturer

3.2 Symbols

3.2.1 Symbols relating to Subclause 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**
$C_{k\,\text{test}}$	the sum of the reflectance values in each **test run** of the **test washing machine**
$\overline{C}_{\text{test}}$	the average sum of the reflectance values of the **test washing machine**
$\overline{C}_{\text{ref}}$	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**, $\overline{C}_{\text{test}}$, and the **reference machine**, $\overline{C}_{\text{ref}}$
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**
$t_{\text{w-1, 0,05}}$	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 Sublause 9.3 – water extraction (spinning)

RMC **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 Subclause 9.4 – rinsing performance

A_m the amount of wash alkali remaining in the **base load**

$A_{m,test}$ the amount of wash alkali remaining in the **base load** measured in the **test washing machine**

$A_{m,ref}$ the amount of wash alkali remaining in the **base load** measured in the **reference machine** with the relevant **programme** as described in Annex E

A_r the increased concentration of alkalinity in extracted water

W_e the averaged concentration of alkalinity in extracted water

W_s the averaged concentration of alkalinity in the laboratory supply water

m_e the mass of the sample of extracted water

m_s the mass of the sample of laboratory supply water

M the mass of the conditioned **base load** (g)

M_r the mass of **base load** at the end of the **test run**

R rinsing index

$\bar{R}$ the mean of rinse indices for all valid **test runs** in the **test series**

R_k the rinsing index from one **test run**

s standard deviation of the rinse indices for all valid **test runs**

3.2.4 Symbols relating to Subclause 9.5 – 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)

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_h the calculated hot water energy for the operation (kWh)

W_{ht} the calculated total hot water energy determined during the test (kWh)

W_{total} total energy (kWh)

3.2.5 Symbols relating to Clause 10 – wool shrinkage

CFS cycle felting severity – average shrinkage per wash

LS linear felting shrinkage (%) – length

SR the shrinkage rate at the completion of the **test series** (**test washing machine**)

SRI the shrinkage rate index (compared to reference shrinkage rate)

W_0 the mean measurements (width or length), of the original wool shrinkage specimens after initial preparation and before washing

W_k the mean measurements (width or length) of the washed wool shrinkage specimens at the completion of the **test series**

WS Linear felting shrinkage (%) – width

$\bar{y}$ the arithmetic mean of the individual readings for each set of measurements (width or length) for the set of three wool shrinkage specimens

y_i the individual readings for each measurement (width or length) of each individual wool shrinkage specimen

3.2.6 Symbols relating to Annex G

M_{bd} the mass of base load at the end of the bone dry run (g)

3.2.7 Symbols relating to Annex I

$\overline{A}$ weighted average age of the **base load** as number of **test runs**

a_i age of item (after conditioning)

n_i number of items; (of the same type and age)

w_i the mass per piece given in Table C.1

3.2.8 Symbols relating to Annex L

P_{off} **Off mode** power

P_{on} **Left on mode** power

4 Requirements

4.1 General

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

- Washing performance
- Rinsing performance
- Water extraction performance
- Water consumption
- Energy consumption
- Off mode power and left on mode power
- Cycle time
- Wool shrinkage performance

Any claims of performance referring to this document for these parameters shall be measured in accordance with the requirements of this document (refer to Clause 7 for details).

NOTE Methods for the determination of mechanical action on the clothes load are under consideration for inclusion in this document. Methods under consideration are available as a publicly available specification – see IEC/PAS 62473.

This document 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 for each relevant textile type. Relevant textile types are cotton, synthetic/blends and wool.

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

The **rated capacity** for any textile type shall not exceed the maximum mass of dry laundry, in kilograms, to be used in the **test washing machine** in accordance with IEC 60335-2-7.

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 N.

If the **rated capacity** for synthetics/blends and wool is not specified by the manufacturer or supplier, the **test load** shall be respectively 40 % and 20 % of that for cotton.

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 centimetres and shall be rounded to the nearest whole centimetre.

Height a_1 = 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 and maximum possible heights.

Height a_2 = 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 and maximum possible heights.

Width b = horizontal dimension, between the sides, as measured between two parallel vertical planes against the sides of the **washing machine** including all projections.

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 **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** or **spin extractor,** where required, shall be determined in accordance with Annex N.

NOTE 1 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.

NOTE 2 Dimension a_2 is generally only applicable to top access **washing machines** while dimension c_2 is generally only applicable to front access **washing machines**.

5 Test conditions, materials, equipment and instrumentation

5.1 General

The tolerances specified for parameters within this document, 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 S. If numbers have to be rounded, they shall be rounded to the nearest number according to ISO 31-0, Clause B.3 Rule B. If the rounding takes place to the right of the comma, the omitted places shall not be filled with zeros.

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

For measurement of **off-mode** power and **left-on mode** power, additional requirements may apply – refer to IEC 62301.

5.2 Ambient conditions

5.2.1 Electricity supply

The supply voltage to each **test washing machine** shall be maintained at the rated voltage ±2 % throughout the test. If a voltage range is indicated, then the supply voltage shall be the nominal voltage of the country in which the appliance is intended to be used.

The supply frequency to each **test washing machine** shall be maintained at the rated frequency ±1 % throughout the test. If a frequency range is indicated, the test frequency shall be the nominal frequency of the country in which the machine is intended to be used.

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

5.2.2 Water supply

5.2.2.1 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 document.

5.2.2.2 Water hardness

For all treatments of the **test load** prior to a **test series** and all **washing machine test runs** in accordance with this document either hard water or soft water may be used. If hard water is used it shall have a total water hardness of (2,5 ± 0,2) mmol/l. If soft water is used it shall have a total water hardness of (0,5 ± 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 IEC 60734.

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

5.2.2.3 Water temperature

The temperature of the laboratory supply water to each **test washing machine** shall be measured and recorded to the nearest 0,1 °C. It shall be:

– for cold water (15 ± 2) °C for all reference **programmes** except Cotton 20 °C;

– for cold water (20 ± 2) °C is the recommended option when using the Cotton 20ºC reference **programme**. This is recommended for **test washing machine programmes** with no internal heating and cold fill only (cold water wash). The cold water supply temperature to the **reference machine** in this case may be the same as the **test washing machine** or it may be 15 ºC as specified above.

– for hot water the temperature indicated by the manufacturer ± 2 K, or (60 ± 2) °C, if no value is given.

NOTE 1 The results for a water supply temperature of 15 °C and 20 °C to the **reference machine** may not be directly comparable.

When the manufacturer specifies a hot water temperature range, which includes (60 ± 2) °C, the hot water temperature shall be set at (60 ± 2) °C. When the manufacturer specifies a hot water temperature range, which does not include (60 ± 2) °C, the hot water temperature shall be set at the end of the temperature range which is closest to (60 ± 2) °C. When the manufacturer specifies a single temperature with a tolerance, then that temperature shall be used.

The hot and cold water inlet supply temperature (as applicable) shall be determined as close as possible to the point of connection of each **test washing machine** to the laboratory water supply system.

NOTE 2 It is recommended that temperature be the last parameter measured before the supply point to the **washing machine**. Clause 8 requires water temperatures and volumes to be recorded on a continuous basis during filling in order to determine weighted average temperature. The use of alternative cold water supply temperatures is under consideration.

5.2.2.4 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 throughout the test, including during filling operations. The water supply to the reference machines shall be in accordance with D.1.5.1 or D.1.6.1 (as applicable).

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 measured pressure shall be rounded to the nearest whole 10 kPa to compare with the allowed range.

5.2.3 Ambient temperature and humidity

5.2.3.1 Ambient temperature and humidity for washing machine testing

The ambient temperature of the test room shall be maintained at (23 ± 2) °C throughout the **washing machine** test. The measured ambient temperature for **washing machine** testing shall be reported, it shall be rounded to the nearest 0,5 °C.

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

5.2.3.2 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.

NOTE Specific requirements regarding conditioning of the **base load** are specified in Subclause 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.

5.3 Test materials

5.3.1 General

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

- base loads (load items);
- stain test strips;
- wool shrinkage specimens;
- detergent.

NOTE Suitable sources of test materials are given in Annex U.

5.3.2 Base loads

5.3.2.1 Cotton base load

Where a cotton load is specified for testing, the cotton **base load** shall consist of sheets, pillowcases and towels as specified in Annex C.

5.3.2.2 Synthetics/blends base load

Where a synthetics/blends load is specified for testing, the synthetics/blends **base load** shall consist of men's shirts and pillowcases as defined in Annex C.

5.3.2.3 Polyester base load for the wool programme

For testing the wool programmes the **base load** shall consist of double knitted polyester test pieces as defined in Annex C.

5.3.3 Stain test strips

Stain test strips are 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.

NOTE 1 The red wine is an altered specification from Edition 4 of this document. Sebum is a new stain in Edition 5. The size of the square pieces for each soil type in the stain test strip has been reduced in Edition 5.

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 2 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.

5.3.4 Wool shrinkage specimens

Wool shrinkage specimens are as specified in Annex T.

Three wool shrinkage specimens are always used for the wool shrinkage test, irrespective of **rated capacity**. Each of the wool shrinkage specimens shall be prepared as specified in 10.3.1. prior to use in the wool shrinkage **test runs**.

5.3.5 Detergents

The specification for the IEC 60456 reference detergent A* is given in Annex B.

The reference detergent is distributed in three separate components:

- base powder (with enzyme and foam inhibitor);
- sodium perborate tetrahydrate;
- bleach activator (TAED).

It is recommended that the three components shall be stored separately and be used within a limited time. The date of manufacture for each component shall be marked by the supplier on the container. The life of each component for detergent A* 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 year from the date of manufacture.

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

NOTE Base powder with neither perborate nor TAED shall be used in the preparation of wool shrinkage specimens.

5.4 Equipment

5.4.1 General

This section sets out the specifications for specialized test equipment required for **washing machine** testing to this document, including

- reference machine
- spectrophotometer

- equipment for conditioning the **base load**
- standard extractor
- iron
- titration equipment

A checklist of other laboratory equipment which may be required for **washing machine** testing is provided in 5.4.8.

5.4.2 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.

NOTE 1 For wool shrinkage tests, the **reference machine** is used to calibrate shrinkage of wool shrinkage specimens and is not normally operated in parallel with the **test washing machine**.

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

For the purposes of this document, the **test load mass** used in the **reference machine** shall always be

- 5,0 kg for cotton **programmes**
- 2,0 kg for synthetics/blends **programmes**
- 1,0 kg for the wool **programme**.

NOTE 2 When the **reference machine** is used to normalize the **base load** between **test series**, the maximum mass of dry **base load** which can be normalized in the **reference machine** is different to the **test load masses** above. Refer to Subclause 6.4.4.

5.4.3 Spectrophotometer

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 No 15.2, 1986)
Illuminant / observer	D65 / 10° – ISO/CIE 10526
Measuring geometry	d / 8°
UV-filter	The ultraviolet filter shall have a spectral transmittance of ≤ 0,01 at wavelengths of 400 nm and less, and a spectral transmittance of ≥ 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 mm^2 is acceptable.

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

5.4.4 Equipment for conditioning the base load

This document 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 standardised ambient conditions. The alternative methods of conditioning the **base load** items are as follows:

- leaving the **base load** items in a room or chamber with a controlled ambient temperature and humidity (refer to 5.2.3.2) 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 G sets out the method and the specifications for a tumble dryer which is used for this method.

5.4.5 Standard extractor

A **standard extractor** meeting the following specific performance requirements shall be used where a rinse performance measurement is required (refer to 8.5).

The nominal inner drum diameter and nominal **spin speed** of the standard extractor used shall be reported.

The standard extractor shall have a G-force with a water extraction performance which results in a **remaining moisture content** determined in accordance with 8.5 as follows:

- (39 ± 3)% for a cotton **base load** when operated with a spinning time not more than 10 min; and
- (17 ± 3)% for a synthetic/blend **base load** when operated with a spinning time not more than 5 min.

Any **spin extractors** may be used as a standard extractor if it can be demonstrated that they can achieve the water extraction performance requirements specified above. The extraction time or speed shall be adjusted to achieve the **remaining moisture content** specified above for the relevant load types and sizes, but this time may not exceed 10 min for cotton or 5 min for synthetic/blends. As re-loading of the **base load** after one **spin extraction operation** is not permitted, a pre-test to determine the appropriate spin time is required for other **spin extractors**.

Experience has shown that use of a standard extractor with an inner drum diameter of between 240 mm and 250 mm and a spin speed of about 2 800 r/min using standard bundles defined in 8.5.2 for a period of 10 min will meet the specification above.

Where a standard extractor which is larger than the primary specification above is used, the standard extractor shall be loaded and used in accordance with Annex J. The maximum load size of any **base load** placed in a **standard extractor** shall not exceed the maximum load recommended by the manufacturer.

NOTE 1 A standard extractor should be of a design that allows the user to remove any retained water in the extractor between runs.

NOTE 2 A large extractor with a capacity of max. 10 kg is available commercially. See Annex U for manufacturer.

5.4.6 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.

5.4.7 Titration equipment

The following equipment is required when an alkalinity measurement is required under 8.5.

All volumetric glassware should meet all “Class A” specifications, as defined by the American Society for Testing and Materials (ASTM) Standards E 287, E 288, and E 969 unless otherwise stated (e.g. DIN 12691, “Blaubrand”).

pH meter: accuracy least ± 0,05 pH units (1 decimal place)

Glass beaker with stirrer: sufficient size to place the pH-electrode below the surface of the sample

Titration equipment:

- manual titration (additional): burette / burette stand, 10 ml burette calibrated in 0,01 ml divisions and stopcock; or
- automatic titration (additional): microprocessor controlled titration device. Burette size: preferably 10 ml calibrated in 0,01 ml divisions. Minimum rate: 25 µl / min or less.

Reagents: all reagents used are ACS reagent grade unless otherwise stated (e.g. puriss p.a.):

- 0,1 N hydrochloric acid: accurately standardised to four decimal places;
- water: wherever “water” is applicable, use either reverse osmosis (RO), demineralised or distilled water.

The pH meter shall be calibrated at least once a day during continuous use or after any re-start of the device.

The calibration of the pH meter shall be performed at pH 7 and then at pH 4 with commercially available pH buffers.

Precautions should be initiated to avoid temperature differences between calibration and measurement phase (optimal: 23 °C). The stirring rate should also be kept equal for calibration and measurement phase. For calibration follow the instruction manual of your pH meter.

5.4.8 Other equipment

Testing of **washing machines** according to this document 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 and various liquors extracted from the **washing machine** and the **test load** during the test

- time

For some of the above measurements, the specifications of instruments used to take these measurements are not explicitly defined in this document, 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**, mass of titration liquids and mass of detergent (refer to 5.5.2).

Determination of wool shrinkage (refer to Clause 10) also requires the following equipment:

- tray with flat bottom about 50 cm × 50 cm and with sides approximately 5 cm high – for preparation of wool shrinkage specimens;
- ruler accurate to ± 0,5 mm for measurement of wool shrinkage specimens.

5.5 Instrumentation and accuracy

5.5.1 General

Instruments used and measurements made for this document shall comply with the following specifications.

5.5.2 Instruments

Parameter	**Unit**	**Minimum resolution**	**Minimum accuracy**	**Additional requirements**
Mass				
Full **test load mass** or **base load** mass above 3 kg	g	2 g	± 5 g	-
Individual load items, full **test load mass** or **base load** mass less than or equal to 3 kg	g	0,5 g	± 1 g	-
Detergent mass	g	0,05 g	± 0,1 g	-
Titration mass	g	0,005 g	± 0,01 g	-
Temperature				
Ambient temperature	°C	0,1 °C	± 1 K	-
Water temperature	°C	0,1 °C	± 0,6 K	-
Ambient humidity	% (RH)	1 % (RH)	± 3 % (RH)	The specifications shall be met over a temperature range of 15 °C to 25 °C.
Water volume (water inlet)	L	0,1 L	± 2 %	Separate metering for hot and cold inlets, where applicable NOTE Devices using viscosity should be calibrated at the actual nominal temperature ± 5 °C, and the nominal flow rate. Liquid volumes for titration are covered by the specifi-

Parameter	Unit	Minimum resolution	Minimum accuracy	Additional requirements
				cation for mass in Subclause 5.4.1.
Water pressure	kPa	10 kPa	± 5 %	-
Time	s	5 s	± 1 %	-

5.5.3 Measurements

Parameter	Unit	Minimum accuracy	Additional requirements
Total water hardness	mmol/L	± 2 %	-
Electrical energy			
Programme energy	kWh	± 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. IEC 62053-21 for more information.
Off mode and **left on mode** power	kWh	Measurement instrumentation for off mode and left on mode power are described in IEC 62301	
pH	-	± 0,05	The accuracy requirement shall be met over a temperature range of 15 °C to 25 °C.

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 document. 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 50 g of the reference detergent 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 supplied for both hot and cold water, they shall each be connected to an appropriate laboratory water supply system for testing (refer to 5.2.2).

Any filters shall be thoroughly cleaned before each **test series**. Prior to the **test series** (not more than one day in advance) 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.

6.2.1.4 Preparation of the test machine for a test run

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

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, or if the **test washing machine** has been left open and standing at the stable laboratory ambient temperature for not less than 2 h.

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.

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**.

6.3 Detergent

6.3.1 General

The detergent used for all **test runs** shall be as specified in 5.3.5. 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 document 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 5.2.1) and a standard laboratory water supply system (refer 5.2.2).

NOTE 1 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.

NOTE 2 Base powder with neither perborate nor TAED shall be used in the preparation of wool shrinkage specimens. However full detergent A* is used for a wool shrinkage test.

6.3.2 Detergent dose

The detergent dose for the **test washing machine** and the **reference machine** shall be determined from the selected reference **programme** and the **test load** as set out in Table 1:

Table 1 – Detergent dose

Load type and Reference Programme	Test Washing Machine		Reference machine Type 1		Reference machine Type 2	
	Dose Hard Water (refer to 5.2.2.2)	Dose Soft Water (refer to 5.2.2.2)	Dose Hard Water (refer to 5.2.2.2)	Dose Soft Water (refer to 5.2.2.2)	Dose Hard Water (refer to 5.2.2.2)	Dose Soft Water (refer to 5.2.2.2)
Cotton – all reference programmes except Cotton 20 ºC and Cotton 30 ºC	54 g + 16 g/kg	36 g + 10,7 g/kg	155 g	100 g	180 g	120 g
Cotton – Cotton 20 ºC and Cotton 30 ºC only	54 g + 8 g/kg	36 g + 5,3 g/kg	78 g	52 g	78 g	52 g
Synthetic/Blends	54 g + 16 g/kg	36 g + 10,7 g/kg	125 g	80 g	150 g	100 g
Wool	54 g + 16 g/kg	36 g + 10,7 g/kg	70 g	46,7 g	70 g	46,7 g

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 reference detergent after mixing of detergent components is fourteen days. 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 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 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 before the load is added

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

- the determination of **test load mass**,
- the average age requirements for **base load** items used in a **test series**,
- the pre-treatment of new **base load** items prior to use in testing,
- the normalization of the **base load** items between **test series**,
- the 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**,
- the 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 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. Subclause 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. A schematic flow diagram showing the selection of load items to meet age requirements for a **test series** is shown in Figure 2.

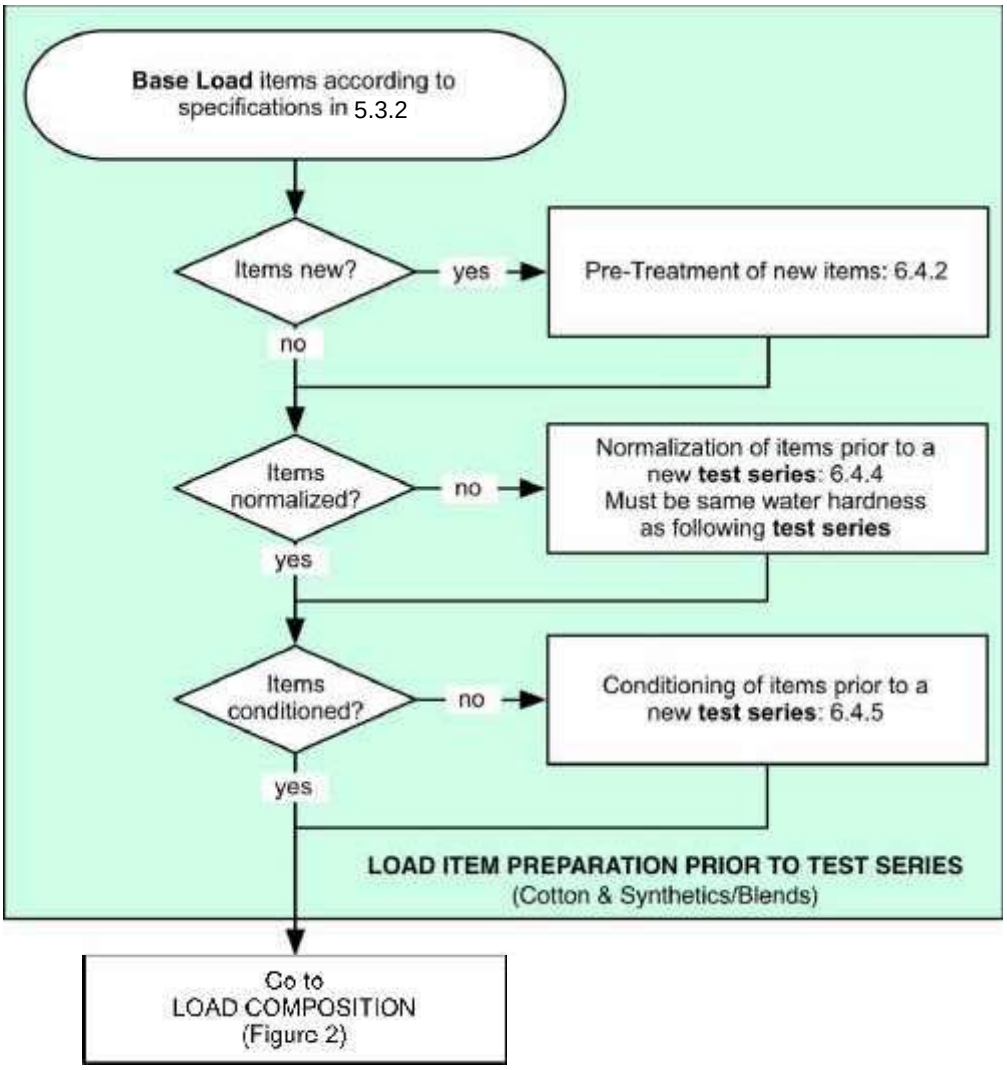


Figure 1 – Load item preparation prior to a test series

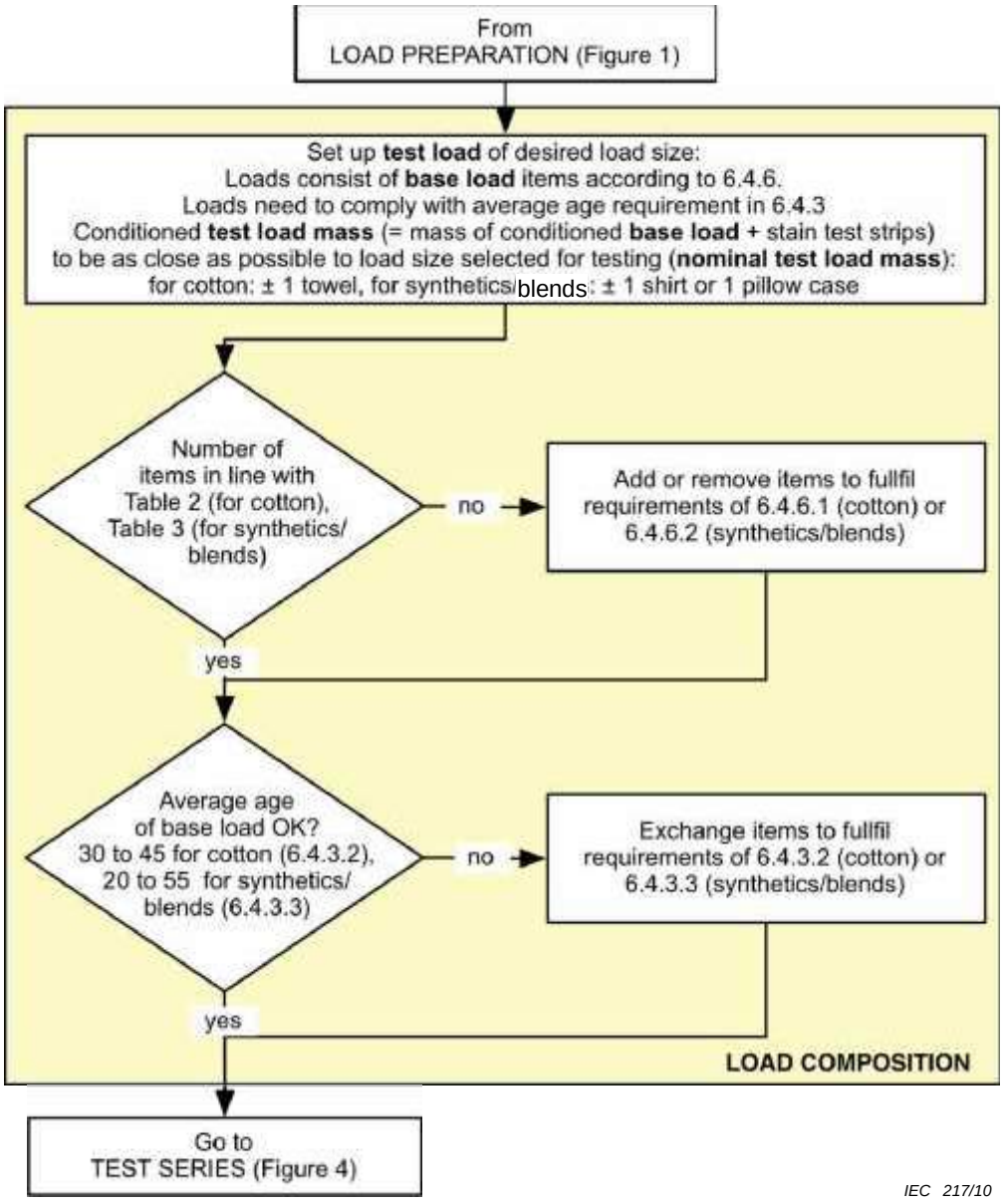


Figure 2 – Load composition and age requirements

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

New cotton and synthetics/blend **base load** items shall be treated before their first use by undergoing a normalization wash process five times, as defined in 6.4.5 but without intermediate drying and using 15 g /kg of the reference detergent A*. This is followed by normalization according to 6.4.4 and by conditioning according to 6.4.5.

The polyester **base load** (for use with wool programmes) does not require any pre-treatment prior to use in tests.

6.4.3 Requirements regarding the age of base load items

6.4.3.1 General

Any individual cotton or synthetic/blend **base load** item shall not be used for more than 80 **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).

NOTE To meet the age requirements specified in this document, a system of tracking the number of **test runs** for each load item is required.

6.4.3.2 Average age requirements for cotton base load items

To minimise the influence of changes in the characteristics of the **base load** items with increasing age, the cotton **base load** for each **test run** shall consist of load items that are well distributed in age for each different item type to give a weighted average age of the **base load** between 30 and 50 **test runs**. That means the weighted average age of the **base load** before starting a **test series** shall be between 30 and 45 **test runs**. The number of items or average age shall not be adjusted during a test series.

The weighted average age of the test load is calculated according to Annex I.

6.4.3.3 Average age requirements for synthetics/blends base load items

To minimise the influence of changes in the characteristics of the **base load** items with increasing age, half of the synthetics/blends **base load** shall consist of items used up to 40 **test runs** and the other half more than 40 **test runs**. The synthetics/blends **base load** shall consist of shirts and pillowcases that are well distributed in age to give a weighted average age of the **base load** between 20 and 60 **test runs.** That means the weighted average age of the **base load** before starting a **test series** shall be between 20 and 55 **test runs**. The number of items or average age shall not be adjusted during a test series.

6.4.3.4 Average age requirements for polyester base load items for wool programmes

There are no weighted average age requirements for polyester **base load** items for wool programmes.

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** in the **reference machine** 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 for each load type. Normalization of the **base load** is followed by conditioning according to 6.4.5 in order to determine the load item 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 5.2.2.2) 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**. However, knowledge of the water hardness for the next likely **test series** would be useful.

6.4.4.2 Normalization of cotton base load items before a new test series

All cotton **base load** items shall be treated once in a **reference machine** without detergent and using the 60 °C cotton reference **programme**. On completion of the **programme** the **base load** items shall then be dried in a tumble dryer.

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 must be less than 0 %.

For normalization purposes up to 6,5 kg can be washed in the **reference machine**. Where the **base load** to be normalized is more than 6,5 kg, the **base load** shall be split into two even parts (as far as is possible, with a mix of items in each part) for the normalization process.

6.4.4.3 Normalization of synthetics/blend base load items before a new test series

All synthetics/blends **base load** items shall be treated in a **reference machine** without detergent and using the 60 °C synthetics/blends reference **programme**. On completion of the **programme** the **base load** items shall then be dried in a tumble dryer.

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 must be less than 0 %.

For normalization purposes up to 4 kg can be washed in the **reference machine**. Where the **base load** to be normalized is more than 4 kg, the **base load** shall be split into two even parts (as far as is possible, with a mix of items in each part) for the normalization process.

6.4.4.4 Normalization of polyester base load items for wool programmes before a new test series

The polyester **base load** does not have to be normalized after a **test series**, but the **base load** items shall be dried in a tumble dryer.

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 normalisation and drying at the completion of a **test series** in order to check the standardized mass of each load item 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.

NOTE 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 5.2.3.2. 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 each load item is then 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 G.

6.4.6 Test load composition

6.4.6.1 Cotton test load composition

The **test load** consists of the **base load** as specified in 5.3.2.1 and the stain test strips as specified in 5.3.3. Affixing stain test strips is specified in 6.4.7. Subclauses 6.4.2 to 6.4.5 set out requirements regarding the preparation, maintenance and selection of a **base load** for a **test series**.

The **test load mass** is adjusted so that it corresponds to the required **test load mass** for the specified **programme** of the test machine. The numbers of sheets, pillowcases and towels in the cotton **base load** for various required **test load masses** are specified in Table 2. The number of stain test strips are also specified in Table 2. Final adjustment of the **test load mass**, which includes the weight of the stain test strips, is made by adding or removing towels so that the total mass is as close as possible (± 60 g) to the nominal required **test load mass**.

Table 2 – Number of items in the cotton test load for various test load masses

Required test load mass kg [a, b]	Approximate base load mass kg [b]	Number of stain test strips	Number of sheets	Number of pillowcases	Number of towels [c]
1	0,96	2	0	2	4
1,5	1,46	2	0	3	7
2	1,96	2	0	4	9
2,5	2,44	3	0	5	11
3	2,94	3	2	4	5
3,5	3,42	4	2	4	9
4	3,92	4	2	4	14
4,5	4,40	5	2	6	14
5	4,90	5	2	6	18
5,5	5,38	6	2	8	18
6	5,88	6	2	8	23
6,5	6,36	7	2	10	23
7	6,86	7	2	12	23
7,5	7,34	8	3	12	21
8	7,84	8	3	12	25
8,5	8,32	9	3	14	25
9	8,82	9	4	14	23
9,5	9,30	10	4	14	28
10	9,80	10	4	16	28
10,5	10,28	11	5	15	28
11	10,78	11	5	15	32
11,5	11,26	12	5	16	35
12	11,76	12	6	17	30
12,5	12,24	13	6	17	35
13	12,74	13	6	18	37
13,5	13,22	14	6	19	39
14	13,72	14	6	19	44
14,5	14,20	15	7	20	39
15	14,70	15	7	21	42

[a] For **test load masses** to the whole or half kilogram rating which are greater than those specified in the table, the number of stain test strips is equal to the **nominal test load mass** (rounded to the nearest kilogram), the number of sheets is the **nominal test load mass** divided by (3 × 0,725) (rounded to the nearest whole sheet) and the number of pillowcases is the **nominal test load mass** divided by (3 × 0,24) (rounded to the nearest whole pillow case). The balance of the required **nominal test load mass** is made up of towels as required. The mass of all **base load** items can be expected to decline slightly with increasing age.

[b] Difference between **base load** mass and **test load mass** is due to the mass of the test strips, see definitions 3.1.18 / 3.1.19.

[c] The actual number of towels may differ from the number indicated above (which is intended to be indicative).

6.4.6.2 Synthetics/blends test load composition

The **test load** consists of the **base load** as specified in 5.3.2.2 and the stain test strips as specified in 5.3.3. Affixing stain test strips is specified in 6.4.7. Subclauses 6.4.2 to 6.4.5 set out requirements regarding the preparation, maintenance and selection of a **base load** for a **test series**.

The **test load mass** is adjusted so that it corresponds to the required **test load mass** for the specified **programme** of the test machine. The numbers of pillowcases and shirts in the synthetics/blends **base load** for various required **test load mass**es are specified in Table 3. The number of stain test strips are also specified in Table 3. The synthetic/blends **base load** is set up first with an equal number of shirts and pillowcases. Final adjustment of the **test load mass**, which includes the weight of the stain test strips, is made by adding or subtracting one shirt or one pillowcase, whichever brings the **test load mass** to be closest to the nominal required **test load mass**.

Table 3 – Number of items in the synthetics/blends test load for various test load masses

Required test load mass kg [a, b]	Approximate base load mass kg [b]	Number of stain test strips	Number of shirts [c]	Number of pillowcases [c]
1	0,96	2	2	3
1,.5	1,46	2	4	4
2	1,96	2	5	6
2,5	2,44	3	7	6
3	2,94	3	8	7
3,5	3,42	4	9	9
4	3,92	4	11	10
4,5	4,40	5	12	12
5	4,90	5	13	13

[a] For **test load masses** greater than 5 kg, the number of items is specified as follows: the **base load** consists of an equal number of shirts and pillowcases. Adjustment of the **test load mass** is made after adding the stain test strips, by adding or subtracting one shirt or one pillowcase whichever adjusts the **test load mass** to be closest to the required **nominal test load mass**. The number of stain test strips is equal to the required **nominal test load mass** rounded to the nearest whole kilogram.

[b] Difference between **base load** mass and **test load mass** is due to the mass of the test strips, see definitions 3.1.18 / 3.1.19.

[c] The actual number of items above are indicative only. The difference between the number of shirts and pillowcases for any **test load** shall be not more than one. The mass of all **base load** items can be expected to decline slightly with increasing age.

6.4.6.3 Polyester test load mass for wool programmes

The **test load** consists of the **base load** as specified in 5.3.2.3 and three wool shrinkage specimens as specified in 5.3.4. Wool shrinkage specimens are not affixed to polyester **base load** items but are distributed through the **base load** as specified in Clause 10. Subclauses 6.4.2 to 6.4.5 set out requirements regarding the preparation, maintenance and selection of a **base load** for a **test series**.

The **test load mass** is adjusted so that it corresponds to the required **test load mass** for the specified programme of the test machine. The estimated number of **base load** items for various required **test load mass**es is specified in Table 4. The **test load mass** shall be adjusted by adding or subtracting **base load** items to be closest to the nominal **test load mass**.

Table 4 – Number of items in the wool programme test load for various test load masses

Required test load mass kg	Approximate base load mass kg	Number of wool shrinkage specimens	Number of polyester base load items [a]
1	0,95	3	27
1,5	1,45	3	42
2	1,95	3	56
2,5	2,45	3	70
3	2,95	3	94
3,5	3,45	3	98
4	3,95	3	113
4,5	4,45	3	127
5	4,95	3	141

[a] Number shall be adjusted to make the **base load** mass as close as possible to the required **base load** mass. The mass of **base load** items can be expected to decline slightly with increasing age.

6.4.7 Addition of stain test strips or wool shrinkage specimens to the base load

6.4.7.1 General

Stain test strips are attached to cotton and synthetic/blend base loads in order to assess washing performance as set out in 6.4.7.2. Wool shrinkage specimens are used with a polyester base load to assess wool shrinkage performance as set out in 6.4.7.3.

6.4.7.2 Attachment of stain test strips to cotton and synthetic/blend base loads

Stain test strips specified in 5.3.3 shall be affixed to specified **base load** items for each load type as follows:

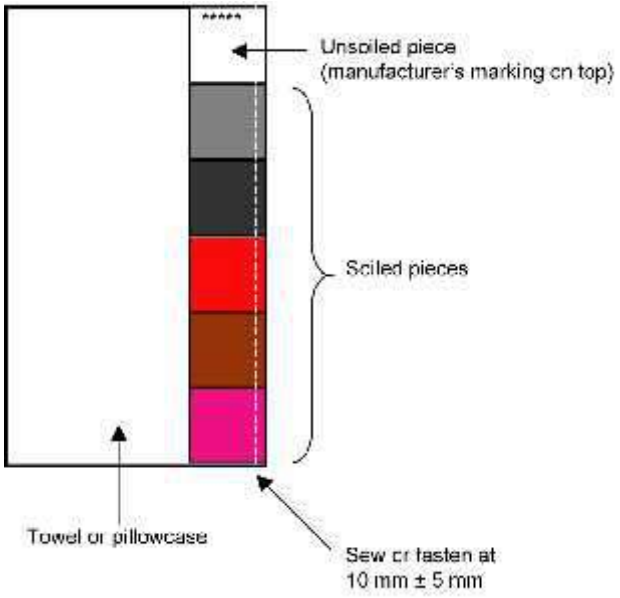
- cotton **base load** – stain test strips are attached to towels;
- synthetics/blends **base load** – stain test strips are attached to pillowcases;

The number of stain test strips used for a performance test shall be as shown in Table 2 for a cotton **base load** (refer to 6.4.6.1) or Table 3 for a synthetics/blends **base load** (refer to 6.4.6.2).

The orientations described in the following text refer to a plan view of the towel or pillowcase and stain test strip in Figure 3.

Towels or pillowcases to which stain test strips are attached for a washing performance test shall be flattened by hand or iron prior to attachment. Attach the stain test strips to towels or pillowcases as follows:

- place the stain test strip on top of the towel or pillowcase so that the unsoiled piece of the strip is at the top and with serial number or other manufacturers marking facing up, as shown in Figure 3;
- move the stain test strip so that the right hand edge of the strip aligns with the right hand edge of the towel or pillowcase 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 towel or pillowcase in this position along a line that is a distance of (10 ± 5) mm from the right-hand edge of towel or pillowcase and strip. Where non-metallic fasteners are used, a sufficient number shall be used to ensure that the strip is adequately secured along its length. Metallic fasteners of any type are not permitted.



IEC 218/10

Figure 3 – Attached test strip

6.4.7.3 Wool shrinkage specimens

In the case of assessment of wool **programmes** for shrinkage performance, wool shrinkage specimens are not attached to polyester base load items but are placed throughout the **base load.** Only 3 wool shrinkage specimens are used, irrespective of the **test load** size (refer to 6.4.6.3). Refer to Clause 9 for details of the wool shrinkage test.

7 Performance measurements – general requirements

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

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
- rinsing performance (soluble components)
- energy consumption
- water consumption
- programme time

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

The measurement and evaluation of wool shrinkage performance is specified in Clause 10. The assessment of wool performance shrinkage requires the use of a separate **base load** and **test series**.

NOTE 1 Other performance parameters (washing, rinsing, water extraction, energy and water) are not normally determined for a wool shrinkage test.

NOTE 2 Increased alkalinity is used in this document as a tracer to detect soluble residues from detergent and soil in the **base load**. Other residues, such as non-soluble or surface active components, are not part of this as-

sessment. A method for the assessment of rinse performance for insoluble detergent components is under consideration.

NOTE 3 The measurement of energy consumption in low power modes are set out in Annex L. Alternative evaluation options are set out in Annex O.

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

- load type (e.g. cotton, synthetics/blends, polyester load for wool shrinkage tests)
- performance tests required (washing performance, water extraction performance, rinsing performance, water and energy consumption, programme time)
- **programme** to be tested on the **test washing machine** and the relevant reference **programme** on the **reference machine**
- test load mass (rated capacity or part load)
- water hardness (soft or hard)

The primary requirement of this document is for determination performance at **rated capacity** for each relevant load type and set of test conditions. Any claim of performance to this document 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 for a cotton load or a synthetic/blend load:

- washing performance
- water extraction performance
- rinsing performance (soluble components)
- energy consumption
- water consumption
- programme time

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

NOTE The measurement and evaluation of wool shrinkage performance is specified in Clause 10.

While the text in this document 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 5.2.1
- connected to a laboratory water supply system specified in 5.2.2
- in ambient conditions as specified in 5.2.3

- with the **test washing machine** and the **reference machine** prepared in accordance with 6.2
- using a **base load** specified in 5.3.2 and a **test load** that has been prepared in accordance with the requirements of 6.4
- using the detergent specified in 5.3.5 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 **base load** type (refer to 5.3.2) and 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** (refer 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 H.

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. The **programme** selected for the **reference machine** shall be the one recommended in Annex F.

In the case of a **manual washing machine**, the manufacturer's instructions regarding the settings and operation of the **washing machine** shall be followed. Where no specific instructions are provided, the test procedure for a manual washing machine in Annex M shall be followed.

The **programme** selected on the **test washing machine** (with any associated settings) and the **reference machine** shall be reported.

NOTE In order to minimise the influence of laboratory conditions and test materials, a reference **programme** should be selected that is intended for a similar purpose when compared to the **programme** on the **test washing machine** (load type, claimed wash temperature) – refer to Annex F for guidance.

8.2.4 Test procedure

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

NOTE 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 **programme**.

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

Within 10 min of the completion of the **programme**, remove the **test load**. The stain test strips shall be carefully removed as quickly as possible. Proceed to follow the relevant re-

quirements of each of the performance tests being performed in the **test series**. Assessment of water extraction performance and alkalinity 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 **programme** 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** (refer 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 ± 3) %. Do not adjust number of items or average age 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 should 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 incorrect **test run** is eliminated completely from any subsequent evaluation.

NOTE Refer to 9.1 regarding evaluation of results where more than 5 **test runs** are undertaken in a **test series**. The reason for rejection of a **test run** from a **test series** should be explained in the test report. Where an additional **test run** is required on a **test washing machine**, only the **test washing machine** of interest and the **reference machine** need 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 and rinsing 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 normalised as per 6.4.4 for use in the next test series.

A schematic representation of a **test series** is set out in Figure 4.

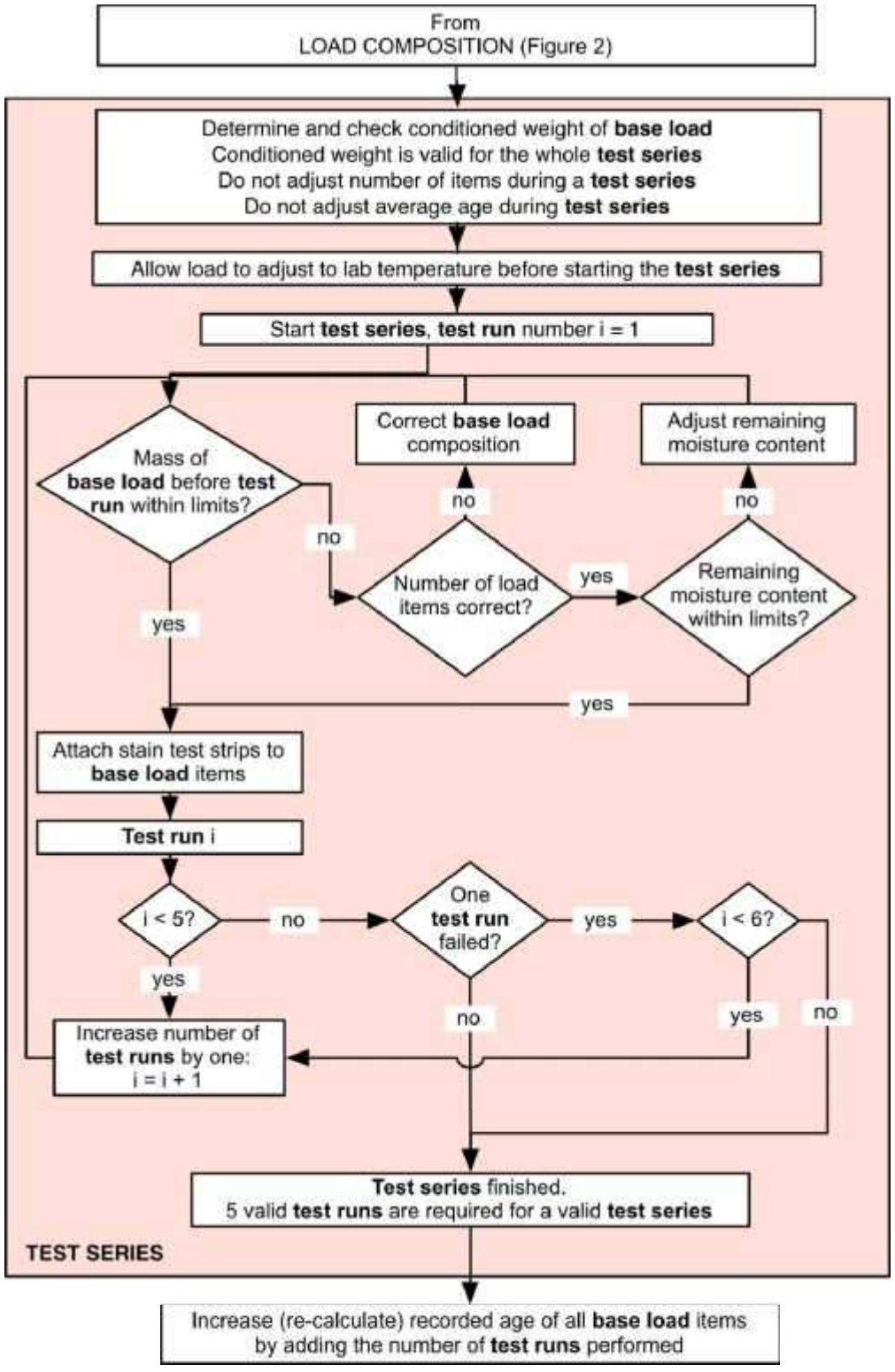


Figure 4 – Test series: process and decisions for load mass and age

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 are removed from the **test load** at the completion of the **programme.**

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 5.4.6 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 may be stored in a dry dark place until the reflectance measurement is undertaken (refer to 8.3.3).

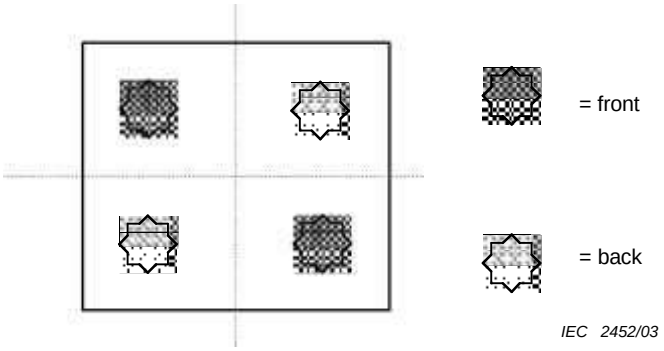
NOTE Residual humidity in the stain test strips will influence the measurement results, as will overheating during ironing. Exposure of the stain test strips to direct daylight at any time is not advisable.

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 5.4.3.

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

Reflectance measurements are taken with not less than four layers of the same washed soil type as backing for the piece being measured. Every washed piece is measured twice on both sides, at the positions indicated in Figure 5. Each of the 4 individual readings shall be recorded. The average value of the four readings for each soil type is 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 5 – Positions for measuring soiled test pieces

8.4 Measurements to determine water extraction performance

8.4.1 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 **programme** 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 completion of the **programme**. It is also intended to be used to assess the performance of separate **spin extractors** and **manual washing machines** that have a separate **spin extractor**.

NOTE The **spin extraction** of **manual washing machines** with a spinning **operation** (including **washing machines** with a separate spinning device such as twin tubs) can be assessed using this method. While this method could also be used for assessment of hand operated wringing machines, this is not generally recommended as the results are somewhat dependent on the skill of the operator. However, the method could provide some qualitative assessment of such a device.

8.4.2 Washing machines

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

At the completion of the test **programme** as set out in 8.4.1, without delay, remove the soiled **test strips** and weigh the **base load**. The mass of the moist **base load** at the completion of the **programme** is recorded.

NOTE The final mass of the **base load** has to be measured prior to any subsequent water extraction to assess rinse performance, see 8.4.

8.4.3 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 **programme**, 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.

8.5 Measurements to determine rinsing performance

8.5.1 General

This clause contains specifications for a test using the residual alkalinity of the detergent solution in a base load after **spin extraction** as a measure of the rinsing performance. The purpose is to evaluate how well a typical textile load is rinsed as regards water-soluble residues. This clause contains specific requirements for the measurement of rinsing performance. Evaluation of the measurements performed in this clause are set out in 9.4.

This test is conducted in accordance with Clause 8.2. At least five complete **test runs** shall be carried out using the selected **programme** (refer to 8.2.4).

After the completion of the **programme**, the **spin extraction** and sampling is carried out in accordance with 8.5.2.

This method is intended for **automatic washing machines** that have spin operation at the completion of the **programme**. It is not intended to be used to assess separate spin extractors or **manual washing machines** that have a separate spin extractor.

8.5.2 Spin extraction and sampling

Before each spin extraction the standard extractor (refer to 5.4.5) shall be thoroughly cleaned from alkalinity remaining from previous spin operations by flushing it with laboratory supply water, tilting it – if possible – and dried by running it for an appropriate time.

NOTE 1 Ensuring that the standard extractor is empty is critical to avoid dilution of the water subsequently extracted from the base load.

A sample of approximately 1 l is taken from the laboratory supply water used for the **test washing machine**.

After a complete **programme** including washing, rinsing and spinning, the **test load** shall be removed from the washing machine, then the mass of the **base load** (with any stain test strips removed) is determined (noting that the mass of the **base load** is also required for determination of the water extraction index in Subclause 8.4).

Without delay the **base load** shall be split into bundles. Each bundle of cotton load shall contain one sheet, two pillowcases and six towels. Each bundle of synthetic/blend shall contain four pillowcases and four shirts. The mass of each bundle is determined.

Every bundle shall be spun in separate spin extractors immediately.

NOTE 2 The measurement of alkalinity is seriously affected by interactions of the **base load** with the atmosphere.

Each bundle shall be treated in the following way:

For cotton load bundles: Treat one sheet in the same way as described in J.3 and place it flat on the base of the standard extractor. Treat two pillowcases (separate) in the same way as described in J.3 and place them along the wall of the standard extractor. Treat five towels (separate) in the same way as described in J.3 and place them along the wall of the standard extractor. Finally fold one towel in the middle of the longer side and place it flat at the top.

Each bundle is spun separately in the standard extractor for 10 min or the spin time determined in 5.4.5. Each bundle and the extracted water is weighed after extraction.

If no bundle can be formed due to the number of items requested (i.e. < 3,5 kg) proceed as follows:

Bundle specifications for cotton loads			
Nominal load size (kg)	Number of sheets	Number of pillowcases	Number of towels
Greater than 3,5 kg	1	2	6
3,0 kg to 3,5 kg	1	2	up to 6
Less than 3,0 kg	all items		

For synthetic/blend load bundles: Treat shirts and pillowcases as described in J.3 and distribute them evenly along the wall of the standard extractor and spin it for 5 min. The bundles and the extracted water are weighed after extraction.

All the extracted water from the bundles is collected, the last amount, if possible, by tilting the standard extractor towards the outlet. It is thoroughly mixed and a sample is transferred into a dry and clean bottle and closed tightly if the sample is not titrated within 1 h.

Remaining items after the splitting into bundles are weighed. They are spun separately in the standard extractor for 10 min for cotton and 5 min for synthetic/blends or the spin time determined in 5.4.5. The extracted water of this spin extraction is weighed and rejected. The remaining items are weighed after extraction.

If a **spin extractor** other than one complying with the primary **standard extractor** specification in 5.4.5 is used, the actual spin time above shall be adjusted (reduced) as specified in 5.4.5 to meet the specified **remaining moisture content** requirements.

A large **standard extractor** may be used in which several bundles may be spun simultaneously. The large **standard extractor** shall be loaded according to the procedure described in Annex J. If the load size exceeds the capacity of the large **standard extractor** the load shall be divided into two equal bundles.

NOTE 3 Recorded weights are used to check validity of the spin extraction process (see Annex K).

8.5.3 Alkalinity measurements

8.5.3.1 General

The residual alkalinity in the **base load** is defined as the milliequivalents alkali per kilogram of **base load**. It is determined by titration with 0,1 N hydrochloric acid to a pH of 4,5. The corresponding value of the laboratory supply water is subtracted.

The titration itself is performed by one of two alternative methods: manual or automatic. Automatic titration is preferred for reasons of precision and reproducibility.

8.5.3.2 Alkalinity measurement

Two samples of the extracted water shall be titrated. The temperature of the samples shall be at (20 ± 5) °C. If the values of alkalinity concentration found are different by more than 2 %, a third sample shall be titrated and the average of the values obtained.

A sample of the laboratory supply water collected as described in 8.5.2 shall be tested for alkalinity in the same way as the extracted water.

8.5.3.3 Titration

The alkalinity shall be determined through titration as set out in Steps (A) to (C) below.

Step (A): after mixing the sample, put an amount of about 50 g to 100 g (see note) of the sample into a titration beaker and weigh the exact amount of sample on a scale. Record sample name and mass.

NOTE Amount depending on the expected alkalinity and on the volume of sample available; if necessary add reverse osmosis, distilled or demineralised water up to about 100 g.

Step (B): prepare the measurement equipment as needed for your specific device and start the automatic measurement. While stirring the sample titrate with HCl 0,1N to a steady (10 s) pH 4,5 endpoint. Near to the endpoint, ensure the titration speed is reduced to avoid overshooting. In case of automatic titration set speed profile accordingly.

Step (C): once terminated record all further data like titration volume n_e (alkalinity of extracted water), n_S (alkalinity of the laboratory supply water) (in ml, two decimal places) and titration time for each sample. The normal titration time should be around 2 min to 10 min per sample. If possible add a record printout.

8.6 Measurements to determine water and energy consumption and programme time

8.6.1 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 **programme** 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 9.5.

Determination of power consumption in **off mode** and **left on mode** is specified in Annex L.

NOTE 1 This clause is applicable also to **washing machines** without **spin extraction**.

NOTE 2 Information on other low power mode energy consumption of **washing machines** is also contained in Annex L.

8.6.2 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 programme**.

Measurements are commenced when the **programme** is initiated (without any user programmed delay). They are stopped at the **end of programme**.

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

9 Assessment of performance

9.1 General

This section sets out the primary evaluation methods for the assessment of washing machine performance under this document. While these methods are intended as the main basis for **washing machine** comparisons, a range of other methods and approaches for evaluation of measured test data are included in Annex O which can yield more useful information in some cases.

This section includes the evaluation of

- washing performance
- water extraction performance
- rinsing performance (soluble components)
- energy consumption
- water consumption
- programme time

For the evaluation of washing performance (9.2) and rinsing performance (9.4) the result from the **test washing machine** is compared to the result from the **reference machine** which is operated in parallel. Assessment and information about low power mode energy consumption are included in Annex L.

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:

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

where

x_{ij} is the average reflectance value of the 4 individual readings for each of the 5 soil types on a stain test strip;

n is the number of stain test strips per **test run.**

NOTE 1 The standard deviation s_i for each soil type i, i.e. x_{ij}, within a given **test run** may be calculated as

$$s_i = \sqrt{\sum_{j=1}^{n} \frac{(x_{ij} - \bar{x}_i)^2}{n-1}}$$

b) The sum C_k of the average reflectance values in each **test run** is calculated as follows:

$$C_k = \sum_{i=1}^{m} \bar{x}_i$$

where

$\bar{x}_i$ is the average reflectance value for each soil type, as calculated in a);

m is the number of soil types per stain test strip.

c) The average sum $\overline{C}$ of the reflectance values for each of the five types of soil, for all **test runs**, is calculated as follows:

$$\overline{C} = \frac{\sum_{k=1}^{w} C_k}{w}$$

where

C_k is the sum of the average reflectance values in each **test run**, as calculated in b);

w is the number of **test runs** in the **test series.**

d) The standard deviation s_C of C_k, is defined as

$$s_C = \sqrt{\frac{\sum_{k=1}^{w} (C_k - \overline{C})^2}{w-1}}$$

where

C_k is the sum of the average reflectance values in each **test run**, as calculated in b);

$\overline{C}$ is the average sum of the reflectance values in each of the five types of soil, for all **test runs** in the **test series**. This is calculated in c);

w is the number of **test runs.**

e) The ratio q of the average sum is calculated as

$$q = \frac{\overline{C}_{\text{test}}}{\overline{C}_{\text{ref}}}$$

where

$\overline{C}_{\text{test}}$ is the average sum of the reflectance values for the **test washing machine**, as calculated in c);

$\overline{C}_{\text{ref}}$ is the average sum of the reflectance values for the **reference machine**, as calculated in c).

The calculated ratio q shall be rounded to the nearest 0,001.

f) The standard deviation s_q of the ratio q, is defined as

$$s_q = \sqrt{\frac{\sum_{k=1}^{w} \left(\frac{C_{k\,\text{test}}}{\overline{C}_{\text{ref}}} - a\right)^2}{w-1}}$$

where

$C_{k\,\text{test}}$ is the sum of the reflectance value in each **test run** of the **test washing machine**, as calculated in b);

$\overline{C}_{\text{ref}}$ is the average sum of the reflectance value in each **test run** of the **reference machine**, as calculated in c);

q is the ratio of the average sum, as calculated in e);

w is the number of **test runs.**

g) The confidence interval p for the ratio of the average sum is defined as

$$p = q \pm \frac{s_q}{\sqrt{w}} \times t_{w-1,\ 0,05}$$

where

s_q is the standard deviation of the ratio q, as calculated in f);

$t_{w-1,\ 0,05}$ is the "Student T" factor for (w-1) degrees of freedom for a confidence level of 95 % (i.e. 2,776 for 5 **test runs**, which equals 4 degrees of freedom);

w is the number of **test runs.**

NOTE 2 If for the reference wash **programme** cotton 60 °C the ratio $\frac{s_C}{\overline{C}}$ (data calculated in c) and d)) is higher than 0,0175 (= 1,75 %) the laboratory conditions should be checked. Tolerances for other **programme**s are under consideration.

NOTE 3 The equation assumes parallel running of the **test washing machine** and the **reference machine**.

NOTE 4 Additional information can be obtained from the wash performance measurements as set out in Annex O.

9.3 Evaluation of water extraction performance

The water extraction performance shall be evaluated below using the measurements determined in 8.4.

The **remaining moisture content** RMC is calculated for each **test run** in the **test series** and is expressed as a percentage:

$$RMC = \frac{M_{\text{r}} - M}{M}$$

where

M is the mass of the conditioned **base load**;

M_{r} is the mass of the **base load** at the end of the test run (i.e. after **spin extraction**).

The water extraction performance is the arithmetic mean of the RMC values obtained in the **test series**. It is expressed as a percentage, rounded to the nearest whole percent.

9.4 Evaluation of rinsing performance

9.4.1 General

The rinsing performance shall be evaluated as described below using the measurements determined in 8.5.

9.4.2 Calculations

Alkalinity concentration W (W_e or W_s) of each sample is calculated by the volume amount (in ml) of used HCl for the sample, and is usually expressed as milliequivalents *meq* alkalinity per kg water:

$$W = \frac{n_{HCl} \times 0{,}1 \frac{meq}{ml}}{m}$$

where

n_{HCl} is the amount (volume) of HCl used (measured in ml);

m is the actual mass of the sample (entered into calculation in kg);

m_e is the mass of the extracted water;

m_s is the mass of the laboratory supply water.

W_e shall be the average for the extracted water from the bundles, W_s that for the laboratory supply water.

9.4.3 Evaluation

The increased alkalinity concentration of spin-extracted water relative to the laboratory supply water is calculated as

$A_r = W_e - W_s$ [milliequivalents per kg water]

where

A_r is the increased concentration of alkalinity in the extracted water;

W_e is the averaged concentration of alkalinity in the extracted water;

W_s is the averaged concentration of alkalinity in the laboratory supply water.

The amount of alkalinity remaining in the **base load** in milliequivalents per kg of **base load** is calculated by

$$A_m = A_r \frac{M_r - M}{M}$$

where

A_m is the amount of wash alkali remaining in the **base load**;

A_r is the increased concentration of alkalinity in extracted water;

M is the conditioned mass of the **base load**;

M_r is the mass of **base load** at the end of the **test run**.

The rinsing index, R, is determined by

$$R = \frac{A_{m,test}}{A_{m,ref}}$$

where

$A_{m,test}$ is measured in the **test washing machine**;

$A_{m,ref}$ is measured in the **reference machine** with the relevant **programme** as described in Annex E.

NOTE It is only possible to determine a value for A_m and R where there is a **spin extraction operation** at the completion of the selected **programme**.

The standard deviation is calculated as

$$s = \sqrt{\frac{\sum_{k=1}^{w} (R_k - \overline{R})^2}{w - 1}}$$

where

R_k is the rinsing index from one **test run**;

$\overline{R}$ is the mean of rinse indices for all **test runs** in the **test series**;

w is the number of **test runs** used in the calculations.

9.5 Evaluation of water and energy consumption and programme time

9.5.1 General

The water and energy consumption and **programme time** shall be evaluated using the measurements determined in 8.6.

The arithmetic mean of the measured values is calculated.

9.5.2 Water volumes

Water volumes are expressed in litres, and rounded to the nearest 0,1 l. Separate volumes for hot and cold water shall be reported, where applicable. Total water consumption shall be reported rounded to the nearest whole litre.

9.5.3 Programme time

Programme time is the time from the initiation of the **programme** (excluding any user programmed delay) until the completion of the **programme. Programme time** is determined as the average of values measured during each **test run** within a **test series. Programme time** is rounded to the nearest minute.

9.5.4 Energy consumption

The energy consumed over a **programme** (called the **programme** energy), which is the energy consumption value determined under this document, is the sum of the electrical energy plus any cold water correction plus the energy embodied in any hot water**.**

Programme energy: The **programme** energy is determined as follows:

$$W_{total} = W_{et} + W_{ct} + W_{ht}$$

where

W_{et} is the total electrical energy metered during the test;

W_{ct} is the total cold water energy correction determined below;

W_{ht} is the calculated total hot water energy determined below.

Programme energy only includes energy consumed during the **programme.** Additional energy consumption may occur outside the **programme. Off mode** power and **left on mode** power determination is set out in Annex L. Information on other low power mode energy consumption of **washing machines** is also contained in Annex L.

Electrical energy is expressed in kWh rounded to the nearest 0,01 kWh.

Cold water energy correction factor: if the inlet temperature of the cold laboratory supply water deviates from 15 °C, the cold water energy correction factor shall be determined for those **operations** where the internal heater operates and/or where the **test washing machine** draws in external hot water using the following formula:

$$W_c = (V_c \times (t_c - 15)) / 860$$

where

W_c is the cold water energy correction in kWh for the **operation**. The value of W_c for each applicable **operation** shall be summed to give total cold water energy correction W_{ct};

t_c is the measured average inlet temperature of the cold laboratory supply water in degrees Celsius averaged on volume weighted basis for each **operation**;

V_c is the volume of the cold water used during an **operation** where the internal heater operates and/or where the machine draws in external hot water using the following formula. For the calculation the volume of cold water V_c shall be used as recorded (accuracy 0,1 l).

1/860 is the energy equivalent.

NOTE 1 The correction should be done when the temperature of the cold water supply is between 13 °C and 17 °C. Outside of this temperature range the test is invalid. Note the value W_c may be positive or negative.

NOTE 2 It is preferred that readings of temperature and volume are integrated over each **operation** to get an accurate average weighted temperature and volume for use in the determination of the cold water correction factor. This normally requires the use of a data logger to record temperature and water volume data at regular intervals throughout each **operation**.

Hot water energy: when the unit is supplied with an external hot water source, the hot water energy shall be calculated using the following formula:

$$W_h = (V_h \times (t_h - 15)) / 860$$

where

W_h is the calculated hot water energy in kWh for the **operation**;

t_h is the measured average inlet temperature of the hot laboratory supply water in degrees Celsius averaged on a volume weighted basis for each **operation**;

V_h is the volume of external hot water used during the **operation**. For the calculation the volume of hot water V_h shall be used as recorded (accuracy 0,1 l).

The value of W_h for each applicable **operation** (including any **operation** that occurs after the completion of the **programme**) shall be summed to give the calculated total hot water energy, W_{ht}.

NOTE 3 It is preferred that readings of temperature and volume are integrated over each **operation** to get an accurate average weighted temperature and volume for use in the determination of the hot water energy. This normally requires the use of a data logger to record temperature and water volume data at regular intervals throughout each **operation**.

10 Shrinkage during the wool wash programme

10.1 General

This clause contains the test method for the determination of the wool shrinkage rate (SR) and Shrinkage Rate Index (SRI) when a **test washing machine** is operated on a wool wash **programme**.

10.2 Overview

10.2.1 General

Wool shrinkage specimens are carefully prepared to determine their initial dimension under defined conditions prior to washing. The wool shrinkage specimens are then washed with the specified **base load** for a total of four **test runs** (which make up a single **test series**) on the wool **programme** under test. At the completion of the four **test runs**, which are run sequentially without drying of the wool shrinkage specimens, the dimensions of the specimens are again determined under controlled conditions and these are compared to the original measurements. These two sets of measurements are used to determine the wool shrinkage values. The results from the **test run**, along with data on the reference shrinkage level for the batch of wool shrinkage specimens used (refer to 10.2.2), are used to determine the shrinkage performance of the **programme** tested on the **test washing machine**.

The **reference machine** using a special wool shrinkage **programme** (see Annex E) is used to determine the reference shrinkage level for each batch of wool shrinkage specimens.

NOTE The reference machine is used in the same way as a **test washing machine** when determining the reference shrinkage level for a batch of wool shrinkage specimens. The wool shrinkage reference **programme** on the **reference machine** has a high shrinkage level and is typically used to define a limit for an acceptable shrinkage level. The **reference machine** is not normally run in parallel with a **test washing machine** when performing a reference wool shrinkage test.

10.2.2 Determination of reference shrinkage

Prior to use, each batch of wool shrinkage specimens shall be calibrated in order to account for variations in the fabric used from batch to batch. This is done by washing samples of the wool shrinkage specimens from the batch in the **reference machine** using the reference wool **programme** given in Annex E and following the procedure specified in 10.3.2. A reference shrinkage level for each new batch of wool shrinkage specimens shall be determined prior to their use. Any reference shrinkage value must be determined with the same detergent batch and same water quality as used for the test washing machine.

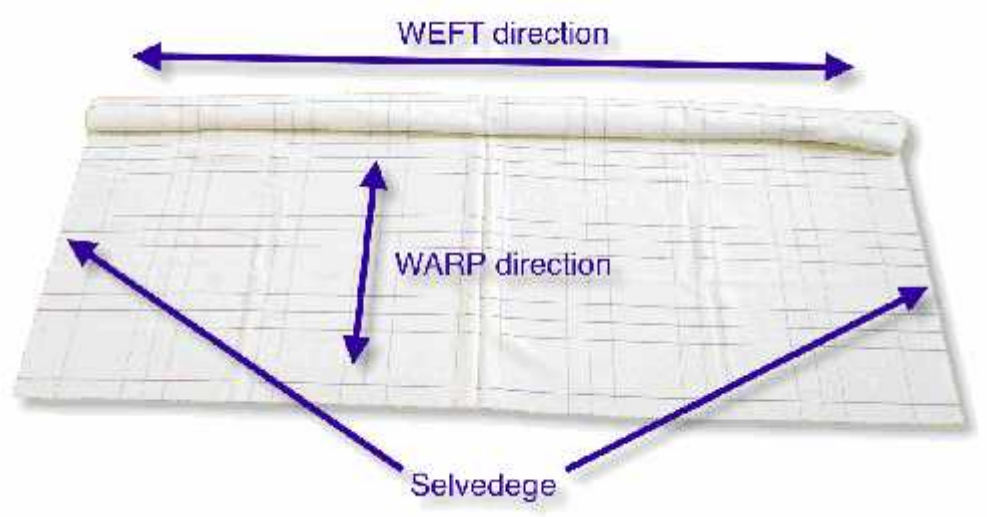
10.3 Procedure

10.3.1 Preparation of wool shrinkage specimens

The wool shrinkage test material is normally delivered uncut with 4 test samples in the weft (filling) direction (width). The width of the uncut test material as delivered is about 140 cm. Both sides of the material do have a selvedge in warp (length) direction, as shown in Figure 6. The warp (length) direction should be clearly marked on the test specimen before cutting the shrinkage test material into test samples.

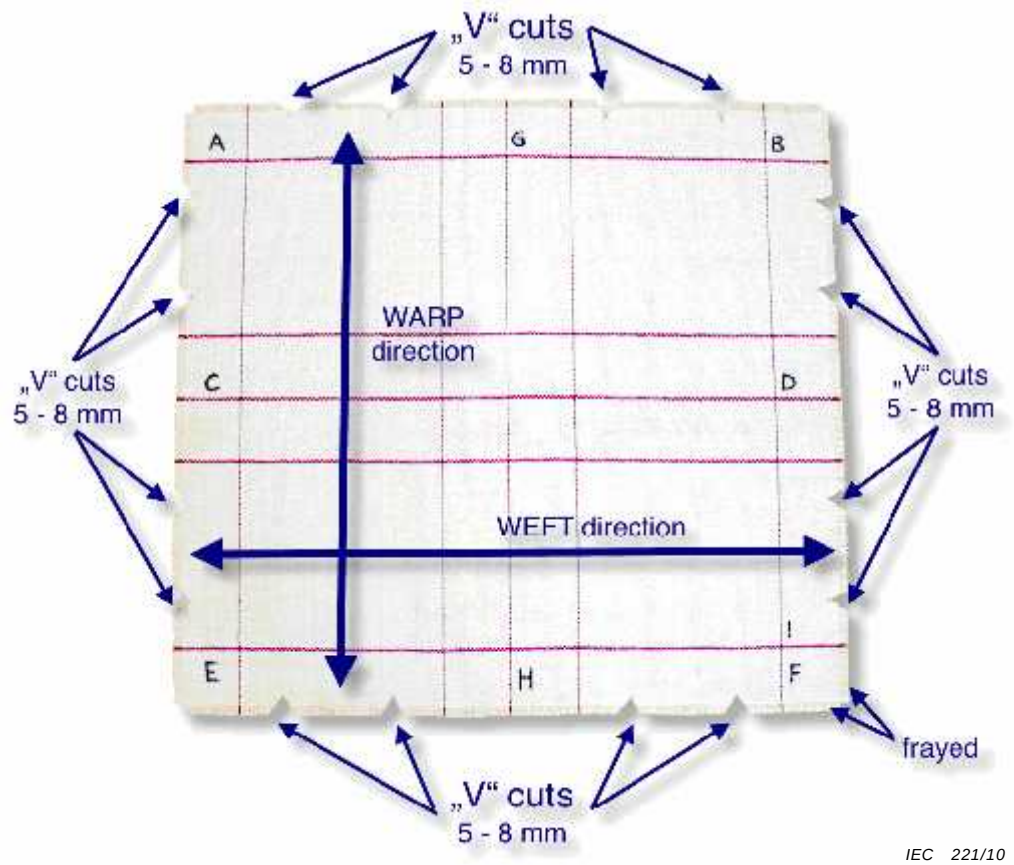
Three wool shrinkage specimens are always used for the wool shrinkage test, irrespective of **rated capacity**. Each of the wool shrinkage specimens shall be prepared as specified below prior to use in the wool shrinkage **test runs**.

The four edges of each wool shrinkage specimen are frayed to 0,5 cm around all four sides. Fraying the edges reduces edge felting, which can cause distortion of the fabric during subsequent measurements. Once the edges are frayed, make “V” cuts into each side of the fabric as shown in Figure 7.



IEC 220/10

Figure 6 – Wool shrinkage specimen, uncut



IEC 221/10

Figure 7 – Wool shrinkage specimen, fraying the edges and V-cuts

The wool shrinkage specimen has marker threads in both the weft and warp directions and these cross at the measurement points, as illustrated in Figure 8. The warp or length direction of the specimen needs to be correctly identified and the measurement points have to be marked as shown in Figure 8.

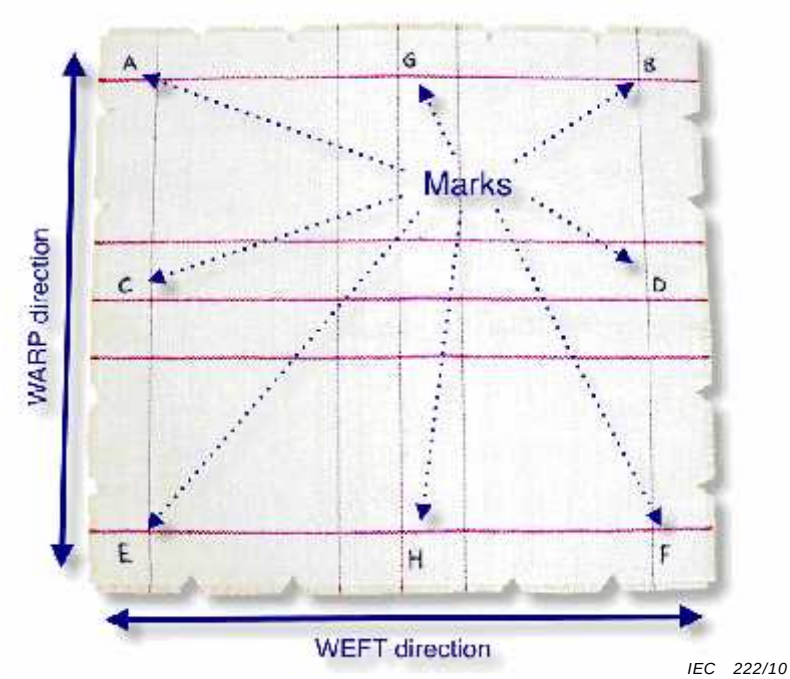


Figure 8 – Wool shrinkage specimen, marks

Dissolve 3 g of base powder of the reference detergent A* (refer to 5.3.5) in 1,5 l of laboratory supply water at an initial temperature of 40 °C. The wool shrinkage specimens shall then be immersed in this liquid for 1 h. They shall then be rinsed three times in not less than 1,5 l of the laboratory water supply at 15 °C without detergent for 10 min without agitation for each rinse (total rinsing time of 30 min).

NOTE Base powder is the detergent specified in 5.3.5 without perborate or TAED. The immersion and rinsing is usually undertaken in a flat tray as specified in 5.4.8.

Fill the measuring tray with fresh laboratory supply water without detergent at 15 °C to a depth of 1 cm. Immerse the three wool shrinkage specimens in the tray so that they lie flat. Carefully remove any creases, folds or air bubbles without distorting or stretching the fabric. After leaving the specimens submerged for 15 min, determine the dimensions of each specimen while submerged in the tray between the points indicated in Figure 8 in the order specified: A-B, C-D, E-F, A-E, G-H then B-F. The three measurements of the width and length for each wool shrinkage specimen shall then be used to determine the average initial values for each specimen.

On completion of measurements, remove the three specimens from the tray and remove excess water by very gently squeezing by hand. The whole specimen has to be supported when it is lifted out of the water as the weight of water in an unsupported specimen may cause stretching of the fabric.

10.3.2 Wool programme test

If the **test washing machine** has several **programmes** or settings available for washing wool, the **programme** with the highest temperature shall be selected with all options likely to maximise the shrinkage (i.e. the worst case, e.g. any pre-wash and/or extra rinse options for the test).

NOTE 1 This **programme** is expected to give the worst shrinkage result. Other wool **programmes** may also be tested.

Immediately after the initial measurement, carefully transfer the wet wool specimens to the **test washing machine** together with a polyester **base load** in accordance with 5.3.2.3 corresponding to the **rated capacity** of the **test washing machine**. The wool specimens shall be placed in the **test washing machine** between items from the base load.

Weigh out the detergent dose as specified in 6.3.2, mix it as specified in 6.3.3 and place it as specified in 6.3.4 in the **test washing machine** and commence the selected **programme**.

NOTE 2 The reference detergent used for the wool wash shrinkage test is the full Detergent A* (i.e. base detergent plus perborate and TAED) as specified 5.3.5. The detergent should not be pre-dissolved.

Do not remove the three wool shrinkage specimens from the drum on completion of the wool wash **programme** (which includes **spin extraction** where included within the **programme**, but excluding any drying operation). If an automatic **spin extraction** is not included, follow the manufacturer's instructions. If there are no specific instructions and there is a **spin extraction** "**programme**", this shall be used where possible. In the absence of a **spin extraction** facility, remove the wool shrinkage specimens and gently squeeze by hand then place back in the **test washing machine**.

Without undue delay between **test runs** (do not allow the **base load** or the wool shrinkage specimens to dry out), add the detergent dose specified in 6.3.2 to the **test washing machine** and commence a new **test run** on the selected **programme**. This process shall be repeated until four **test runs** have been completed on the selected **programme**. The **test series** shall be completed within one working day.

NOTE 3 It is recommended that 4 air tight containers with the required amount of detergent in each are left by the machine during the test series to reduce the chance that detergent is omitted at the start of each new **test run**.

At the completion of the **test series** (4 **test runs**), transfer the wool shrinkage specimens to the measuring tray. Fill the measuring tray with fresh laboratory supply water without detergent at 15 °C to a depth of 1 cm. Immerse the three wool shrinkage specimens in the tray so that they lie flat. Carefully remove any creases, folds or air bubbles without distorting or stretching the fabric. After leaving the specimens submerged for 15 min, again determine the dimensions of each specimen in the tray while submerged between the points indicated in Figure 8 in the order specified: A-B, C-D, E-F, A-E, G-H then B-F. In the event that the fabric is distorted by felting on the edges, renew the "V" cuts prior to measurement.

10.3.3 Evaluation

The measurements of the wool shrinkage specimens are taken before and after washing in the following order (see Figure 8): A-B, C-D, E-F, A-E, G-H, B-F.

The following calculations are carried out.

a) Average width and length for each specimen before (initial values) and after the **test series**

The arithmetic mean $\bar{y}$ of the individual readings y_i for each set of three measurements for width and length (i.e. width: A-B, C-D, E-F and length: A-E, G-H, B-F) is calculated for each of the 3 wool shrinkage specimens as follows:

$$\bar{y} = \sum_{i=1}^{3} y_i$$

b) Linear felting shrinkage for each specimen after the **test series**

The linear felting shrinkage, for width and length is calculated:

$$WS \text{ or } LS = \frac{W_0 - W_k}{W_0}$$

where

WS is the percentage of the width shrinkage for each shrinkage specimen;

LS is the percentage of the length shrinkage for each shrinkage specimen;

W_0 is the mean measurement (width or length as applicable) of the original wool shrinkage specimen after initial preparation and prior to washing (refer to 10.3.1);

W_k *is* the mean measurement (width or length as applicable) of the washed wool shrinkage specimen, after the completion of the **test series** (refer to 10.3.2).

c) Shrinkage Rate (SR)

The shrinkage rate for each specimen after the **test series** is calculated as

$$SR = WS + LS - \frac{WS \times LS}{100}$$

The shrinkage rate for the **test series** (SR_{test}) is calculated as the average shrinkage rate (SR) for the 3 wool shrinkage specimens used in the **test series**.

d) Cycle Felting Severity (CFS)

The CFS is calculated as the average shrinkage rate for the **test series** per wash.

$$CFS = \frac{SR_{\text{test}}}{4}$$

e) Shrinkage rate index (SRI)

The mean shrinkage rate index for the **test washing machine** is determined from the values for the **test series** SR_{test} (refer to 10.3.2). The corresponding mean value using the same batch of wool shrinkage specimens, SR_{ref}, is calculated for the **reference machine** (refer to 10.2.2). While the reference shrinkage rate index (SR_{ref}) for the batch may be determined at any time, for this value to be valid, it shall be determined with the same detergent batch and same water quality as used for the **test series** on the **test washing machine**.

The shrinkage rate index, SRI, for the **test washing machine** is calculated as follows:

$$SRI = \frac{SR_{\text{test}}}{SR_{\text{ref}}}$$

NOTE The value of SRI above is not comparable to the parameter of the same name (SR_i) as defined in IEC 60456-Edition 4.

11 Data to be reported

For each test, the relevant data that shall be reported are listed in Annex S. It is recommended that the data is presented in the format shown in Annex S.

Annex A
(normative)

Specification of stain test strips with standardized soiling

A.1 Artificial soils

The washing performance of a household **washing machine** is the result of mechanical and chemical action, and a combination of both. Natural soils contain fatty matter, proteins and organic and inorganic pigments in complex mixtures. Some kinds of natural soil are more sensitive to mechanical action, and some to chemical action, such as oxidation (bleaching), solubilisation and emulsification. High temperatures increase the effect of mechanical and chemical action.

In this document soil removal performance of a **washing machine** is determined by means of the following different types of standard artificial soils. These soils are based on specially developed stains that are intended to assess each of the main washing parameters. They have been found to be suitable for the assessment of washing performance:

– specimen based on artificial sebum enabling the measurement of the scouring effect, mainly due to mechanical and thermal action;
– specimen based on carbon black and mineral oil enabling the measurement of the scouring effect, mainly due to mechanical and thermal action;
– specimen based on blood enabling the measurement of the removal of protein pigments;
– specimen based on cocoa enabling the measurement of the removal of organic pigments;
– specimen based on red wine enabling the measurement of the bleaching effect.

A.2 Supporting fabric for soil

A.2.1 Material

The fabric used as support for the soil is of pure cotton.

A.2.2 Weaving

Final textile characteristics (after pre-treatment – see A.2.3):

Weight (EN 12127)	(200 ± 10) g/m^2
Yarn twist (ISO 2061)	
Warp	(700 ± 100) T/m
Weft	(450 ± 100) T/m
Thread count	
Warp	(34 ± 2) double thread /cm
Weft	(20 ± 2) thread /cm
Yarn count (ISO 2060)	
Warp	(30 ± 1) Tex
Weft	(50 ± 1) Tex

A.2.3 Pre-Treatment

A.2.3.1 General

The fluidity index shall be between 0,4 Pa·s and 0,5 Pa·s. The pre-treatment may include singeing, desizing, scouring and calendering. Fluorescent and optical brightener shall not be used. The fabric is pre-treated through bleaching to obtain the following characteristics.

A.2.3.2 Reflectance

Tristimulus value Y: greater than 86 % for unsoiled cloth, measured with an instrument specified in 5.4.3.

A.2.4 Reproducibility

Only specialized manufacturers, manufacturing large quantities of textiles, are likely to be able to supply this fabric with an adequate reproducibility.

A.3 Artificial soil

A.3.1 Soiling composition

A.3.1.1 Composition of soil based on sebum/pigment

Synthetic sebum:

Cows fat	: 32,8 %
Wool fat	: 18,3 %
Free fatty acid	: 18,0 %
Cholesterol	: 3,7 %
Squalen	: 8,9 %
Coconut oil	: 3,6 %
Hard paraffin	: 3,1 %

Pigment:

Carbon black (see A.3.1.2)
Kaoline
Iron oxide (yellow and black)

The proportion of pigments and sebum shall be such as to obtain the reflectance specified in A.4.2.

A.3.1.2 Composition of soil based on carbon black and mineral oil

Pigment, carbon black:

Average size of grains	: 295 Å
Average surface of grains	: 94 m^2/g
Carbon content	: 96,0 %

Oil, paraffin oil:

Specific weight	: 0,885
Ignition temperature	: 221 °C
Liquefaction temperature	: -26 °C

The proportion of pigments and fatty materials shall be such as to obtain the reflectance specified in A.4.2.

A.3.1.3 Composition of soil based on blood

Pig's blood, fresh and stabilized by the addition of 10 g/l ammonium citrate.

A.3.1.4 Composition of soil based on chocolate with milk

Unsweetened cocoa (20/22 % fat, not alkalised) with sugar, full-cream cow's milk and water.

A.3.1.5 Composition of soil based on red wine

"Alicante" red wine treated with hot air.

NOTE Alicante is a trademark. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of this trademark. Equivalent products may be used if it can be shown to produce equivalent results.

A.4 Stain test strips

A.4.1 Application of soil

The application of soil by immersing the textile is recommended.

The treatment may include the following operations:

– immersion;
– calendering;
– drying;
– new immersion, if necessary;
– calendering;
– drying;
– ageing.

A.4.2 Soil checking after deposition of soil

The manufacturer should make sure that soil is evenly and regularly deposited. At the end of preparation, the Y tristimulus reflectance measurements on a dry sample using an instrument specified in 5.4.3, shall be within the range specified below for each soil:

– sebum /pigment: (50 ± 3)
– carbon black/mineral oil: (25 ± 3)
– blood: (19 ± 3)
– chocolate/milk: (37 ± 3)
– red wine: (44 ± 3)

The difference between front and back should be within the defined limits.

NOTE The unsoiled reflectance prior to soiling is given in A.2.3.12.

A.4.3 Washed reflectance values

From each of the following **programmes**, five **test runs** in the **reference machine** using programmes described in Annex E shall be carried out:

– cotton 60 °C, 180 g detergent A*
– cotton 40 °C, 180 g detergent A*
– cotton 60 °C, 90 g detergent A*

The optical reflectance is measured using an instrument specified in 5.4.3 and evaluated in accordance with 9.2.

The ratios and tolerances between the different **programmes** are defined in Table A.1 and shall be certified by the supplier of the material.

Table A.1 – Ratios and tolerances of standardized soils, Reference Machine CLS and MP Lab

Soil type	Ratio cotton 40 °C/ cotton 60 °C	Cotton 60 °C Ratio: 90 g /180 g
Sebum/pigment	0,93 ± 0,03	0,98 ± 0,03
Carbon black/oil	0,88 ± 0,03	0,94 ± 0,03
Blood	0,91 ± 0,04	0,92 ± 0,05
Chocolate/milk	0,86 ± 0,04	0,88 ± 0,05
Red wine	0,86 ± 0,03	0,89 ± 0,03
Sum (with sebum)	0,89 ± 0,02	0,92 ± 0,02

These ratios define the total test system of reference machines, **base load**, detergent, stain test strips (making up a **test load**) and reflectance measurement. Therefore ratios may be used as general qualification criteria for the test system within a laboratory, and can be used to assess the additional uncertainty from laboratory to laboratory.

A.5 Marking of stain test strips and accompanying data

Each batch of stain test strips shall be marked with a batch number and delivered with the following information:

- Batch number to permit checking date of manufacture;
- expiry date (the maximum period should be not more than one year from date of manufacture);
- reflectance value of the non-soiled fabric (see A.2.3.12);
- reflectance values of the soiled fabrics (unwashed) (see A.4.2);
- reflectance values after washing consisting of the tristimulus values Y for the individual soil types after washing in the reference washing machine at 60 °C and also for 40 °C and 60 °C with 90 g detergent A* together with the resulting ratios according to A.4.3.

A.6 Advice for users

Follow manufacturer recommendations regarding storage and transport.

It is recommended that the user periodically check the reflectance values, given in A.4.2 and A.4.3.

A.7 Suppliers

For suppliers, see Annex U.

Annex B
(normative)

Reference detergent A*

Reference detergent A* is defined in Table B.1. The reference detergent is distributed as three separate components:

– base powder with enzyme and foam inhibitor;
– sodium perborate tetrahydrate;
– bleach activator tetra-acetylethylenediamine.

The proportions of components of the reference detergent used in tests are as follows:

– 77 % base powder with enzyme and foam inhibitor;
– 20 % sodium perborate tetrahydrate;
– 3 % bleach activator tetra-acetylethylenediamine (TAED).

Table B.1 – Composition of the reference detergent A*

Ingredient	%	Tolerance (±)
Linear sodium alkyl benzene sulfonate	8,8	0,5
Ethoxylated fatty alcohol $C_{12/14}$ (7 EO)	4,7	0,3
Sodium soap (tallow soap)	3,2	0,2
Foam inhibitor concentrate (12 % silicon on inorganic carrier)	3,9	0,3
Sodium aluminium silicate zeolite 4 A (80 % active substance)	28,3	1,0
Sodium carbonate	11,6	1,0
Sodium salt of a copolymer from acrylic and maleic acid (granulate)	2,4	0,2
Sodium silicate (SiO_2:Na_2O = 3,3:1)	3,0	0,2
Carboxymethylcellulose	1,2	0,1
Phosphonate (DEQUEST 2066, 25 % active acid)	2,8	0,2
Optical whitener for cotton (stilbene type)	0,2	0,02
Sodium sulfate	6,5	0,5
Protease (Savinase 8.0)	0,4	0,04
Sodium perborate tetrahydrate (active oxygen 10,00 % – 10,40 %)	20,0	
Tetra-acetylethylenediamine (active content 90,0 % – 94,0 %)	3,0	

NOTE 1 It is recommended that the detergent manufacturer should indicate the pH of the product supplied. Further product specifications are under consideration.

NOTE 2 For suppliers, see Annex U.

The base powder with enzyme and foam inhibitor shall fulfil the following solubility requirements:

Solubility residues (see note below)**:**

Insoluble residue at 20 °C: ≤ 39 % after 2 min
≤ 37 % after 5 min.

NOTE The solubility residues are determined using the following procedure:

This operating procedure covers the IEC-A* solubility test which is used to determine the low temperature solubility of IEC-A* reference base detergent.

Equipment:

- 1000 ml glass beaker
- Magnetic stirrer
- Vacuum pump with trap
- 3 Piece Glass Buchner funnel 9 cm diameter
- 500 ml Pyrex side arm conical flask
- knitted black cotton filter fabric circles, 9 cm diameter (e.g. fabric style EW-442 supplied by wfk Testmaterials or EMPA Testmaterials, see Annex U; EW-442 is 100% cotton, swiss pique knit, circular, yarn count 37 tex; dyed direct black 22).

Procedure:

Carry out 3 replications and record the results as an average of the 3 replicates.

Fill beaker with 800 ml of deionised water and allow the temperature to equilibrate to 20 °C. Place beaker on the magnetic stirrer and set stirrer speed to 200 r/min. Sample IEC-A* base detergent to approximately 10 g and accurately weigh out 2 g. Add the product to the beaker, start stopwatch and stir for the specified time (2 min or 5 min, see solubility specifications below). Connect vacuum pump to conical flask and switch on vacuum pump.

Weigh the black fabric circle. Place black fabric into Buchner funnel smooth side up. Pour solution from the beaker onto the black fabric, and leave until all the solution has been sucked through the fabric and the residue remains. Remove black fabric from Buchner funnel, place on a sheet of paper and label sample.

Repeat for the remaining 2 replicates.

Allow black fabric to dry at ambient for 24 h. Re-weigh dried black fabric circles and record the % residue.

Annex C
(normative)

Specifications for base loads

C.1 Cotton base load

The cotton **base load** shall consist of sheets, pillowcases and towels conforming with the specifications given in Table C.1 (measured at (20 ± 2) °C, (65 ± 5) % relative humidity and certified by the supplier).

Table C.1 – Specification of the cotton base load items

Criteria for conditioned new items	Bed sheets	Pillowcases	Towels
Substrate	Long staple pure cotton		
Yarn	Ring spun		
Yarn twist (T/m)			
Warp	600 ± 20		610 ± 20
Weft	500 ± 15		490 ± 15
Yarn Count (tex)			
Warp	33 ± 1		36 ± 1
Weft	33 ± 1		97 ± 1
Weave	Plain weave linen 1/1		Huckaback
Pick count (pick/cm)			
Warp	24 ± 1		20 ± 1
Weft	24 ± 1		12 ± 1
Mass per unit area (g/m^2)	185 ± 10		220 + 10
Dimensions (mm)			
Length	2 400 ± 150	800 ± 50	1 000 ± 50
Width	1 600 ± 40	800 ± 20	500 ± 30
Weight per piece (g)	725 ± 15	240 ± 5	110 ± 3
Finish	Desizing, boiling off, singeing, bleaching, no filling or stiffening size		
Water uptake in % [a]	138 ± 10	138 ± 10	250 ± 15
Shrinkage [b,c] **warp in %**			
After 5th **test run** as compared to new item	–5 ± 1	–7 ± 1	–16,5 ± 1
After 25th **test run** as compared to after 5th **test run**	–3 ± 1	–3 ± 1	–3 ± 1
Shrinkage [b,c] **weft in %**			
After 5th **test run** as compared to new item	–5 ± 1	–7 ± 1	–11 ± 1
After 25th **test run** as compared to after 5th **test run**	–3 ± 1	–3 ± 1	–3 ± 1

Table C.1 *(continued)*

Description of preparation of seams and yarns
SHEETS: Short edges (cut edges) are double hemmed, hem size 10 mm, the long edges (selvedges) are not hemmed. Sewing material is polyester cotton, single seam, lock stitch, distance of seam from edge is 9 mm, stitch length 3 mm.
PILLOW CASES: A piece of 80 cm × 160 cm is folded to 80 cm × 80 cm, the two edges (cut edges) next to the closed edge are lock stitched with a distance to the edge of 1 cm. The pillow case is then turned inside out and the open edge (selvedges) lock stitched 0,5 cm from the edge. Sewing material is polyester cotton, single seam, lock stitch, stitch length 3 mm.
TOWELS: All 4 edges are double hemmed, hem size is 5 mm. Sewing material is polyester cotton, single seam, lock stitch, distance of seam from edge is 4 mm, stitch length 3 mm.
[a] The procedure used (DIN 53923 – see Bibliography) is established for the determination of water absorption capacity of textiles with high water absorption capacity. Water absorption capacity is the amount of water that a textile fabric, conditioned at (20 ± 2) °C / (65 ± 2) % relative humidity, takes up during storage in water of 20 °C for 60 s. The sample with the conditioned mass, *mc*, is fixed on a sieve of stainless steel and dipped into a flat dish with 20 °C water. After 60 s the sample is taken out of the water, drop dried for 120 s and then weighed again (*m*60). The water absorption capacity *wac* is (*m*60 – *mc*) × 100: *mc*. The data are measured after 25 **test runs** as specified in footnote [b]. [b] In order to qualify the suitability of the textiles for use to this document the manufacturer of the textiles should carry out **test runs** on samples from the production batch in the **reference machine**. The following wash **test runs** should be carried out in the **reference machine**: • **test runs** 1 to 5: pre-treatment according to 6.4.2; • **test runs** 6 to 25: perform **test runs** according to 8.2 in **reference machine** using the 60 °C cotton reference **programme** (without prewash but including rinsing and spinning) but without any normalization between **test runs**. [c] Determination of shrinkage according to ISO 3759 after the washing process as defined in footnote [b].

C.2 Synthetics/blends base load

Table C.2 – Specification of the synthetics/blends base load items

Criterion for conditioned new items	Men's shirt	Pillowcases
Substrate	(65 ± 3) % polyester (35 ± 3) % cotton	(65 ± 3) % polyester (35 ± 3) % cotton
Yarn	Ring Spun	Ring Spun
Yarn twist (T/m)		
Warp	450 ± 20	1 050 ± 50
Weft	450 ± 20	1 050 ± 50
Yarn count (tex)		
Warp	13 ± 1	150 ± 4
Weft	13 ± 1	150 ± 4
Weave	Plain 1/1	Plain 1/1
Pick count (pick/cm)		
Warp	43 ± 2	47 ± 2
Weft	30 ± 2	31 ± 2
Mass per unit area (g/m^2)	105 ± 10	125 ± 10
Dimensions (mm)	German size 41	
Length	-	800 ± 50
Width	-	800 ± 20
Weight per piece (g)	205 ± 10	165 ± 10
Finish	Bleaching, mercerizing, sanforizing	Desizing, washing, bleaching, thermofixation
MEN'S SHIRTS: Buttoned men's shirt, plastic buttons, no buttons/ holes on sleeves, simple collar, no interlining		
PILLOW CASES: A piece of 80 cm × 160 cm is folded to 80 cm × 80 cm, the two edges (cut edges) next to the closed edge are lock stitched with a distance to the edge of 1 cm. The pillow case is then turned inside out and the open edge (selvedges) lock stitched 0,5 cm from the edge. Sewing material is polyester cotton, single seam, lock stitch, stitch length 3 mm.		
In order to qualify the suitability of the textiles for use to this document the manufacturer of the textiles should carry out **test runs** on samples from the production batch in the **reference machine**.		

C.3 Polyester base load for wool programme

Knitted polyester textile

Mass	(35 ± 3) g
Mass per unit area	(200 ± 25) g/m^2
Size	(30 ± 3) cm × (30 ± 3) cm double layer sewn along all four edges.

The items shall be free of process oil prior to delivery.

NOTE In order to qualify the suitability of the textiles for use to this document the manufacturer of the textiles should carry out **test runs** on samples from the production batch in the **reference machine**.

Annex D
(normative)

Reference machine specification

D.1 Specification of the reference washing machines and method of use

D.1.1 General

Two types of **reference machine** are specified in this standard (Type 1 and Type 2). At the time of publication only Type 1 machines below are in production.

D.1.2 Type 1

Reference “Wascator FOM 71CLS” is equipped with a weight sensing water inlet control system for very small tolerances on the water inlet. See Table D.1 for specifications.

D.1.3 Type 2

Reference “FOM 71MP-Lab with flow meter“ is equipped with a flow meter for volumetric measurement of water giving small tolerances. Part number Flowmeter is 472 990298, to be supplied by the manufacturer of the reference machine. See Table D.2 for specifications.

D.1.4 Further information

Procedures and programming information for the **reference machine** can be found in Annex E.

D.1.5 Reference machine type 1: Method of use

D.1.5.1 Installation of the reference machine

For type 1 model ensure that there is an air gap between the drain hose and the laboratory drainage system.

- Ensure that the machine is properly connected to the laboratory’s mains system (supply voltage) according to the manufacturer’s instruction.
- Calibrate the level control and perform a zero calibration of the weight scale according to instructions in the manufacturer’s installation manual.
- Ensure that the laboratory water supply system can deliver (15 ± 2) l of water per min into the reference machine.

D.1.5.2 Regular maintenance

Once a year, calibrate the machine according to certified procedures or the manufacturer’s calibration instructions. Once a year midway between two calibrations make a maintenance check according to maintenance and programming manual for reference machines.

NOTE Maintenance and programming manual for reference machines can be obtained from the manufacturer or via the manufacturer’s web site (see Annex U).

Table D.1 – Description of the reference washing machine and method of use type 1

Type 1	**Front loading horizontal rotating machine**		**Wascator FOM 71 CLS**
Inner drum	Diameter		(520 ± 1) mm
	Depth		(315 ± 1) mm
	Volume		61 l
	Lifting vanes	Number	3
		Height	(50 ± 1) mm
		Length	Extended the depth of the inner drum
		Spacing	120°
	Perforation	Diameter	5 mm
	Material		18/8 stainless steel
Outer drum	Diameter		(554 ± 1) mm
	Material		18/8 stainless steel
Timer			Programmable
Drum speed	Wash speed	Range	Programmable (20-59) r/min, step size 1 r/min
		Tolerance at test load 5 kg , 26 l of water	± 1 r/min
	Water extraction (spin)	Range	Programmable 200 – 1100 r/min
		Tolerance	± 20 r/min
Heating system	Heating power		5,4 kW ± 2 %
	Thermostat	Range	(4 – 97) ºC
		Accuracy at switch off temperature	± 1 ºC
		Switch on temperature	≤4 ºC below switch-off temperature
Reversing rhythm	Normal/Gentle ON Normal/Gentle OFF	Programmable	(0 – 250) s (0 – 250) s
		Step size	1 s
Water system	Cold water supply	At water pressure 240 kPa	(20 ± 2) l/min
	Level sensing	Step size	≤3 mm
		Repeatability	± 5 mm (± 1 l)
	Weight sensing		Standard (weight)
		Step size	0,1 kg
		Dosing accuracy	± 0,2 kg
		Weighting accuracy	± 0,1 kg
	Drain system	Drain valve	> 30 l/min

D.1.5.3 Before test series

- Perform a test run on reference programme Cotton 60 ºC or Cotton 40 ºC without test load.
- Compare the test results obtained with values given in Maintenance and programming manual for reference machines.
- If the measured values for temperature, fill volume and total water quantity are outside the prescribed range in Table E.2 perform a new calibration or maintenance check.

NOTE Maintenance and programming manual for reference machines can be obtained from the manufacturer or via the manufacturer's web site (see Annex U).

- Perform a weight check in accordance with the maintenance and programming manual for **reference machines** and if it is out of machine specification recalibrate the scale.

D.1.5.4 During a test series

For the type 1 models, be sure not to lean or place or change any items on the machine during the weighing sequence (filling sequence).

After each test run verify that the **reference machine** complies with all requirements specified in Table E.2.

D.1.6 Reference machine type 2: Method of use

D.1.6.1 Installation of the reference machine

- Ensure that the machine is properly connected to the laboratory's mains system (supply voltage) according to the manufacturer's instruction.
- Perform a calibration of the level control according to instructions in the manufacturer's installation manual.
- Calibrate the flow meter against the water pressure according to the flow meter installation manual.
- Ensure that the laboratory supply system can deliver (15 ± 2) l/min of water into the **reference machine**.

D.1.6.2 Regular maintenance

Once a year, calibrate the machine according to certified procedures or the manufacturer's calibration instructions. Once a year midway between two calibrations make a maintenance check according to maintenance and programming manual for reference machines.

NOTE Maintenance and programming manual for reference machines can be obtained from the manufacturer or via the manufacturer's web site (see Annex U).

D.1.6.3 Before test series

- Perform a test run on reference programme Cotton 60 ºC or Cotton 40 ºC without test load.
- Compare the test results obtained with values given in maintenance and programming manual for reference machines.
- If the measured values for temperature, fill volume and total water quantity are outside the prescribed range in Table E.2, perform a new calibration or maintenance check.
- Make a volume check in accordance with the maintenance and programming manual for **reference machines** and if necessary recalibrate.

D.1.6.4 During a test series

If, during a cleaning performance **test run**, the **reference machine** does not meet the requirements set out in Table E.2, then this run and all parallel **test runs** shall be deemed to be invalid.

Table D.2 – Description of the reference washing machine and method of use type 2

Type 2	**Front loading horizontal rotating machine**		**FOM 71 MP-Lab with flowmeter**
Inner drum	Diameter		(515 ± 5) mm
	Depth		(335 ± 5) mm
	Volume		65 l
	Lifting vanes	Number	3
		Height	(50 ± 5) mm
		Length	Extended the depth of the inner drum
		Spacing	120°
	Perforation	Diameter	5 mm
	Material		18/8 stainless steel
Outer drum	Diameter		(575 ± 5) mm
	Material		18/8 Stainless steel/alumina
Timer			Programmable
Drum speed	Wash speed	Range	Fixed 52 r/min
		Tolerance at test load 5 kg , 26 l of water	± 1 r/min
	Water extraction (spin)	Nominal speed	500 r/min
		Tolerance	± 20 r/min
Heating system	Heating power		5,4 kW ± 2 %
	Thermostat	Range	(4 – 97) ºC
		Accuracy at switch off temperature	± 1 ºC
		Switch on temperature	≤4 ºC below switch-off temperature
Reversing rhythm	Normal/Gentle ON Normal/Gentle OFF	Programmable	(0 – 250) s (0 – 250) s
		Step size	1 s
Water system	Cold laboratory supply water	At water pressure 240 kPa	(16 ± 2) l/min
	Level sensing	Step size	≤3 mm
		Repeatability	± 5 mm (± 1 l)
	Drain system	Drain valve	> 30 l/min
Flowmeter (programmable)	Volume sensing (flow)	Flow range	(0-20) l/min
		Dosing accuracy	≤± 0,3 l
		Step size	1 l

NOTE The type 2 reference machine is no longer in production but may still be used.

D.1.6.5 Programming set volumes

Enter the set (target) water consumption volumes according to **programme** instructions in manufacturer's manual. The set values specified in Table D.3 shall be entered into control unit connected to the flow meter of the **reference machine** for each reference programme selected. The flow meter can only handle two volumes (A1 and A2) at the same time, so the values stored need to be checked wherever a different reference programme is selected.

Table D.3 – Programmed volume for type 2 reference machine

Programme	Set value A1 (litre)	Set value A2 (litre)
Cotton 85 ºC	26	18
Cotton 60 ºC	26	18
Cotton 40 ºC	26	18
Synthetics/blends 60 ºC	22	4
Synthetics/blends 40 ºC	22	--[a]
Wool 40 ºC	26	--[a]
Cotton 30 ºC	26	18
Cotton 20 ºC	26	18
[a] No set value for A2 needed.		

Annex E
(normative)

Reference machine programme definitions

E.1 General

This annex describes the various reference programmes for the **reference machine**. The programmes are described in Table E.1.

NOTE Maintenance and programming manual for reference machines can be obtained from the manufacturer or via the manufacturer's web site (see Annex U).

E.2 Programming instructions

For type 1 machines (refer to Annex D) ready made memory cards containing all IEC 60456 Edition 5 programs can be obtained from the manufacturer of the reference machine. These cards are locked and the content cannot be exchanged or altered.

For type 2 machines (refer to Annex D) full programming details are available in the maintenance and programming manual for reference machines.

NOTE Maintenance and programming manual for reference machines can be obtained from the manufacturer or via the manufacturer's web site (see Annex U).

E.3 Tolerances

Some process parameters related to the **reference machine** parameters have prescribed tolerance limits. These limits are shown in Table E.2.

E.4 Start up programme

In order to normalise the conditions within the **reference machine** prior to each **test run**, a special start up **programme** shall be run (refer to 6.2.2) if the **reference machine** has not been in use for more than 2 h (from the end of the last **programme** to the start of the next **test run**). All **reference machines** have a factory installed start up programme. The start up **programme** takes about 8 min to complete and is always run without load and without detergent.

The start up **programme** consists of

1: 1st cold rinse at a water level of 130 mm for 2 min

2: drain

3: 2nd cold rinse at a water level of 200 mm for 2 min

4: drain

5: extraction 500 r/min for 30 s.

Table E.1 – Specification of reference washing programmes

Procedure	Agitation during heating washing and rinsing[e]	Nominal **Test load mass** kg	Maximum temperature ° C	Washing			Rinse 1		Rinse 2		Rinse 3		Rinse 4		Spin
				Water quantity l	Wash time[j] min	Cool down	Water quantity l	Rinse time min	Water quantity l	Rinse time min	Water quantity l	Rinse time min	Water quantity l	Rinse time min	Spin time min
Cotton 85ºC	Normal [d]	5	85 [a]	26[b]	9[i]	No	18 [c]	3	18 [c]	3	18 [c]	2	18 [c]	2	5
Cotton 60ºC	Normal [d]	5	60 [a]	26 [b]	9[i]	No	18 [c]	3	18 [c]	3	18 [c]	2	18 [c]	2	5
Cotton 40ºC	Normal [d]	5	40	26 [b]	12[i]	No	18 [c]	3	18 [c]	3	18 [c]	2	18 [c]	2	5
Synthetics/blends 60 ºC	Normal [d]	2	60[a]	22 [b]	9[i]	Yes[f]	22 [c]	3	22 [c]	3	22 [c]	2	-	-	2
Synthetics/blends 40 ºC	Normal [d]	2	40	22 [b]	12[i]	No	22 [c]	3	22 [c]	3	22 [c]	2	-	-	2
Wool 40 ºC	Gentle [g]	1	40	26 [c]	3,5[i]	No	26[c]	3	26[c]	3[h]	26[c]	2	-	-	6
Cotton 30 ºC	Normal [d]	5	30	26 [b]	18	No	18 [c]	3	18 [c]	3	18 [c]	2	-	-	5
Cotton 20 ºC	Normal [d]	5	20	26 [b]	8	No	18 [c]	3	18 [c]	3	18 [c]	2	-	-	5

[a] Heat to 40 ºC, agitate for 15 min before heating to wash temperature.

[b] Corresponding to approximately 100 mm water level.

[c] Corresponding to approximately 130 mm water level.

[d] Drainage normal action 1 min after washing and all rinses.

[e] All fillings are static.

[f] Cool down 2 min, normal action, water quantity 4 l.

[g] Gentle heat to 20 ºC static heat to 35 ºC, gentle agitation 30 s and static heat to 40 ºC. Drainage gentle action 1 min after washing and all rinses.

[h] 1 min spin time after second rinse.

[i] For Type 2 machines the wash time for all cotton and synthetics/blends programmes is 15 min and for wool 40 ºC is 3 min.

[j] **Reference machine** wash time is defined as time of the main wash after the main wash fill has reached its set temperature (heating element first turns off) until the completion of drum mechanical action during the main wash **operation**. Note that this is different to **main washing duration** (refer to 3.1.26).

[k] For Type 1 machines the flushing of the detergent is made after a pre-fill of 6 l of water into the drum was made.

[l] Supply water temperature for the cotton 20 °C programme is different than for the other programmes (refer to 5.2.2.3).

Table E.2 – Tolerances given for some procedure parameters

Procedure	**Temperature tolerance at set temperature** ° C	**Water quantity tolerance per fill for each operation** l/fill	**Total water quantity and tolerance** l	**Total consumed energy with tolerance** kWh	**Remaining moisture content with tolerance** %
Cotton 85 °C	± 1	± 0,5	98 ± 2,5	-	85 ± 4
Cotton 60 °C	± 1	± 0,5	98 ± 2,5	1,8 ± 0,15	85 ± 4
Cotton 40 °C	± 1	± 0,5	98 ± 2,5	0,9 ± 0,15	85 ± 4
Synthetics/blends 60 °C	± 1	± 0,5	94 ± 2,5	-	-
Synthetics/blends 40 °C	± 1	± 0,5	88 ± 2	-	-
Wool 40 °C	± 1	± 0,5	104 ± 2	-	-
Cotton 30 °C	± 1	± 0,5	80 ± 2	-	-
Cotton 20 °C	± 1	± 0,5	80 ± 2	-	-

NOTE 1 The tolerances given in the table for temperature and water are valid both for full and empty reference machines. The tolerances for energy and **remaining moisture content** refer to loaded machine.

Specified supply flow rate for the reference machines is (15 ± 2) l/min. For type 1 machines this flow rate corresponds to a filling time for first fill of 127 s ± 14 s and for type 2 machines to a filling time of 109 s ± 14 s.

NOTE 2 The first filling time is defined as time from start of operation (press of start button) until end of filling.

NOTE 3 The difference in filling time between type 1 and type 2 machines depends on filling logics and pre-fill of water before flushing the detergent.

Annex F
(informative)

Reference programmes and examples of comparable washing machine programmes

This annex provides guidance to test laboratories on the selection of reference programmes on the **reference machine** which is then run in parallel with the **test washing machine** when performing an assessment of performance in accordance with Clause 8. The intent is to select a programme for a similar purpose (load type and wash intensity) in the **reference machine** and the **test washing machine** so that the **reference machine** provides a good base performance reference for comparison with the **test washing machine**. Refer to Annex E for a description of the reference **programmes**.

NOTE For some regions and countries, the **reference machine** programme is specified when assessing **test washing machine** performance.

Table F.1 – Reference programmes and examples of comparable washing machine programmes

Reference programme	**Programme characteristics**	**Examples of comparable household washing machine programmes**
Cotton 85 ºC	Maximum temperature 85 °C Main wash and 4 rinses Normal agitation Spin time 5 min	High temperature White washes or Cotton programmes in heated washing machines (European style)
Cotton 60 ºC	Maximum temperature 60 °C Main wash and 4 rinses Normal agitation Spin time 5 min	Colourfast washes or Cotton programmes in heated washing machines (European style)
Cotton 40 ºC	Maximum temperature 40 °C Main wash and 4 rinses Normal agitation Spin time 5 min	Cotton programmes or programmes for blends and dark coloured items in heated washing machines (European style)
Synthetics/blends 60 ºC	Maximum temperature 60 °C Main wash and 3 rinses Normal agitation Cool down Spin time 2 min	Synthetic/blend programmes or programmes for easy care items in heated washing machines (European style)
Synthetics/blends 40 ºC	Maximum temperature 40 °C Main wash and 3 rinses Normal agitation Spin time 2 min	Synthetic/blend programmes or programmes for dark coloured easy care items in heated washing machines (European style)
Wool 40 ºC	Maximum temperature 40 °C Main wash and 3 rinses Gentle agitation Spin time 6 min	Wool programmes or programmes for delicate items
Cotton 30 ºC	Maximum temperature 30 °C Main wash and 3 rinses Normal agitation Spin time 5 min	Warm and cold water programmes in non-heated machines
Cotton 20 ºC	Maximum temperature 20 °C Main wash and 3 rinses Normal agitation Spin time 5 min	Cold water programmes in non-heated machines

Annex G
(normative)

The bone-dry method of conditioning

G.1 General

This annex sets out the specification for the tumble dryer and the method when the bone dry method of conditioning is used under 6.4.5.3.

When using the bone dry method, there are specified limits regarding the maximum load that can be conditioned in a dryer. When the bone dry method is the usual method used, a large capacity dryer with manual or timer control is generally recommended. Dryers with electronic controls or that have auto-sensing capability may cut the power input before load has reached a fully bone dry state and can be difficult to control, so are not recommended for this purpose.

G.2 Tumble dryer specifications

The tumble dryer used to determine the bone-dry mass shall comply with the following requirements:

The nominal bone-dry mass of the items being dried as a single load shall be not more than 1 kg for each 20 l of measured rated drum volume and, when expressed in kg, shall be less than 3,3 times the heating element rating of the tumble dryer (expressed in kW).

NOTE The above describes the limit case. If faster drying times are desired, the use of larger element to mass ratios, or reversing tumble dryers, or both, are recommended.

A power-meter shall be used to ensure that in the last 10 min of the bone-dry-programme the heater is turned on without any cut offs.

An electric tumble dryer used shall be equipped with a temperature sensor able to read the temperature of the inlet air. The average temperature reading during the last step is recorded as T_{inletair}. The temperature of the inlet air is determined by measurement of the inlet air temperature at the plane directly where the air enters the drum. The measurement shall be made by attachable surface temperature sensors attached at the drum as near as possible to the entrance of the hot air. Electric dryers used to bring a load to the bone dry condition shall have an average temperature of the inlet air during the final 20 min of operation of not less than 75 °C.

Gas dryers are permitted, but special rules regarding their calibration are set out in G.3.

G.3 Bone dry procedure – Electric dryers

If necessary, the **base load** shall be divided into not more than two portions and the procedure below applied separately to each portion.

NOTE If possible, the **base load** should be brought to the bone-dry condition as one portion and not divided.

The procedure is as follows.

a) Place the dry items in the tumble dryer and operate on the hottest temperature/ **programme** for 30 min.

b) Every 10 min the items shall be manually reshuffled and checked to ensure that no item has rolled up or rolled inside another, thus trapping moisture. This process, including opening and closing the door, shall be completed in 30 s maximum.

c) After 30 min, stop the tumble dryer and determine the mass of the items before it cools down. If the items have to be removed from the tumble dryer to determine the mass, this is to be done as quickly as possible.

d) Repeat steps b) and c) above, except operate the tumble dryer for 20 min only.

e) If the mass of the base load is within 1 % or 20 g whichever is the smaller of the previous measurement, record this value as bone-dry mass M_{bd} and the average temperature of the inlet air, $T_{inletair}$, over this period.

f) If not, repeat steps d) and c) until it is within 1 % or 20 g whichever is the smaller.

g) In the case of a cotton load, determine the bone dry factor for the dryer run from Equation G.1, which is based on the average temperature of the inlet air for the final 20 min where e) above is valid:

$$Bone\ dry\ factor = 1{,}08 - 1{,}35 \times 10^{-6} \times \left(\frac{1}{T_{inletair}}\right) + 1{,}35 \times 10^{-6} \times \left(\frac{1}{T_{inletair}}\right)^2 \quad \text{(Equation G.1)}$$

h) The conditioned mass of the **base load** shall be as follows:

- for a cotton base load, the conditioned mass is taken as the *bone_dry_factor* in Equation G.1 times the bone-dry mass M_{bd} determined in e) above. Only dryers which yield a calculated bone dry factor from Equation G.1 in the range 1,06 to 1,08 are valid;
- for a synthetics/blends base load, the conditioned mass is taken as 1,025 times the bone-dry mass.

i) After drying the **base load** items to determine the bone dry mass the dryer shall be unloaded and the **base load** items shall be spread out and left to cool at the ambient temperature prior to use in performance tests for a period of not less than 30 min.

G.4 Bone dry procedure – Gas dryers

Gas dryers may also be used to bring a base load to the bone dry condition. The procedure is as set out in a) to f) for electric dryers in G.3.

However, as the gas combustion products normally pass through the load and the composition of gas may vary, to qualify a gas dryer for use with the bone dry method it is necessary to undertake one of the following calibrations in order to determine the bone dry factor for a gas dryer:

- determination of a bone dry factor (or function) across a range of typically used load sizes and load types when compared to an electric dryer; or
- determination of a bone dry factor (or function) across a range of typically used load sizes and load types when compared against a conditioned base load prepared in accordance with 6.4.5.

The bone dry factors determined above shall be re-confirmed if the quality of the gas supply changes. Only gas dryers which yield a calibrated bone dry factor for a cotton load (as set out above) in the range 1,06 to 1,08 are valid.

The provisions of h) and i) for electric dryers in G.3 also apply to gas dryers.

Annex H
(normative)

Folding and loading the test load

H.1 General

This annex sets out the method for folding of the test load and loading it into the **test washing machine** and the **reference machine**. Experience has shown that the way that a **washing machine** is loaded can influence the results obtained, especially with respect to washing performance. To achieve reproducible results it is therefore necessary to specify both the loading sequence and the position and placement of all load items in the **test washing machine** and the **reference machine** for all performance tests.

H.2 Folding the items prior to loading the washing machine

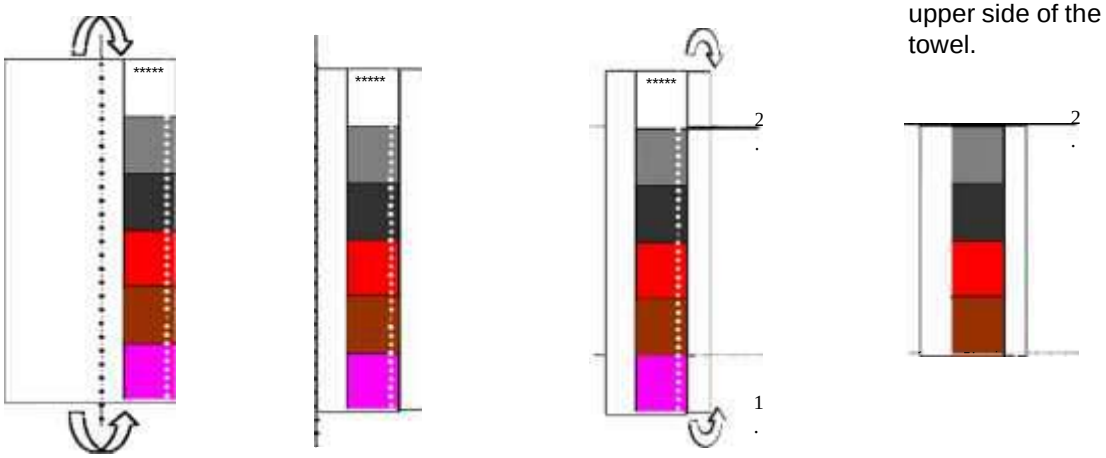
H.2.1 General

This section sets out the folding of load items before they are placed into the **washing machine** as specified in H.3.

H.2.2 Cotton load

H.2.2.1 Towel with a stain test strip attached

Towels with a stain test strip attached shall be folded in accordance with Figure H.1.



IEC 222/10

Figure H.1 – Folding towel with a stain test strip attached

H.2.2.2 Towel without a stain test strip

Towels without a stain test strip attached shall be folded in accordance with Figure H.2.

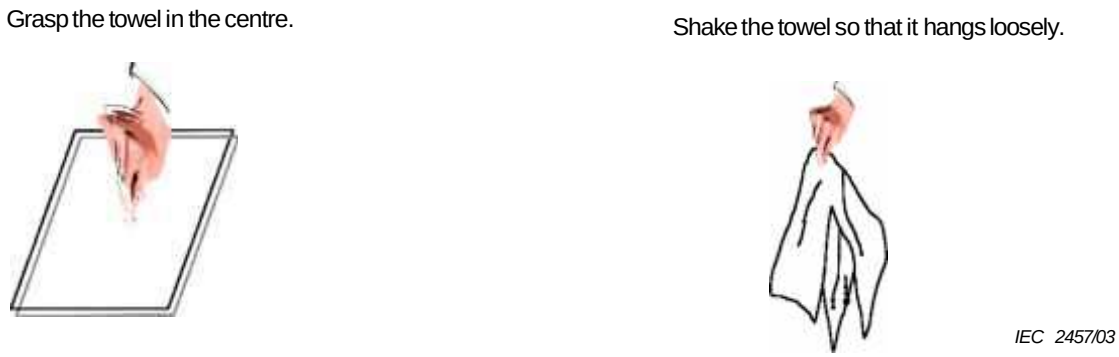


Figure H.2 – Folding towel without a stain test strip attached

H.2.2.3 Pillowcase

Pillowcases shall be folded in accordance with Figure H.3.

Figure H.3 – Folding pillowcases

H.2.2.4 Bed sheets

Bed sheets shall be folded into thirds to form letter “Z” in accordance with Figure H.4.

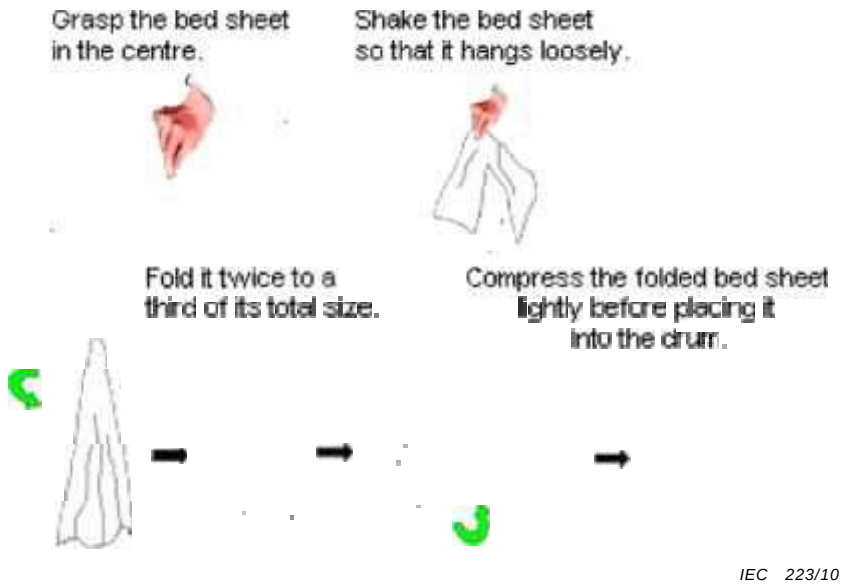


Figure H.4 – Folding bed sheets

H.2.3 Synthetics/blends load

H.2.3.1 Pillowcase with a stain test strip attached

Pillowcases with a stain test strip attached shall be folded in accordance with Figure H.5.

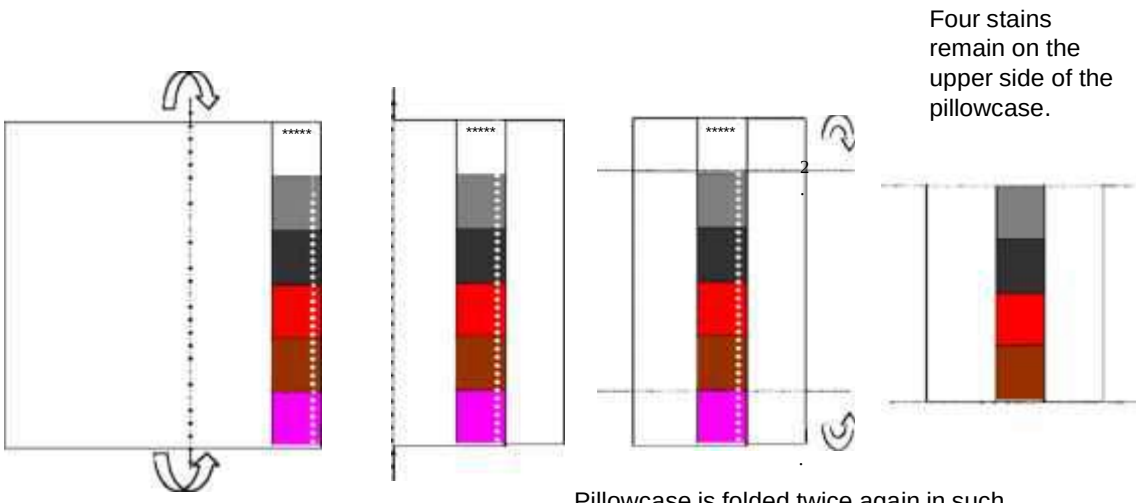


Figure H.5 – Folding pillowcases with a stain test strip attached

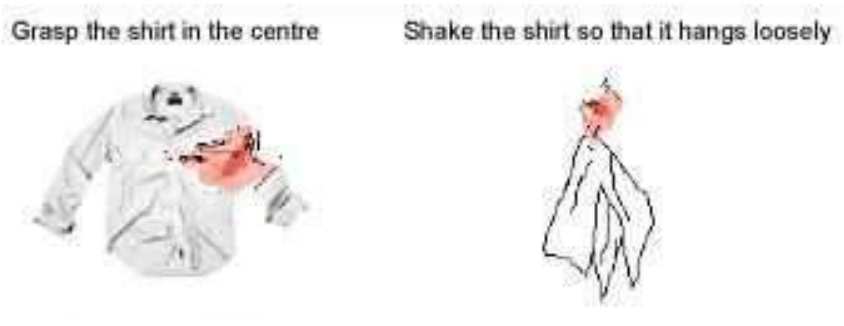
H.2.3.2 Pillowcase without a stain test strip attached

Pillowcases without a stain test strip attached shall be folded in accordance with Figure H.6.

Figure H.6 – Folding pillowcases without a stain test strip attached

H.2.3.3 Shirts

Shirts shall be folded in accordance with Figure H.7.



IEC 225/10

Figure H.7 – Folding shirts

H.2.4 Polyester load for the wool programme

There is no need to fold the load items used for the wool programme.

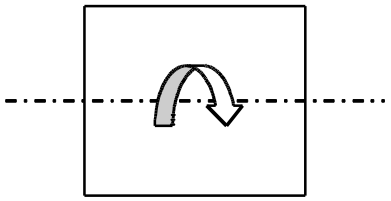
H.3 Loading items into the washing machine – general rules

H.3.1 Machine type

For the purposes of loading, all **washing machines** shall be classified as either **horizontal axis washing machine** or **vertical axis washing machines** as specified below.

H.3.1.1 Horizontal axis washing machines

In a **horizontal axis washing machine** the load is placed in a drum which rotates around an axis which is usually horizontal or close to horizontal (see definition). This is illustrated in Figure H.8. In most cases, the drum rotates around this axis for washing and spinning **operations**.



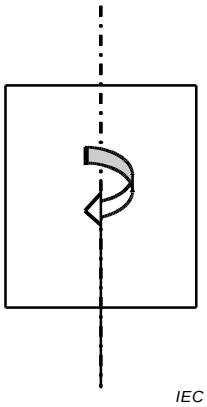
IEC 226/10

Figure H.8 – Illustration of horizontal axis washing machine

H.3.1.2 Vertical axis washing machines

In a **vertical axis washing machine** the load is placed in a drum which rotates around an axis which is usually vertical or close to vertical (see definition). This is illustrated in Figure H.9. In cases where the drum does not rotate for any **operation** (i.e. no spinning function available and no rotation during washing) then the **washing machine** is classified as a **vertical axis washing machine**.

Components, protrusions or mechanical devices of different style (e.g. agitator, impeller) inside the drum in a **vertical axis washing machine** may cause slight variations in the loading scheme described. These variations are covered in the loading sequence for **vertical axis washing machines.**



IEC 227/10

Figure H.9 – Illustration of vertical axis washing machine

H.3.2 Loading sequences

H.3.2.1 General rules

Washing machines are always loaded item by item in layers from bottom to top. Excessive force should not be used. All items shall be placed into the drum in the orientation described below.

H.3.2.2 Items with attached strip

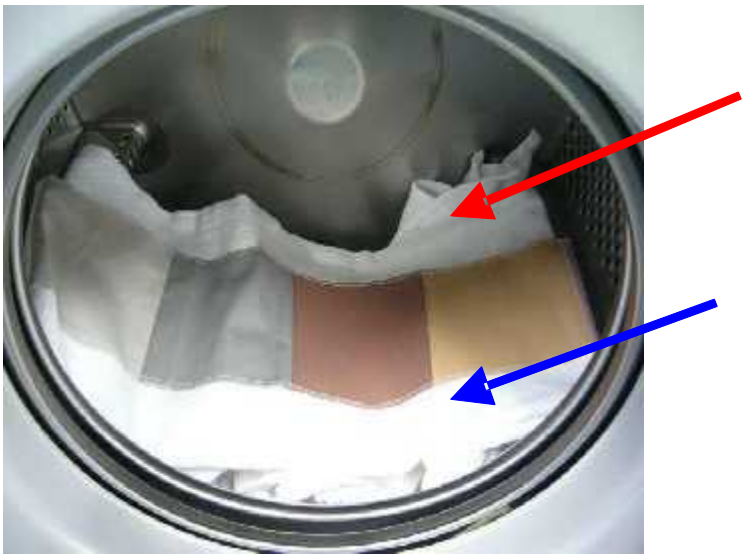
H.3.2.2.1 General

Load items which have stain test strips attached (e.g. towel for cotton load, pillowcase for synthetics/blends load) are always laid flat in the **washing machine** with the 5 soils of the stain test strip facing upwards. Load items with stain test strips attached should not be placed one top of each other.

H.3.2.2.2 Loading for horizontal axis washing machines

Horizontal axis washing machine shall be loaded as described in this section.

The folded towel/pillowcase with the stain test strip is placed in the drum with the sebum/carbon black/blood/cocoa stains facing upwards and the folded side of the towel/pillowcase facing to the front of the **washing machine** drum as illustrated in Figure H.10.



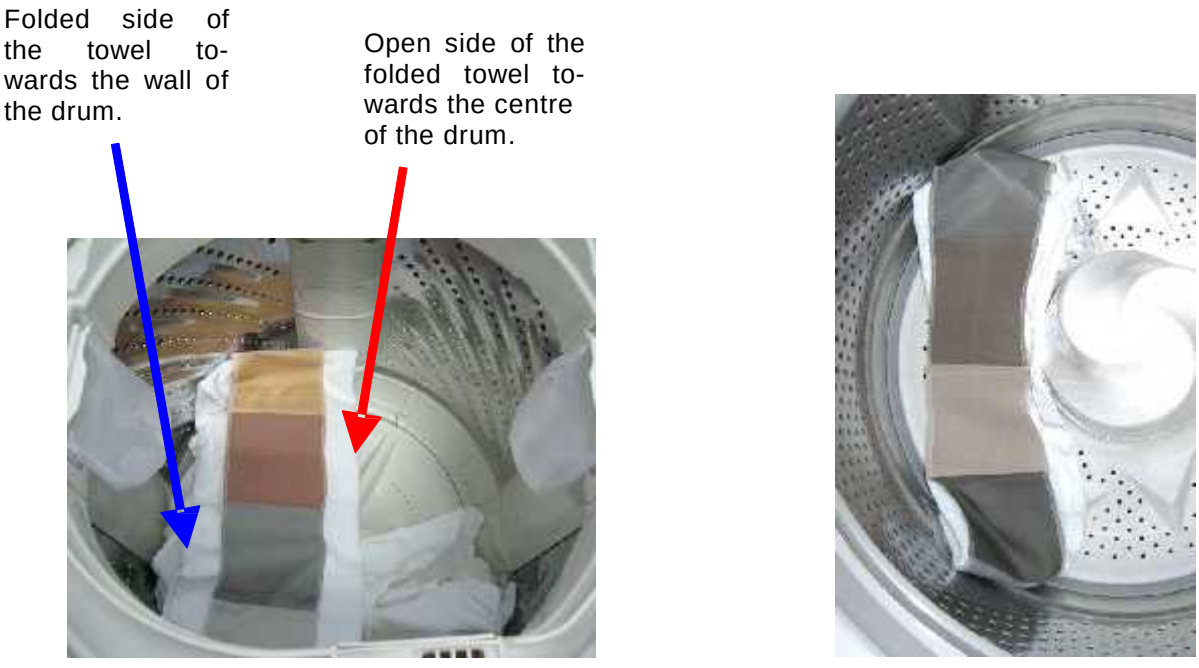
IEC 228/10

Figure H.10 – Horizontal axis washing machine: placement of items in the drum

H.3.2.2.3 Loading for vertical axis washing machines

Vertical axis washing machine shall be loaded as described in this section.

The folded towel/pillowcase is placed in the drum with the sebum/carbon black/blood/cocoa stains facing upwards and the folded side of the towel/pillowcase facing the drum wall as illustrated in Figure H.11.



IEC 229/10

Figure H.11 – Vertical axis washing machine: placement of items in the drum

H.3.2.3 Cotton test load

Follow the loading sequence step by step as given in Clause H.4 for a **horizontal axis washing machines** and in Clause H.5 for a **vertical axis washing machines**. The load items defined for each step are evenly distributed in a single level of the drum for **horizontal axis washing machine** (looking in from the front) or one quarter of the drum for a **vertical axis washing machine** (looking down in plan view).

H.3.2.4 Synthetics/blends test load

The **test load** shall be evenly spread in the **washing machine**.

Shirts and pillowcases are loaded alternately for a **horizontal axis washing machine** from the bottom to the top, and for a **vertical axis washing machine**, clockwise with one item per quarter. Each subsequent layer shall be indexed by 1 quadrant. An example is given in Table H.1.

Pillowcases which have stain test strips attached are evenly distributed, e.g. every second pillowcase is one with stain test strip attached.

Table H.1 – Vertical axis washing machines, loading sequence example for a synthetics/blends load

Quadrant	Front	Left	Back	Right
Layer 8	shirt	pillowcase with strip	no item	shirt
Layer 7	pillowcase with strip	no item	shirt	pillowcase
Layer 6	no item	shirt	pillowcase	shirt
Layer 5	pillowcase	shirt	pillowcase with strip	no item
Layer 4	shirt	pillowcase with strip	no item	shirt
Layer 3	pillowcase with strip	no item	shirt	pillowcase
Layer 2	no item	shirt	pillowcase	shirt
Layer 1	shirt	pillowcase	shirt	pillowcase with strip

H.3.2.5 Polyester test load

The **test load** shall be evenly spread in the **washing machine**.

H.4 Special loading requirements for cotton loads – horizontal axis washing machines

H.4.1 General loading directions

A **horizontal axis washing machine** is loaded in steps from bottom to top. The sequence step by step is given in Table H.2.

Each step consists of either

- one sheet,
- one towel with attached strip,
- one or several towels without strip,
- one or several pillowcases.

If there are several items they shall be placed with alternating orientation as illustrated in Figure H.12.

Figure H.12 – Horizontal axis washing machine: illustration of alternating orientation

Towels are placed into the drum from back to front parallel to the drum axis. If two or more towels are called for at the same time, they are to be laid alternately in opposite directions on the same level, side by side.

Pillowcases are placed side to side across the drum axis. If two pillowcases are required, they are laid in opposite directions on the same level.

Sheets are placed as a lying “Z” perpendicular to the **washing machine** axis with the point to the left.

For an example and pictures for one sequence (5 kg), see H.4.4.

H.4.2 Horizontal axis washing machine: loading step by step

The sequence shall be from the bottom to top of the drum as set out in Table H.2. Step 1 starts at the bottom of the drum, step 27 is at the top of the drum. An example is set out in H.4.4.

NOTE For the example in Subclause H.4.4, the Table has been transposed relative to Table H.2.

Table H.2 – Horizontal axis washing machines, loading sequence

step	horizontal axis	10,00	9,50	9,00	8,50	8,00	7,50	7,00	6,50	6,00	5,50	5,00	4,50	4,00	3,50	3,00	2,50	2,00	1,50	1,00
1	pillowcase	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
2	towels adjust number here	4	4	4	4	4	4	4	4	4	3	3	2	3	2	1	2	2	2	1
3	towel + strip	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	pillowcase	2	2	2	2	2	2	2	1	1	1									
5	towel + strip	1	1	1	1	1	1	1	1	1	1									
6	sheet	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
7	towel + strip	1	1	1	1	1	1								1					
8	pillowcase	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
9	towel + strip							1	1	1	1	1	1	1						
10	towels adjust number here	3	3	2	3	3	2	3	3	3	2	2	2	2	1		1	1		
11	towel + strip	1	1	1	1	1	1													
12	sheet	1	1	1	1	1	1													
13	towel + strip	1	1																	
14	pillowcase	2	1	1	1	1	1	1	1	1	1	1	1				1			
15	towel + strip			1	1			1	1			1	1			1	1			
16	towels adjust number here	4	4	2	2	3	1	2	2	3	2	3	1				2	1	1	
17	pillowcase	2	1	1	1	1	1	1	1	1	1	1	1							
18	towel + strip	1	1																	
19	sheet	1	1	1																
20	towel + strip	1	1	1	1	1	1													
21	towels adjust number here	3	3	2	3	3	2	3	3	3	2	2	2	2			1	1		
22	towel + strip							1	1	1	1	1	1	1						
23	pillowcase	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1		
24	towel + strip	1	1	1	1	1	1								1					
25	sheet	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
26	towel + strip	1	1	1	1	1	1	1	1	1	1									
27	pillowcase	2	2	2	2	2	2	2	1	1	1									
28	towel + strip	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
29	towels adjust number here	4	4	4	4	4	4	4	4	4	3	3	2	3	2	1	2	2	2	1
30	pillowcase	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1

H.4.3 Loading for load sizes above 10 kg

Additional items for **test loads** heavier than 10 kg are added to the following steps:

- **Sheets** need to be added between two steps:
  - Sheet no. 5 between step 14 / 15
  - Sheet no. 6 between step 16 / 17
  - Sheet no. 7 between step 8 / 9
  - Sheet no. 8 between step 22 / 23
- **Pillowcases** are added to all steps one by one as needed in the order from the outer to the inner layers: step 1 – 30 – 4 – 27 – 8 – 23 – 14 – 17.
- **Towels** are added to the steps marked for adjustment one by one as needed in the order from inner to outer layers: step 16 – 10 – 21 – 2 – 29.
- **Towels with strips** attached needs to be distributed evenly. For **horizontal axis washing machines** holding more than 10 kg it is expected that the drum is deep enough to have two towels with attached strip placed in one step next to each other as shown below in Figure H13.
- **Towels with strips** are added to all steps one by one as needed in the order from the inner to the outer layers: step 13 – 18 – 11 – 20 – 9 – 22 – 7 – 24 – 5 – 26 – 3 – 28.
- **Towels with strips** are only placed in step 15 when there is an odd number of towels with test strips.

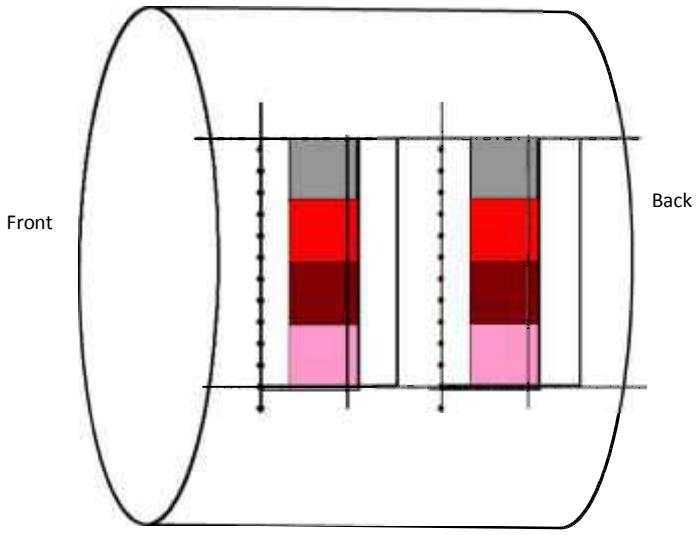


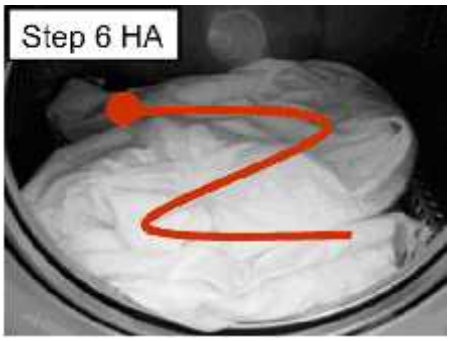
Figure H.13 – Placement of 2 towels with strips in one layer for load sizes larger than 10 kg

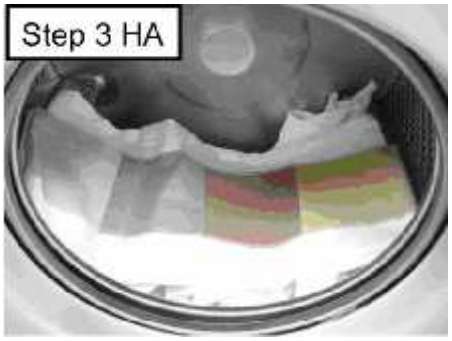
H.4.4 Example

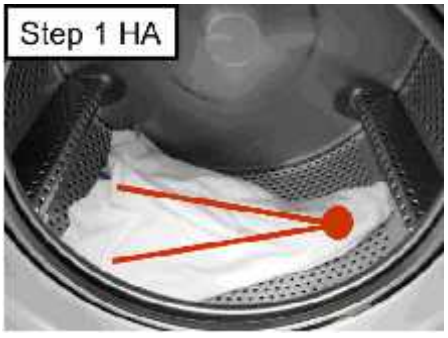
Table H.3 illustrates how to place a 5 kg load into a **horizontal axis washing machine** from bottom to the top.

Table H.3 – Horizontal axis washing machine, loading example (5 kg)

Horizontal axis washing machine - loading example (5 kg)		
item	**picture**	**number of items**
Pillowcases		1
Towels		3*
Towels + strip		1
Sheets		1
Pillowcases		1
Towels + strip		1
Towels		2*
Pillowcases		1
Towels		3*
Towels + strip		1
Pillowcases		1
Towels		2*
Towels + strip		1
Pillowcases		1
Sheets		1
Towels + strip		1
Towels		3*
Pillowcases		1
	* adjust number of towels here	







H.5 Special loading requirements for cotton loads – Vertical axis washing machines

H.5.1 General loading directions

Vertical axis washing machines are loaded in groups from bottom to top. The sequence step by step is given in Tables H.4 to H.7.

The wash load is divided into five groups and placed as set out in Tables H.4, H.5, H.6 and H.7 (as applicable). The purpose of groups 1 to 4 is to ensure that the total load is in balance in a **vertical axis washing machine**. Thus as far as possible every item in each group has an equivalent item in the opposite quadrant of the drum in another group, although not at the same level in the drum. There are some exceptions to this principle due to the need to remain within the specified load weights.

Group 5 is composed of additional items to make up to the required weight and to allow for adjustment thereof.

The items are placed evenly around the axis using the 4 quadrants as shown in Figure H.14. The first item of group 1 is placed in the front quadrant with other items placed in a clockwise order around the drum according to the order given in the tables. The first item of group 2 is placed in the left quadrant with remaining items placed in succession. The first item of group 3 is placed in the back quadrant and so on.

Each towel with an attached soil/stain test strip is always placed on the top of the item loaded in the preceding step.

In principle, the soil/stain test strips are distributed evenly across the depth of the load (between layers) and distributed evenly within each group (around the circumference in the system).

The loading scheme depends on the number of sheets as follows.

- Four sheets: one goes into each quadrant
- Three sheets: first goes to the front, second to left-back area, third to back-right area
- Two sheets: one to the right quadrant, one to the left quadrant

In general there are four main groups, each starting in another quadrant.

The number of steps for each is no more than six but depends on load size. For smaller loads are fewer steps required.

For a **vertical axis washing machine** without a central agitator, items may be spread to utilise the volume in the centre of the bowl.

If there are several items they shall be placed with alternating orientation.

Towels are placed into the drum around the drum axis. If two or more towels are called for at the same time, they are to be laid in opposite directions alongside each other in the same quadrant.

Pillowcases are placed side to side across the drum axis. If two pillowcases are called for, they are to be laid in opposite directions alongside each other in the same quadrant.

Sheets are placed in the designated quadrant with point towards clockwise direction viewed from above.

For more details see the pictures and one sequence (5 kg) in Subclause H.5.4.

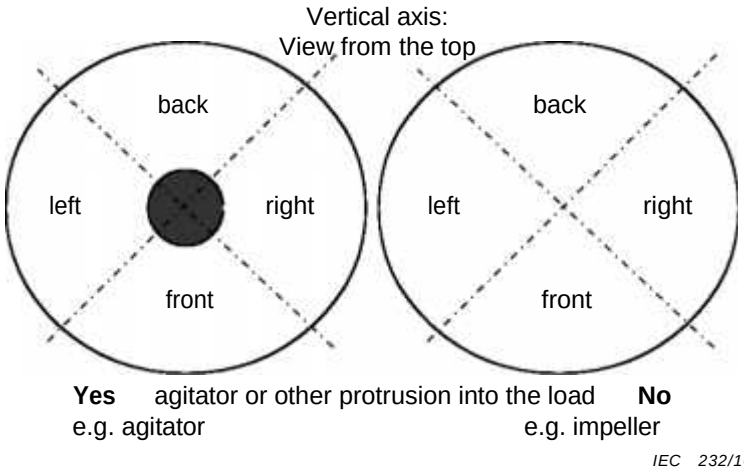


Figure H.14 – Vertical axis washing machines, four quadrants (plan view)

H.5.2 Vertical axis washing machine: loading step by step

The sequence shall be from bottom to top of the drum as set out in Table H.4. Group 1 is loaded first and other items go from the bottom of the drum; group 5 is the last group of items and these are placed on top.

Table H.4 – Vertical axis washing machines, small loads without sheets (1,0 kg to 2,5 kg)

step	group	vertical axis	2,5	2,0	1,5	1,0	
1	1	Pillowcases	1	1	1	1	front
2		Towels	1	1	1	1	left
3		Towel+strip	1	1	1	1	left
4		Pillowcases					back
5		Towel+strip					back
6		Sheets					
1	2	Pillowcases	1	1			left
2		Towels	1	1			back
3		Towel+strip					back
4		Pillowcases					right
5		Towel+strip					right
6		Sheets					
1	3	Pillowcases	1	1	1	1	back
2		Towels	1	1	1	1	right
3		Towel+strip	1	1	1	1	right
4		Pillowcases					front
5		Towel+strip					front
6		Sheets					
1	4	Pillowcases	1	1			right
2		Towels	1	1			front
3		Towel+strip					front
4		Pillowcases					left
5		Towel+strip					left
6		Sheets					
1	5 add on	Pillowcases	1		1		left
2		Towels	1				front
3		Towel+strip					front
4		Pillowcases					right
5		Towel+strip	1				back
6		Towels adjust number here	3	3	3		spread on top

Table H.5 – Vertical axis washing machines, medium loads with two sheets (3,0 kg to 7,0 kg)

step	group	vertical axis	7,0	6,5	6,0	5,5	5,0	4,5	4,0	3,5	3,0	
1	1	Pillowcases	2	2	1	1	1	1	1	1	1	front
2		Towels	2	2	2	2	2	2	2	1	1	left
3		Towel+strip	1	1	1	1	1	1	1	1	1	left
4		Pillowcases	1	1	1	1	1	1				back
5		Towel+strip	1	1	1	1	1	1				back
6		Sheets	1	1	1	1	1	1	1	1	1	right
1	2	Pillowcases	2	1	1	1	1	1	1	1	1	left
2		Towels	2	2	2	2	2	2	2	1		back
3		Towel+strip	1	1	1	1	1	1	1	1		back
4		Pillowcases	1	1	1	1						right
5		Towel+strip	1	1								right
6		Sheets										
1	3	Pillowcases	2	2	1	1	1	1	1	1	1	back
2		Towels	2	2	2	2	2	2	2	1		right
3		Towel+strip	1	1	1	1	1	1	1	1	1	right
4		Pillowcases	1	1	1	1	1	1				front
5		Towel+strip	1	1	1	1						front
6		Sheets	1	1	1	1	1	1	1	1	1	left
1	4	Pillowcases	2	1	1	1	1	1	1	1	1	right
2		Towels	2	2	2	2	2	2	2	1		front
3		Towel+strip	1	1	1	1	1	1	1	1		front
4		Pillowcases	1	1	1	1						left
5		Towel+strip										
6		Sheets										
1	5 add on	Pillowcases										left
2		Towels										front
3		Towel+strip										front
4		Pillowcases										right
5		Towel+strip									1	back
6		Towels adjust number here	8	8	9	4	5	1	2	1	1	spread on top

Table H.6 – Vertical axis washing machines, large loads with three sheets (7,5 kg to 8,5 kg)

step	group	vertical axis	8,5	8,0	7,5	
1	1	Pillowcases	2	2	2	front
2		Towels	2	2	2	left
3		Towel+strip	1	1	1	left
4		Pillowcases	1	1	1	back
5		Towel+strip	1	1	1	back
6		Sheets	1	1	1	right
1	2	Pillowcases	2	2	2	left
2		Towels	2	2	2	back
3		Towel+strip	1	1	1	back
4		Pillowcases	1	1	1	right
5		Towel+strip	1	1	1	right
6		Sheets	1	1	1	front-left
1	3	Pillowcases	2	2	2	back
2		Towels	2	2	2	right
3		Towel+strip	1	1	1	right
4		Pillowcases	1	1	1	front
5		Towel+strip	1	1	1	front
6		Sheets	1	1	1	left-back
1	4	Pillowcases	2	2	2	right
2		Towels	2	2	2	front
3		Towel+strip	1	1	1	front
4		Pillowcases	1	1	1	left
5		Towel+strip	1	1	1	left
6		Sheets				
1	5 add on	Pillowcases	1			left
2		Towels	2			front
3		Towel+strip	1			front
4		Pillowcases	1			right
5		Towel+strip				back
6		Towels adjust number here	6	9	5	spread on top

Table H.7 – Vertical axis washing machines, very large loads with four sheets (9,0 kg to 10,0 kg)

step	group	vertical axis	10,0	9,5	9,0	
1	1	Pillowcases	2	2	2	front
2		Towels	3	3	3	left
3		Towel+strip	1	1	1	left
4		Pillowcases	1	1	1	back
5		Towel+strip	1	1	1	back
6		Sheets	1	1	1	right
1	2	Pillowcases	2	2	2	left
2		Towels	3	3	3	back
3		Towel+strip	1	1	1	back
4		Pillowcases	1	1	1	right
5		Towel+strip	1	1	1	right
6		Sheets	1	1	1	front
1	3	Pillowcases	2	2	2	back
2		Towels	3	3	3	right
3		Towel+strip	1	1	1	right
4		Pillowcases	1	1	1	front
5		Towel+strip	1	1	1	front
6		Sheets	1	1	1	left
1	4	Pillowcases	2	2	2	right
2		Towels	3	3	3	front
3		Towel+strip	1	1	1	front
4		Pillowcases	1	1	1	left
5		Towel+strip	1	1	1	left
6		Sheets	1	1	1	back
1	5 add on	Pillowcases	2	1	1	left
2		Towels	3	3	1	front
3		Towel+strip	1	1	1	front
4		Pillowcases	2	1	1	right
5		Towel+strip	1	1		back
6		Towels adjust number here	3	3	1	spread on top

H.5.3 Vertical axis washing machine: load sizes above 10 kg

Additional items for loads heavier than 10 kg are added on top.

The sequence of the five groups is repeated.

H.5.4 Example

Table H.8 illustrates how to place a 5 kg load into a **vertical axis washing machine**.

Table H.8 – Vertical axis washing machine – loading example (5 kg)

step (example only)	group step (related to table H.4)	placement	quadrant	item	picture	no. of items
18	5.6	on top		Towels		5*
17	4.3	front		Towels – strip		1
16	4.2	front		Towels		2
15	4.1	right		Pillowcases		1
14	3.6	left		Sheets		1
13	3.4	front		Pillowcases		1
12	3.3	right		Towels – strip		1
11	3.2	right		Towels		2
10	3.1	back		Pillowcases		1
9	2.3	back		Towels – strip		1
8	2.2	back		Towels		2
7	2.1	left		Pillowcases		1
6	1.6	right		Sheets		1
5	1.5	back		Towels – strip		1
4	1.4	back		Pillowcases		1
3	1.3	left		Towels – strip		1
2	1.2	left		Towels		2
1	1.1	front		Pillowcases		1
* adjust number of towels here						

Annex I
(normative)

Calculation of weighted average age of the cotton base load

I.1 Determination of the weighted average age

The weighted average age of a cotton **base load** is calculated as follows:

$$\overline{A} = \frac{1}{\sum n_i \cdot w_i} \sum n_i \cdot w_i \cdot a_i$$

where

a_i is the age of item (after conditioning);

n_i is the number of items (of the same type and age);

w_i is the mass per piece given in Table C.1;

$\overline{A}$ is the weighted average age of the load expressed as the number of **test runs**.

I.2 Example of how to achieve the weighted average age requirements

I.2.1 Overview

Example for the exchange of load items for a 5 kg cotton load to achieve weighted average age of the load between 30 and 50 **test runs** is given in Figure I.1.

Different cell colours represent different item ages. Items that were washed in **test runs** more than 20 times are marked with one mark (‘I’), another mark is added for each 20 **test runs**.

At each change after 20 **test runs**, items are added which have been pre-treated for 5 normalization runs. The old items that have been washed for 80 **test runs** must be removed.

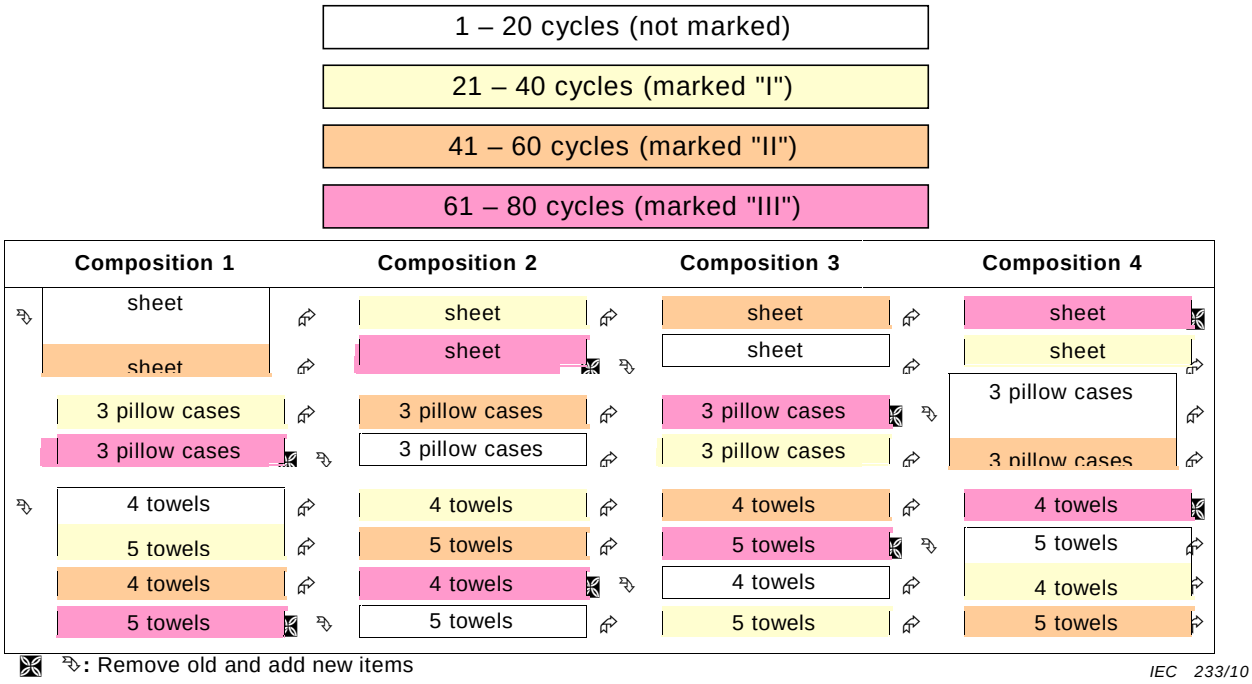


Figure I.1 – Example for the exchange of load items for a 5 kg cotton load

In this procedure the change of sheets and pillowcases is performed item by item and depending on the weight of the towels, conditioned balancing items are added to the base load.

I.2.2 How to build up loads according to this example

Put together 4 equal separate **base loads** all consisting of pre-washed items (refer to 6.4.2), numbers of items as given in Table 1 above. Wash one of the loads 60 times, mark all items with 3 marks (perform normalization cycle after each 5 cycles, again without counting it). Wash another load 40 times, mark all items with 2 marks. Wash another load 20 times, mark all items with 1 mark. Out of the items of the 4 loads it should now be possible to build up 4 mixed age loads following the age compositions as given in Figure I.1 above.

I.2.3 Load maintenance according to this example

Use a mixed age load for 20 **test run**s (not counting pre-treatment or normalization). After the 20 cycles remove all items with three marks (they have now been washed 80 times). Add one mark on all remaining items. Finally add one new (pre-washed) item for each piece you removed.

Annex J
(normative)

Loading a large standard extractor (rinsing performance)

J.1 General

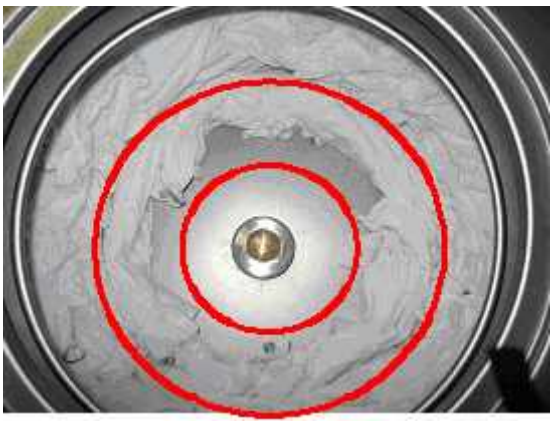
If a large standard extractor is used (other than the primary specification in 5.4.5), where more than one bundle could be spun at a time, the loading of the extractor shall follow the loading procedure given in this annex.

Wet load items shall be placed as close together as possible in an arrangement around the inner wall of the drum so as to reduce the chance of the spin extractor becoming unbalanced.

The following pictures (Figures J.1 and J.2) refer to one example of a large standard extractor which is capable of extracting water from base loads of up to 10 kg.

IEC 234/10

Figure J.1 – Example of a large standard extractor

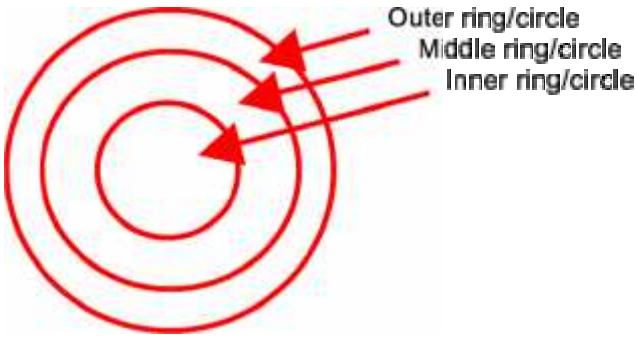


IEC 235/10

Figure J.2 – View from the top: loading the large standard extractor

J.2 Areas of loading

To achieve a well balanced arrangement, it is proposed to divide the loading area of the drum into 3 rings/circles (see Figure J.3).



IEC 236/10

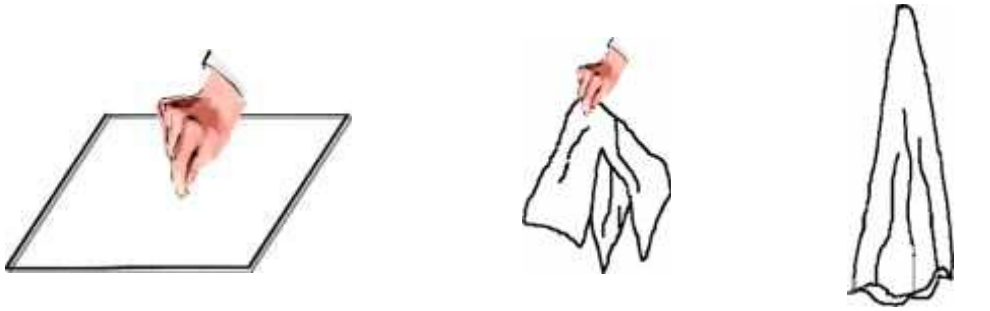
Figure J.3 – Areas for loading

J.3 Folding of items

All items except the sheet shall be folded in the same way as described in Annex H.

The wet sheet shall be folded as follows:

Grasp the bed sheet in the centre, shake the bed sheet so that it hangs loosely, and compress the bed sheet slightly before placing it circumferentially into the drum.



IEC 237/10

Figure J.4 – Folding of items

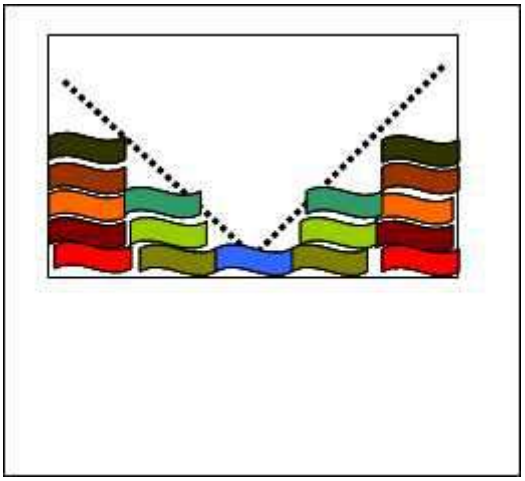
J.4 Distribution of items – general guidelines

Sheets are always placed next to the wall in the outer ring and distributed evenly along the circumference. In the case of a load containing an odd number of sheets, the load shall be balanced circumferentially by using three pillow cases for one sheet.

All sheets, pillow cases and up to 8 towels shall be placed in the outer ring.

All the remaining towels are loaded into middle and inner ring. Towels evenly distributed to balance the load and form a well fixed ring around the drum.

The load needs to be pressed to the wall of the drum forming a shape as shown in Figure J.5 to avoid relocating while spinning causing unbalance.

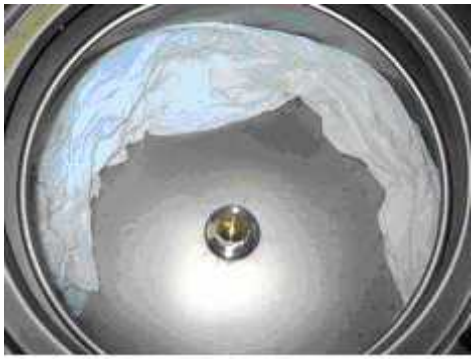


IEC 238/10

Figure J.5 – 3 areas of loading

J.1 Step by step: loading procedure

1) Start with loading all sheets, one per part of the drum, two per layer, next sheets on top of the first layer pressed to the wall (see Figure J.6 and Figure J.7).



IEC 239/10

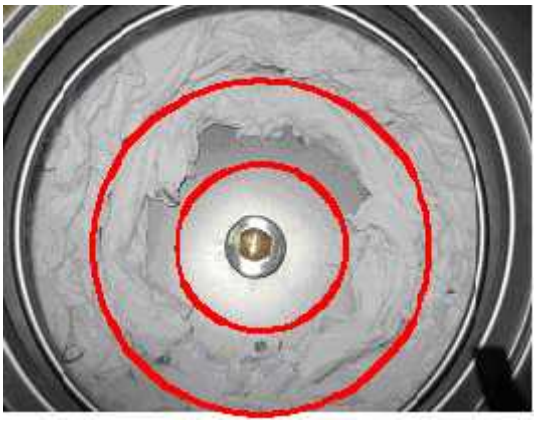
Figure J.6 – Outer circle, with sheets

IEC 240/10

Figure J.7 – Outer circle, with sheets and pillow cases on top

2) Add all pillow cases on top, around the drum, stabilizing the ring of the outer circle (see Figure J.6 and Figure J.7).
3) Finish the outer ring with placing up to 8 towels on top around the drum, again stabilizing the ring.
4) The middle ring consists of layers of 5 towels each, stabilizing the outer ring. Make sure to keep the middle ring lower than the outer ring (see Figure J.8).
5) The inner ring is only filled if items are left, for large loads (see Figure J.9).
6) If the load size is over 10 kg use the last two towels to cover the whole load (see Figure J.10).

NOTE Ensure that the load size in the extractor does not exceed the capacity/maximum load size as given by the manufacturer.

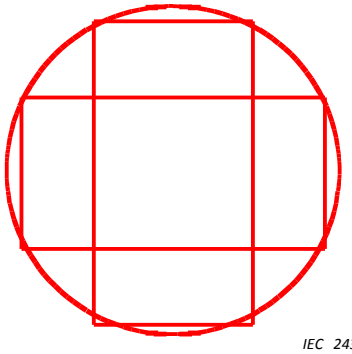


IEC 241/10

Figure J.8 – Middle circle

IEC 242/10

Figure J.9 – Inner circle



IEC 243/10

Figure J.10 – Towels covering the load

Annex K
(informative)

Laboratory internal testing guide

K.1 General

The testing of **washing machines** to this document is highly complex and there are a large number of variables and inputs that need to be carefully controlled in order to get reliable and accurate results. Laboratories have to be equipped with complex technical instruments and many laboratories have complex systems to set and maintain the required laboratory conditions. Laboratory staff are required to deal with many issues during a **test run** and **test series**, and have to organise themselves to deal with the **reference machine** and a **test washing machine** (at least, often more than one). It is therefore strongly recommended that each test laboratory develop their own specific internal test protocol for the testing of **washing machines** which cover the setup of test washing machines, operation of measurement and data logging equipment and laboratory systems.

The development and use of an internal test protocol will lower the stress on the laboratory personnel and will minimise the risk of any errors during the test. Errors are costly as the whole **test run** or even **test series** may have to be abandoned as the result of an error.

Such a protocol should be developed and adapted in accordance with the experience of the personnel and the kind of equipment installed in the test laboratory Ideally, it should be set out as a check list of items which can be performed on a step by step basis.

An in-house protocol can be divided into the following broad sections and should specifically address issues in the following main areas.

- Preparation for testing
- Performing the test
- Recording and checking results

K.2 Elements of an in-house test protocol

K.2.1 General

The following section sets out the rationale and suggested content of the three main areas of an internal testing guide. Other issues may be relevant for your particular laboratory. The intent is that each laboratory prepare a check list and operating sequence that is relevant to their equipment, machines under test and personnel.

K.2.2 Preparation for testing

The following issues should be considered when preparing for a **test run** and/or **test series**.

- Ensure that systems to control ambient conditions and water supply are in operation and are functioning correctly.
- Are there any special requirements for the connection of the **test washing machine** to the water supply and electricity system (size and types of fittings, plug types; are hot and cold outlets required) ?
- Can water and energy be supplied according to specifications? (Is the maximum current rating of the supply greater than the rated current of the **test washing machine,** is supply voltage correct, can the specified water pressure be maintained ?)

- Is all measuring equipment for mass, water (volume, pressure, temperature, hardness), ambient conditions, energy calibrated and operating correctly? Are any calibration checks required prior to the **test series**? Are all instruments within their calibration period?
- Are **base loads** available and prepared to meet the specifications required (average age, normalised (in the correct water hardness), conditioned prior to **test series**) ?
- Are the specified detergent and stain test strips available (have these been stored cor- rectly, are they within their expiry dates, is there sufficient supply of materials from the one batch to complete the **test series** on the **reference machine** and all the **test washing machines**) ?
- Is equipment available to weigh each of the detergent components and to mix these into the required doses for each **test run**? Is equipment available to attach stain test strips to load items and for removing them and drying them after the **test run**?
- Is the **reference machine** working according to the specifications (including ratio data) ? Has the start up **programme** been run just prior to commencement of the **test series**?
- Is the spectrophotometer, standard extractor and titration equipment available and operat- ing correctly (including chemicals) ?
- Have all the parameters for the **test series** been selected (load type, load capacity for the **test washing machine**, detergent dose, water hardness) ?

K.2.3 Performing the test

The following issues should be considered when preparing for and undertaking a **test run**.

- Are the **washing machines** level, stable and resting on all supports?
- Has the **base load** been dried correctly between **test runs**, is there a check that no load items are missing?
- Are connections for water and energy supply working correctly?
- Are guidelines for loading, adding detergent (and amount), programming and starting each **test washing machine** clear and attached to the relevant machine?
- Are there check lists on each **test washing machine** to note that the load details, stain test strips and detergent have been added for the **test run** and that water, energy and ambient conditions have correct start values (zeroed where required)?
- Are all monitoring systems operating correctly and is data being collected?
- Have start times of all of the **test washing machines** been noted and start times planned so that the processing of all the loads on completion of each programme can be done in an orderly fashion (need to know the approximate **programme time** for each **test wash- ing machine** including the **reference machine**)?

K.2.4 Checking test results and reporting

The following issues should be considered during and at the completion of a **test run**.

- Are the conditions for the **test washing machines** as specified in the standard?
- Have test data been recorded?
- Are there any outliers that warrant attention?
- Has the data been independently checked?

K.3 Examples of elements from a detailed internal testing protocol

K.3.1 General

The following lists are examples of details that may be relevant for an internal testing proto- col. The key points should be organised into a step by step operational procedure with checks at critical points in the procedure to eliminate errors.

K.3.2 Initial preparation for testing

- Detergent storage and quantity– are the components within expiry date ? Is there a suffi- cient quantity from the one batch for the **test series** ?
- Weigh portions of each detergent component for the **test series** and record the mass and/or deviations, mix the portions thoroughly put a lid on, storage maximum time 2 weeks (see also K.3.7).
- Stain test strips – are these within their expiry date, are the storage conditions satisfac- tory, are they sufficient from the one batch for the whole **test series** (all machines)?
- When a new batch of stain test strips is delivered, plan for ratio tests (refer to Table A.1).
- If there is a new or not fully trained technician, ensure there is sufficient supervision.
- Check that all parts of the measuring system are calibrated.
- Provide load and loading instructions for each **test washing machine** and load capacity to be tested, mark the capacity and the number of items for each load, attach this information to each machine.
- Choose **programme** to be tested (and note the likely **programme time**) and check that the **test washing machine** is working correctly.
- **Base loads** – prepare for the **reference machine** and all **test washing machines**, ensure these have been conditioned correctly (including correct water hardness for forthcoming test series), record conditioned mass and age distribution details.
- Glass bottles for rinse testing – 1 bottle for each **test washing machine** and the **refer- ence machine** to collect water extracted from the load by the standard extractor. 1 bottle for a sample of the laboratory supply water (zero calibration). Ensure these are clean and dry prior to use.
- Check that the **test washing machine** and **reference machine** is connected to the water and electricity supply.
- If the **test washing machine** has just been installed, conduct normalisation runs as per 6.2.1.2.
- For the **reference machine**, check that this has been installed in accordance with 6.2.2, conduct a compliance check with the requirements in Table E.2.
- Record **test washing machine** serial number, batch number of stain test strips and deter- gent, history and batch of the **base load**, technician responsible for conducting tests.

K.3.3 Prior to testing

- Clean the detergent dispenser (where applicable) and any filters (do not clean filters that empty the sump water from the **test washing machine** during the **test series**).
- Conduct start up **programme** prior to each **test run** on the **reference machine** (refer to E.4).
- Check that ambient conditions and general testing requirements in laboratory are in com- pliance with the specifications in the standard.
- Ensure that there is adequate water supply which meets the specification for the tests.

K.3.4 During the test

- Measure and record water hardness of the laboratory water supply.
- Measure and record ambient conditions.
- Prepare the measuring system.
- Fetch the soiled strips from the refrigerator and mark with the code to be used (or note the existing code on the strips). Record batch details for the **test run**.
- Attach the stain test strips to the towels (cotton) or pillowcases (synthetics/blends) for each **base load.** Record which stain test strips are attached to which **base load**.

- Load the **test washing machine** and **reference machine** according to the loading instruc- tions (noting order of items and folding in Annex H).
- Place the pre-mixed detergent as specified in 6.3.3. Ensure that the detergent dispenser (if used) is clean and dry.
- Start the measuring and recording system.
- Start the **test washing machine**(s) and the **reference machine** – plan their start times so that they finish in a staggered order which will allow the processing of the loads for rinse performance.
- Check that the measuring system is working (for example, temperature of the inlet water, water volume etc.).
- When **test washing machine**(s) and the **reference machine** stop, stop the measuring system.
- At the end of the programme for each machine, as quickly as possible unload and remove the stain test strips from the **test load**. Weigh the wet **base load** and record the mass.
- Divide the load into "specified bundles" (some items will be left over after this process – called remaining load) for further spinning in the standard extractor to determine rinse per- formance.
- Weigh the bundles and immediately load them into as many standard spin extractors as are needed. Ensure that the spin extractors are rinsed out and dried between runs.
- Weigh the water extracted from each bundle individually, then combine it in a single con- tainer for each **test washing machine**. Ensure that all extracted water is mixed prior to taking a sample. If titration is not done immediately store the sample of extracted water in a sealed bottle in the refrigerator until titration is performed.
- Record the mass of the two bundles and of the remaining load and of the extracted water.
- Organise for the stain test strips to be dried (according to laboratory practice (refer to 8.3.2) which should be documented).
- Check the values for main wash, rinse, total water consumption and energy consumption on the reference machine and the test washing machine(s).
- Titrate the rinse samples (or store in refrigerator).
- Collect all parts of each **base load** and dry in a dryer (refer to 8.2.5). Check mass and en- sure that no items are lost. Store the dried load according to laboratory practice prior to the next **test run**.

K.3.5 Additional points to consider for test runs within a test series

- Check the mass of the base load between runs. This should be within ± 3% of the condi- tioned mass. Check that no items have been lost or mixed up.
- Compare values for main wash, rinse, total water consumption and energy consumption on the test washing machine with the previous **test run**.

K.3.6 Evaluation

- Analyse all available parameters recorded by the measuring system including (volume of water (main wash, rinses and total), energy consumption, temperature at water inlet, tem- perature (inside appliance) spin speed during spinning, water pressure, water hardness, **programme time**, **main wash duration**.
- Check that the values recorded for the **reference machine** comply with target values. (If not, check flowmeter. If required, change factors and undertake maintenance.) (Note that if the reference machine requires maintenance during the **test series**, the whole **test se- ries** together with results for all **test washing machines** will probably be invalidated.)
- Measure Y tristimulus reflectance values of the washed stain test strips, calculate the ratio with the **reference machine** and compare results with the certified value for the batch on the **reference machine programme** (where applicable).

- Calculate **remaining moisture content** (RMC) of the **base load** after the completion of the **programme** and after the additional treatment in the standard extractor and ensure that these are in line with accepted tolerances for both the **reference machine** and the **test washing machine**(s).
- Calculate alkalinity.
- Evaluate results from the **test series**, record calculated results and note any lessons learned in terms of operation and testing.
- At the end of the **test series**, normalise the **base load** in preparation for the next **test se- ries**.
- Clean up and sort back all used items into suitable storage conditions.

K.3.7 Special issues for detergent

One of the most common mistakes made in a laboratory is about the correct weight of the detergent. The correct procedure requires that once the 3 separate components are thoroughly mixed they are added to each machine prior to commencement of a **test run.** Common mistakes are forgetting to add one of the detergent components (e.g. perborate), adding components twice or forgetting to add the detergent at all for the test run. Note that the mass of detergent for the **reference machine** is different from the **test washing machine**. Table 1 sets out the mass of detergent for all cases.

It is assumed that laboratories will be conducting a **test series** of five **test runs.** In this case it is recommended that the detergent needed for all five **test runs** be prepared at the start of the **test series** and stored until needed. The mixed detergent can be stored for up to two weeks prior to use. After calculating the amount of each detergent component needed for a **test run** (which is dependent on the water hardness and the load size) the mass of each detergent component is weighed and these are placed together into an individual container for each **test run** for each **test washing machine**. Differences in the dosages should be less than 1 g. It is recommended that a spreadsheet be used to record actual values and to control this process. The detergent components should be thoroughly mixed prior to use.

The containers can then be numbered according to the **test run** number within the **test series** and with the **test washing machine** identifier. This minimises the possibility that one of the components may be missed or dosed twice for a **test run**. A running check sheet attached to each **test washing machine** and the **reference machine** can be used to mark off when detergent is added at the start of each **test run**. The preparation and adding of detergent should be identified as a specific step in the internal testing protocol.

K.3.8 Special considerations for rinsing

Check validity of the separate spin extraction process for determination of the alkalinity:

– add the measured weights of all bundles (including the bundle with the remaining items) before the extraction and compare with the weight of the base load at the end of the wash- ing process when unloading the test washing machine or reference washing machine. The differences should be not more then 2 %;

– add the measured weights of the extracted bundles (including the bundle with the remain- ing items) and the weights of the extracted water and compare this with the weight of the base load at the end of the washing process when unloading the test washing machine or reference washing machine. The difference should be not more then 10% of the total ex- tracted water;

– calculate the **remaining moisture content** of each bundle. It should be within the limits as specified in 5.4.5.

Annex L
(normative)

Measurement of energy consumption in low power modes of washing machines

L.1 General

This annex sets out determination of **off mode** power and **left on mode** power. These are steady state modes that can persist for an indefinite period. These are the only two low power modes specified in this document. Other low power modes may exist in some products, but for the current designs of **washing machines**, these are not considered important in terms of duration and energy consumption.

This annex also provides some general information about other low power mode energy consumption of **washing machines** when they are not performing their main function (refer to L.4).

L.2 Determination of off mode power

Where **off mode** power P_{off} is determined, it shall be determined in accordance with this clause.

The **washing machine** shall be operated through a performance assessment in accordance with Clause 7 and Clause 8. At the completion of the **programme** the washing machine shall be unloaded as specified in Clause 8. For determination of this mode, the **washing machine** shall then be switched off in accordance with the manufacturers' instructions and left to revert to a steady state power consumption of its own accord. Where there is no power switch, the **washing machine** shall be left to revert to a steady state power consumption of its own accord.

NOTE 1 Normally, this mode can be determined in conjunction with a performance **test run** according to this document. However, if a separate measurement of this mode is required, operating the **test washing machine** through any selected **programme** using any realistic load is likely to provide an accurate result.

Ensure that the following conditions remain relevant for the duration of the measurement:

- connected to mains power for the duration of the test;
- no adverse warning indicators are present (normally no lights or indicators are active in this mode);
- laboratory supply water is left on at the specified pressure;
- no network is connected to the product;
- follow manufacturer's instructions regarding configuration where no network is present.

At the completion of unloading, the door/lid remains open unless the manufacturer recommends that the door/lid remains closed when the appliance is not in use. Power measurements in **off mode** shall be determined for a period of not less than 30 min once the appliance has reached a steady state condition. **Off mode** measurements shall only be determined where it is certain that the power level measured persists in a steady state condition for an indefinite period without user intervention. Power measurements for this mode shall be in accordance with the requirements of IEC 62301.

NOTE 2 In some products, some short term duration **operations** may be present for a period after **off mode** is initiated or after the power supply is initially connected. The position of the door/lid can affect this mode in some products. If the manufacturer recommendations are unclear, a reading with the door/lid open and closed should be taken.

Manufacturers or suppliers may have information on the design and operation of their **washing machines** which would allow an accurate determination of this mode through methods other than the method specified above. For the purposes of declaration, a manufacturer or supplier may use any method which gives an equivalent result to the method specified above. For verification purposes, the method specified above has precedence over any other determination.

L.3 Determination of left on mode power

Where **left on mode** power P_{on} is determined, it shall be determined in accordance with this clause.

The **washing machine** is operated through a performance assessment in accordance with Clause 7 and Clause 8. At the completion of the **programme** the **washing machine** is unloaded as specified in Clause 8. For determination of this mode, no action is taken by the operator to switch off the **washing machine** (initiate **off mode)** after it has been unloaded. The **washing machine** is left to revert to a steady state power consumption of its own accord.

NOTE 1 Normally, this mode can be determined in conjunction with a performance **test run** according to this document. However, if separate measurement of this mode is required, operating the **test washing machine** through any selected **programme** using any realistic load is likely to provide an accurate result. This mode is not applicable where the user has to turn the product off to unload it.

Ensure that the following conditions remain relevant for the duration of the measurement:

- connected to mains power for the duration of the test;
- no adverse warning indicators are present (some lights or indicators may be active in this mode);
- laboratory supply water is left on at the specified pressure;
- no network is connected to the product;
- follow manufacturer's instructions regarding configuration where no network is present.

At the completion of unloading, the door/lid remains open unless the manufacturer recommends that the door/lid remains closed when the appliance is not in use. Power measurements in **left on mode** shall be determined for a period of not less than 30 min once the appliance has reached a steady state condition. **Left on mode** measurements shall only be determined where it is certain that the power level measured persists in a steady state condition for an indefinite period without user intervention. Power measurements for this mode shall be in accordance with the requirements of IEC 62301.

NOTE 2 In some products, some short term duration **operations** may occur after the completion of the **pro- gramme**. In some products, this mode may revert to a state which is equivalent to **off mode** (where there is an auto off). The position of the door/lid can affect this mode in some products. If the manufacturer's recommenda- tions are unclear, a reading with the door/lid open and closed should be taken.

Manufacturers or suppliers may have information on the design and operation of their **washing machines** which would allow an accurate determination of this mode through methods other than the method specified above. For the purposes of declaration, a manufacturer or supplier may use any method which gives an equivalent result to the method specified above. For verification purposes, the method specified above has precedence over any other determination.

L.4 Other low power mode energy consumption of washing machines

The main body of this document provides the method of measurement to determine **programme** energy consumption from the commencement of the selected **programme** to the completion of this **programme**. This usually makes up the bulk of energy consumption for most **washing machines**, although this depends on whether water heating is included or required for the **programme** selected and the power consumption of other modes.

There are a number of other states where some energy may be consumed by a **washing machine**. However, the modes defined above in L.2 (**off mode**) and L.3 (**left on mode**) are the main ones of interest. The energy consumption of other short duration modes or states that are outside of the normal **programme** period are generally negligible, but are described here in general terms for completeness.

- Short duration events that are dependent on the behaviour of the user: the most common of these are as follows:
  - delay start mode: only applicable to products with a delay start function and only rele- vant when this is activated by the user – this is always a limited duration mode;
  - anti-crease operation: this can occur at the end of the **programme** (only present in some horizontal axis machines) and this can be terminated at any time when the user accesses the load – this is almost always a short duration mode even when the user does not intervene for some time;
  - steady state mode at the end of the cycle: this mode can exist in **washing machines** that do not automatically revert to **off mode**, but this mode only persists until the user accesses the load (the user can influence the mode by the timing of load access) – this is always a limited duration mode in a practical sense (the user will eventually come and empty the load).
- Short duration events that occur irrespective of user behaviour: these usually occur just after the **programme** is completed. The most common examples are electronic activity to monitor aspects of the machine performance or short duration mechanical events such as pumping that always occurs after the completion of the **programme**, irrespective of user behaviour.

Annex M
(normative)

Testing procedure for manual washing machines

M.1 General

This annex sets out the test method for **manual washing machines**. The **test washing machine** shall be generally installed and used in accordance with the manufacturer's instructions. Where no specific instructions are provided by the manufacturer, the directions set out in this annex shall be applied.

In all other respects, the **test washing machine** and **test load** shall be prepared in accordance with Clause 6 and operated in accordance with the requirements of Clause 7 and Clause 8 when assessing performance to this document. Detergent quantity and placement shall be in accordance with 6.3.

NOTE The recommended reference **programme** on the **reference machine** for this type of **test washing ma- chine** is Cotton 30 °C or Cotton 20 °C.

Manual washing machines are classified under Subclause H.3.1 (**horizontal axis washing machine** or **vertical axis washing machine**) according to their axis of rotation for the pur- poses of folding and loading in accordance with Annex H.

For **manual washing machines**, **cycle time** may be the sum of duration times of each **opera- tion**. For single tub **manual washing machines**, **main wash duration** is equal to **cycle time**.

M.2 Water level

The washing machine shall be connected to hot and/or cold laboratory supply water as set out in the manufacturer's instructions. Where the **test washing machine** has an automatic water level control, this shall be allowed to operate. Where the **test washing machine** requires manual filling, this shall be done to the level recommended in the manufacturer's instructions for the load capacity to be tested. If there are no instructions regarding the water level, the maximum automatic water level shall be selected or manually filled for testing.

M.3 Programme

The **programme** selected for the test of a **manual clothes washing machine** shall be as specified by the manufacturer for the load type and **nominal test load mass** to be tested. Where there is no **programme**, the recommended times for washing, spinning and rinsing **operations** shall be in accordance with the manufacturer's instructions for the load capacity to be tested. If there are no instructions regarding the times for washing, spinning and rinsing **operations**, the default **programme** below shall be used.

For manual washers, the **cycle time** may be the sum of duration times of each **operation**. For single tub manual washers, main wash duration is equal to **cycle time**.

M.4 Default programme

Where no water temperatures are specified in the manufacturer's instructions, a cold wash shall be used (nominally 20 °C using a cold laboratory supply water) and a cold rinse (nominally 20 °C). The default **programme** parameters shall be as follows:

a) The wash operation is 15 min ± 0,5 min for manually switched **washing machines**. Where there is a washing timer provided on the **washing machine**, the maximum time possible with an automatic stop shall be used.

b) At the completion of the wash operation, manually drain the wash tub or allow it to be drained where there is an automatic pump out, until empty. Allow the water to drain of its own accord: do not press the load to remove excess water.

c) Manually transfer the load to the **spin extractor**, where applicable (see notes below re- garding the capacity of the **spin extractor** and other possible means of removing water). This may be either part of the **test washing machine** or may be a stand alone **spin ex- tractor** used with the **test washing machine**. Manually arrange the load items in the **spin extractor** so they are evenly distributed and balanced.

d) The spin **operation** is 5 min ± 0,5 min for manually switched **spin extractors**. Where there is a spinning timer provided on the **washing machine**, the maximum time possible with an automatic stop shall be used.

e) Transfer damp load after the **spin extraction** to the wash drum and conduct a rinse **op- eration** filled with cold laboratory supply water to the same level used in a). The rinse op- eration is for 5 min ± 0,5 min.

f) Repeat b), c) and d) above.

Where the capacity of the **spin extractor** is less than the **test load** used, the **test load** shall be split into 2 equal bundles (as far as possible) for the spin **operation** in d) and f). Spin each bundle as specified in d). Store each of the bundles in a separate container before and after their spin **operation** is completed. Combine the bundles together if proceeding to the rinse **operation** e).

While it is technically possible to perform the above tests on a washing machine without a **spin extraction** function (e.g. wringer which is used for water extraction or hand wringing), the performance results from such a **washing machine** are likely to be somewhat variable.

NOTE **Washing machines** without a **spin extraction** function cannot be assessed for rinse performance under 9.4 or water extraction performance under 9.3.

Annex N
(normative)

Procedure to determine test load size where rated capacity is not declared

N.1 General

This annex sets out two methods for the determination of **test load mass** when rated capacity is not declared. For the purposes of determining the **test load mass**, a manufacturer or supplier may use either method. The method specified in N.2 is the reference method.

N.2 Determination of test load mass using table tennis balls

Target is to determine the entire mass of dry test load that can be placed in the machine during washer operation.

Procedure:

1) Place the clothes washer in such a position that the uppermost edge of the clothes con- tainer opening is levelled horizontally, keeping the transport-lock system locked to avoid errors in volume measurement caused by lowering of the system.
2) Fill the clothes container with the table tennis balls of 40 mm diameter (specification as in ITTF Technical Leaflet T3) under incidental stirring to get the closest package of the table tennis balls and to avoid the appearance of void spaces.
3) For **horizontal axis** washing machines fill in as much table tennis balls as possible re- specting the container door closing (closing of the door must be possible without com- pressing the balls).

   For **vertical axis** washing machines fill in as many table tennis balls as possible to the uppermost edge which may be used to fill in cloths respecting manufacturer instructions.
4) Count the number (y) of table tennis balls in the clothes container.

   NOTE 1 This may be simplified by preparing e.g. a rectangular flat tray where always the same number of balls fits in.
5) Repeat steps 2) to 4) three times, calculate the average of the numbers of table tennis balls (y=(y1+y2+y3)/3) and use this number for calculation of test load mass.
6) The clothes container volume (C in litres) is calculated as follows:

$$C = \frac{y + 41{,}91}{18{,}802}$$

NOTE 2 Empiric ascertained equation by comparison with the method N.3 using water in horizontal axis sys- tems (washer and dryer) with capacities in the range of 35 l to 120 l.

7) **Test load mass** for cotton textile type is calculated as follows:

Test load mass, in kg = (C / 15,0)

and shall be rounded down to 0,5 kg rounding intervals.

The above method shall be used for the determination of **test load mass** for testing purposes only; it shall not be used for capacity claims with reference to this document.

If the **rated capacity** for synthetics/blends and wool is not specified by the manufacturer, the **test load mass** shall be respectively 40 % and 20 % of that for cotton.

N.3 Determination of test load mass using water

Target is to determine the entire mass of dry test load that can be placed in the machine during washer operation.

Measurements of mass shall be made using instruments having an overall uncertainty of measurement of not more than 1 % at the 95 % confidence level. The resolution and recording of mass readings shall be as specified for the following items:

- for the complete mass of the machine and the weight of water: 100 g or better.

Procedure:

1) Place the clothes washer in such a position that the uppermost edge of the clothes con- tainer opening is levelled horizontally, so that the container will hold the maximum amount of water, keeping the transport-lock system locked to avoid errors in volume measurement by lowering of the system.
2) Line the inside of the clothes container with 0,05 mm plastic sheet. All clothes washer components which occupy space within the clothes container and which are recommended for use with the **test run** shall be in place and shall be lined with 0,05 mm plastic sheet to prevent water from entering any void space.
3) Record the total weight of the machine before adding water.
4) Fill the clothes container manually with water between 10 °C ad 25 °C to its uppermost edge which may be used to fill in clothes, respecting manufacturer instructions. For hori- zontal axis washing machines fill until there is no air remaining when closing the door. Measure and record the weight of water, W, in kg.
5) The clothes container volume (C in litres) is calculated as follows:

$$C = W/d$$

where

C is the volume in litres;

W is the mass of water in kilograms;

d is the density of water (= 1 for water in range of 15 °C to 25 °C).

6) **Test load m**ass for cotton textile type is calculated as follows:

Test load mass, in kg = (C / 15,0)

The above method shall be used for the determination of **test load** mass for testing purposes only; it shall not be used for capacity claims with reference to this document.

If the **rated capacity** for synthetics/blends and wool is not specified by the manufacturer, the **test load mass** shall be respectively 40 % and 20 % of that for cotton.

Annex O
(informative)

Additional evaluation of washing performance

O.1 General

During washing performance tests data are taken on 5 different types of soils in a stain test strip for each **test run**. Using the calculations specified in Clause 9 data for each of the soil types is combined into a single value for "washing performance". However, the data for each soil type and each run contains more information which may be useful in understanding the effect of the washing processes in more detail or to assess the variability of individual washing processes. This annex describes how additional information may be extracted from the data which is already measured as part of a wash performance assessment (refer to 8.3 and 9.2).

O.2 Present scheme

For the assessment of wash performance, the result from the **test washing machine** is compared to the **reference machine**. This is based on the assumption that major differences of the measurement can be eliminated by running in parallel a **reference machine** under identical conditions.

Therefore for each **test run** the result of the washing performance is evaluated as the sum of the reflectance readings for all soils together for both the **test washing machine** and the **ref- erence machine.** The washing performance is defined as a ratio of the average **test washing machine** value to the average **reference machine** value. An additional aspect of wash per- formance is the standard deviation which is calculated from the value for each **test run** on the **test washing machine** in relation to the average of the **test series** on the **reference ma- chine**.

As a consequence of this procedure, all variations which are observed within each **test run** (e.g. variations in cleaning depending on the location of the stain test strip) and fluctuations in the **reference machine** between **test runs** are neglected.

O.3 Evaluation per test run

O.3.1 General

Evaluation per **test run** is based on the calculation of averages and standard deviations per stain per **test run**.

For a complete **test series** consisting of five **test runs,** averages of these averages are taken (leading to the same result as the present scheme – refer to Clause 9) but also the standard deviations are averaged. For the sum of the stains the standard deviation is calculated following rules of error propagation (using squared sum). This is done for the **test washing machine** and the **reference machine**. Finally the ratio is formed and the standard deviation is again calculated following error propagation rules (using squared sums of the relative errors). The formulas are set out below.

O.3.2 Calculation for each stain per test run

The average $\overline{x}_s$ reflectance value for each stain (s) in each **test run** is calculated as follows:

$$\bar{x}_s = \frac{\sum_{j=1}^{n}\sum_{i=1}^{4} x_{ij}}{n \times 4}$$

where

x_{ij} is the reflectance value of each single reading per soiled test piece (4 readings per soiled test piece);

n is the number of soiled test pieces per stain and **test run**.

The standard deviation s_s of x_s is calculated as follows:

$$s_S = \sqrt{\sum_{i=1, j=1}^{4,n} \frac{(x_{ij} - \bar{x}_s)^2}{4 \times n - 1}}$$

where

x_{ij} is the reflectance value of each single reading per soiled test piece (4x);

$\bar{x}_s$ is the average reflectance value for each stain in each **test run**;

n is the number of soiled test pieces per stain and **test run**.

O.3.3 Calculation for each test run

The sum C_C of the average reflectance values of the different stain(s) for each **test run** is calculated as follows:

$$C_C = \sum_{i=1}^{m} x_s$$

where

$\bar{x}_s$ is the average reflectance value for each stain in each **test run**;

m is the number of different stains per **test run**.

The standard deviation s_C of C_C is calculated as follows:

$$s_C = \sqrt{\sum_{i=1}^{m} \left(s_S{}^2\right)_i}$$

where

s_s is the standard deviation of $\bar{x}_s$ (average reflectance value for each stain in each **test run)**;

m is the number of different stains per **test run**.

The ratio q_C of the sum of reflectance for each **test run** is calculated as follows:

$$q_C = \frac{C_{C_{\text{test}}}}{C_{C\,\text{ref}}}$$

where

C_C is the sum of the average reflectance values of the different stains for each **test run**.

The standard deviation s_{q_C} of q_C is calculated as follows:

$$s_{q_C} = \sqrt{\sum_{k=\text{test,ref}} \left(\frac{s_C}{c_C} \right)^2_k}$$

where

s_C is the standard deviation of C_C;

C_C is the sum of the average reflectance values of the different stains for each **test run**.

O.4 Evaluation per stain

O.4.1 General

Here the averages and standard deviations are calculated over all measured reflectance values for each stain for the **test series**.

The sum and ratio is calculated for all stains as described above (refer to O.3).

O.4.2 Calculation for each stain per test series

The average $\bar{x}_R$ reflectance value for each stain (s) for the **test series** is calculated as follows:

$$\bar{x}_R = \frac{\sum_{k=1}^{w} \sum_{j=1}^{n} \sum_{i=1}^{4} x_{ijk}}{w \times n \times 4} \quad \text{or} \quad \bar{x}_R = \frac{\sum_{k=1}^{w} \bar{x}_{s_k}}{w}$$

where

x_{ijk} is the reflectance value of each single readings per soiled test piece (4x);

$\bar{x}_s$ is the average reflectance value for each stain in each **test run**;

n is the number of soiled test pieces per stain and **test run**;

w is the number of **test runs** in the **test series**.

The standard deviation s_R of $\bar{x}_R$ is calculated as follows:

$$s_R = \sqrt{\sum_{i=1,j=1,k=1}^{4,n,w} \frac{(x_{ijk} - \bar{x}_R)^2}{4 \times n \times w - 1}}$$

where

x_{ijk} is the reflectance value of each single readings per soiled test piece (4x);

$\bar{x}_R$ is the average reflectance value for each stain for the **test series**;

n is the number of test strips per stain and **test run**;

w is the number of **test runs** in the **test series**.

The sum C_R of the average reflectance values of the different stains for the **test series** is calculated as follows:

$$C_R = \sum_{i=1}^{m} \bar{x}_{R_i}$$

where

$\bar{x}_R$ is the average reflectance value for each stain for the **test series**;

m is the number of different stains per **test run**.

The standard deviation s_{C_R} of C_R is calculated as follows:

$$s_{C_R} = \sqrt{\sum_{i=1}^{m} \left(s_R{}^2\right)_i}$$

where

s_R is the standard deviation of $\bar{x}_R$ (average reflectance value for each stain for the **test series)**;

m is the number of different stains per **test run**.

The ratio q_R of the sum of the average reflectance values for the **test series** is calculated as follows:

$$q_R = \frac{C_{R_{test}}}{C_{R_{ref}}}$$

where

C_R is the sum of the average reflectance values of the different stains for the **test series**.

The standard deviation s_{q_R} of q_R is calculated as follows:

$$s_{q_R} = \sqrt{\sum_{k=\text{test,ref}} \left(\frac{s_{C_R}}{C_R}\right)^2}$$

where

s_{C_R} is the standard deviation of C_R;

C_R is the sum of the average reflectance values of the different stains for the **test series**.

Annex P
(informative)

Testing deviations to reduce costs and their limitations

P.1 Introduction

The test methods in IEC 60456 have been developed over many years and within the requirements and test methods of this standard is embodied a great deal of experience. The test methods in this standard have been developed with repeatability and reproducibility as a primary requirement. Good reproducibility is essential in achieving the highest level of test result comparability – it means that the results of tests carried out on products can be replicated within and across laboratories and even across different countries. To achieve the ability to be able to confidently compare product results between laboratories, this necessarily means that some test parameters and material specifications given in the standard are somewhat restrictive in nature, meaning that some of the test requirements are onerous and some of the equipment specified is expensive. This means that to test to the full requirements of this document may at first sight not appear to be suitable for every application or test programme.

It should be recognised that this standard has been developed to specifically compare the performance of washing machines using the parameters specified. It should be understood that some of these parameters are interdependent and so altering one parameter may inadvertently alter another parameter, and so the results may not be reliable.

This annex addresses the deviations to the parameters or materials used in the test procedures laid out in this standard that are known to be undertaken by organisations testing **washing machines** and outlines the reasoning behind the requirements laid out in this document, explaining when and why compliance with the specified requirements is crucial for obtaining statistically sound, relevant and reliable test results.

Common reasons given by organisations carrying out testing for deviations from the standard include the following points:

- reduce the cost and complexity of testing;
- simplify tests for use in the development of new products and models, or to undertake large scale ongoing development tests;
- use materials and conditions that are assumed to better reflect local consumer use;
- carry out in-house comparative testing of products where reproducibility is less important;
- carry out alternative evaluation of a key parameter or reduction in the number of parame- ters that are measured.

All results for products that claim to have been tested in accordance with this standard shall meet all of the normative requirements of IEC 60456. Any results for products that have been tested using any variation to the standard shall not make any claims that tests are in accordance with this standard or this Annex. Any **test series** shall not be compared to any other **test series** without full compliance to IEC 60456.

P.2 IEC reference machine

IEC 60456 Requirement: A **reference machine** of known performance is specified in IEC 60456 which provides an absolute level of performance as a basis for comparison of results in time and between laboratories to provide a high level of repeatability and reproducibility of results. The results of the **reference machine** runs are used by laboratories as an inter-

nal standard, to reduce the possible impact of batch-to-batch or lab-to-lab variability and to assure the required levels of repeatability and reproducibility.

Known variations: **washing machine**(s) of known performance(s) are used as an "in house reference" system to ensure repeatability and comparability of tests throughout the duration of a test programme. This reference is used as a relative reference (to provide a relative result for all **test washing machines**, in the same way that the IEC **reference machine** is used) or the "in house" reference may be used as a quality assurance measure to ensure that no significant changes occur in test materials and conditions between **test runs** and **test series** within a test programme (for the validation of the test conditions).

Key issues: the IEC 60456 test methods are made up of a highly complex system of materials, equipment and procedures. Any change to any single parameter always carries the risk of an inadvertent impact on repeatability, reproducibility and even suitability of any tests. A comparative test of the performance of **washing machines**, without the use of a **reference machine** should not be considered under any circumstances.

In order to achieve a repeatable result, all comparative tests on the batch of **washing machines** being assessed should be performed concurrently, within a specified test programme, using the same batches of soil cloth, detergent, loads and other consumables. Consideration should be given to designing a test programme that specifies the testing of the machines in a randomised way. Results of performance tests for any one **washing machine**, under such conditions, cannot be compared to results from other laboratories if a comparable **reference machine** of known performance is not used in other labs i.e. repeatability may be analysed and reported but reproducibility cannot be assured.

P.3 Reference detergent

IEC 60456 requirement: the only detergent permitted in IEC 60456 is reference detergent A*. The dose of detergent is fixed for each water hardness and load size.

Known variations: the performance of washing machines is tested using different doses of detergent A* or locally available detergents which may be available from normal commercial or retail outlets.

Key issues: IEC 60456 test methods are made up of a highly complex system of materials, equipment and procedures. Any change to any single parameter always carries the risk of an inadvertent impact on repeatability, reproducibility and even suitability of any tests. Special consideration should be given to the fact that changing detergent dosage or even formulation is known to lead to results that may be erroneous or misleading, especially in a **washing machine** with a sensor system. Use of a detergent other than a defined detergent is risky and it is recommended that advice should be sought from recognised experts in the field of detergency before commencing comparative testing with any other dose or formulation of detergent. It is important to note that changing to other than IEC reference detergent can lead to undetected machine malfunctions. Detergent Type A* formulation is specifically designed to give reliable and relevant test results under the test conditions specified in this standard. For example, Detergent A* has a comparatively very high level of anti-foam which is typically not found in market detergents. This anti-foam level is needed to limit the foam level to what can be expected to occur under consumer conditions with heavier soil loads.

It is critical to note that this standard is intended to compare the performance of **clothes washers**, not for the comparison of detergent performance. Commercially available detergents will vary in composition over time (even if brands and type appear to remain constant), so it is critical that a common batch of detergent be used for internal batch testing of products. Detergent performance may degrade over time, so commercial detergents are necessarily limited to a single batch of tests over a limited period. It is strongly recommended that a single batch should be used throughout the test programme – where multiple packets from a

commercial source are required, these should be combined and thoroughly mixed beforehand and sealed in airtight containers prior to use.

Tests of performance using such detergents or with variations in IEC specified detergent dose cannot be compared to results from other laboratories.

P.4 IEC load items

IEC 60456 requirement: IEC 60456 has a very strict specification for load items as well as the weighted average age of the **base load** that is permitted for testing. The material specification has been developed to ensure consistent results and behaviour of load items over time and between batches.

Known variations: tests are undertaken using IEC load items but the requirement for average weighted load is not applied. Test loads are sometimes made up of typical locally available garments.

Key issues: IEC 60456 test methods are made up of a highly complex system of materials, equipment and procedures. Any change to any single parameter always carries the risk of an inadvertent impact on repeatability, reproducibility and even suitability of any tests. Much work has been done on IEC load specifications, conditioning prior to use, ageing and loading as it has been shown that these factors can influence the performance results for the washing machine. Appropriate care must be taken when not using the IEC load items or control procedures for preparation of test loads. Extensive testing over the years has shown that while the exact composition of the load for cotton items (IEC items versus a load made up of typical load items) can have some influence on the result, in general terms the overall impact is not substantial. IEC load items are been carefully specified to eliminate as far as possible the effect of load composition on performance. However, there is good documentation to demonstrate that the age of the load (number of previous cycles used) has a measurable impact on a number of performance parameters, particularly spinning performance. So it is critical that changes in the age of the load be taken into account throughout a batch test programme (especially if all items chosen are of uniform age) as results early in the test programme may differ from results later in the programme due to changes in load aging. The most significant changes are known to occur in the first 20 cycles. The load items chosen for batch testing should be from one production batch or single source and sufficient quantities should be obtained to complete the batch test programme. The history of each load item should be tracked throughout the test programme and it is important to randomise loads and the sequence of testing of machines as far as possible when the weighted average age of load items is not controlled. The folding and loading schedule should be specified and should be consistent for both the **reference machine** and **test washing machines** if this schedule deviates from the IEC method (the method specified in this standard should be used wherever possible). After each **test run** it is important to rinse (recondition) the load in a specific machine chosen for this purpose for this batch of tests, before drying the load. Tests of performance using non standard load items cannot be compared to results from other laboratories unless comparable items are used.

P.5 IEC stain strips

IEC 60456 requirement: the IEC standard specifies the use of a specific set of 5 stains to assess the washing performance of the washing machine. This stain strip has been developed over many years and there are very strict procedures to ensure the control of the quality and performance of these stains.

Known variations: tests are carried out using smaller versions of the IEC test stains to reduce costs for large scale testing but this may impact on the accuracy of performance measurements. Tests are sometimes done using fewer stain strips per load, eliminating several of the current stains, or using different stains to reduce costs. There are literally hundreds of

possible alternative tracer stains that are used for assessing different aspects of washing performance which are used for research purposes.

Key issues: IEC 60456 test methods are made up of a highly complex system of materials, equipment and procedures. Any change to any single parameter always carries the risk of an inadvertent impact on repeatability, reproducibility and even suitability of any tests. Research and tests over the years has indicated that, even though the IEC stain strips appear to be artificial and specific in nature, it has been shown that they provide a good overall indication of consumers' perception of wash performance. A reduced number of IEC soil strips or smaller versions of the IEC stains may give good indicative results but will decrease the accuracy and increase the variability of the results. To avoid misleading results caused by an uneven wash performance throughout the load, it is essential that the number of test swatches varies with the size of the load, they are evenly distributed around the load, they are attached to load items and a specified loading procedure is followed. Where alternative stains are being considered, advice should be sought from other testing organisations and stain suppliers regarding the purpose of the particular stains and the likely results under the conditions of the test (e.g. reaction to test detergent, water hardness, temperature). Many stains contain natural materials which can vary from batch to batch, and extreme care should be taken to use soil or stain cloths from one batch for a test programme. Sufficient quantities of stain swatches should be procured to complete the test programme. Tests of performance using non IEC complying soil strips or quantities cannot be compared to results from other laboratories.

P.6 Measurement of reflectance

IEC 60456 requirement: IEC 60456 requires the use of an instrument that meets strict specifications for the measurement of reflectance of stain strips after they have been washed. The requirements are specific with regard to light source, geometry and measurement parameters. These requirements have been developed over many years and the reproducibility has been proven through a number of international ring tests. An assessment of the reflectance by an accurate reflectometer is a cornerstone of wash performance measurement.

Known variations: tests are carried out using reflectometers of a lower specification or an instrument that is capable of high speed readings such as Xenon flash, e.g. where there is an ongoing requirement for large numbers of readings. Some tests may specify alternative geometries or the use of other light sources or measurements indexes. Visual assessment of soilings after washing is occasionally done, although this is generally not recommended as a reliable method of grading washing performance.

Key issues: IEC 60456 test methods are made up of a highly complex system of materials, equipment and procedures. Any change to any single parameter always carries the risk of an inadvertent impact on repeatability, reproducibility and even suitability of any tests. It is critical that a single instrument should be used throughout the test programme and calibration of the instrument be regularly undertaken in accordance with the manufacturer's instructions. Illuminant D65 (daylight with UV) is specified in this standard, other illuminants may have similar (e.g. Illuminant C) or very different (e.g. Illuminant A) spectral power distributions which causes different readings. The specified d/8 geometry (diffuse) minimises any effect of texture and sheen on the fabric and was therefore preferred over 45/0 geometry for use in this standard. The standard specifies the use of the tristimulus Y scale as this can be considered as a simple whiteness index and closely reflects human eye perceptions. Using parameter L of the CIE Lab colour system can be shown to give very comparable overall results but Y was selected for reasons of better compatibility with older versions of the standard. The use of other tristimulus values X or Z as well as a or b (both from CIE Lab system) as well as ⊗E are not recommended as they respond to colour changes and may give misleading results. As a general rule the visual assessment of wash performance is not recommended. However, some comparative in-house assessments are known to use visual assessment; guidance on the use of visual assessment is given in the guidelines for panel testing (IEC/TR 61592). As- sessments of performance using non-complying reflectometers or non-complying measure- ment conditions cannot be compared to results from other laboratories.

P.7 Other non-standard test conditions

IEC 60456 requirement: IEC 60456 specifies a wide range of standard test conditions when complying washing machine tests are undertaken. This is to ensure accuracy and repeatability of results.

Known variations: Tests are done using alternative cold water supply temperatures to that specified in the standard, or are not controlled within specified limits. Other test conditions are varied and may have a range of complex impacts on performance.

Key issues: IEC 60456 test methods are made up of a highly complex system of materials, equipment and procedures. Any change to any single parameter always carries the risk of an inadvertent impact on repeatability, reproducibility and even suitability of any tests. The impact of changes in water supply temperature are complex. Where machines heat water internally, the main impact of a variation in the cold water supply temperature will be a change in energy consumption (warmer supply temperatures will result in lower energy consumption) without significant change in most performance parameters (except where there is no water heating or hot water consumption). A rough indication of the energy impact can be calculated using the cold water temperature correction equations in Subclause 9.5. However, these equations only provide an indicative impact of the energy consumption change which is likely (these equations are intended to provide energy corrections for small variations in cold water temperature). Where cold and hot water are drawn into the machine (and there is no internal heating), the effects are more complex. In machines where the ratio of hot and cold water is determined by pressure and tap/solenoid settings, a warmer cold water temperature will result in a higher wash temperature which should improve wash performance slightly (the energy impact will depend on the assumed water temperature base for energy calculations). For machines that adjust the ratio of hot and cold water to achieve a programmed wash temperature, a warmer cold water temperature will increase the ratio of cold water to hot water which will lower energy consumption but should have no wash performance impact (similar to machines that only heat water internally). For machines that use only cold water with no heating capability, the impact of cold water temperature on performance may be significant with no significant energy impact. It is critical that hot and cold water supply temperatures remain as constant as possible throughout the **test series** as small changes in water supply temperature can have noticeable energy and/or performance impacts.

Ambient temperature and humidity control is generally less critical whilst testing **washing machines** but are critical for the conditioning of the clothes load in order to standardise the moisture content prior to use in testing. There will be some energy impacts from deviations in ambient temperature; they affect the thermal mass of the machine prior to the commencement of testing.

The soft or hard water options specified in this standard should cover most common situations. It is important for the hardness of the laboratory supply water to remain as constant as possible throughout the test programme as changes can have noticeable performance impacts.

While it is desirable to control the voltage and frequency of the electricity supply during testing, variations which are larger than those specified in this standard may be acceptable for in-house or routine testing. The main impact of voltage will be on program time for machines that use internal heaters and have a small impact on motor currents and losses. However, proper functioning of some machines may depend on stable and specified voltage and frequency, although most machines can operate satisfactorily under normal variations in supply voltage. Variations in frequency from main supply are normally very small and should not affect the performance of **test washing machines** if they remain with the specified limits.

In all cases, the test conditions should be monitored and reported throughout the duration of the test programme. Tests of performance using non-complying test conditions cannot be compared to results from other laboratories.

P.8 Number of tests

IEC 60456 requirement: the IEC standard specifies that each machine be subject to a **test series** which consists of 5 tests to ensure accurate and repeatable results. These repeat tests provide good data on the repeatability of the test method and the individual **test washing machine** performance.

Known variations: tests are done with lower number of repetitions per machine. Where data on production variability within a model is also required, tests are done with a reduced number of tests on a range of different machines within a model.

Key issues: a physical process such as the washing of clothes is inherently variable and even where test conditions and materials are perfectly controlled there will be some variation in results from run to run. Some of these variations occur because the test method and the parameters measured will naturally vary from run to run and some of this variation occurs because the machine under test may not behave in a consistent manner from run to run. This latter variation may be because of poor control or design (e.g. repeatability of components such as sensors, pressure switches and thermostats) or it may be because of fuzzy logic or learning capability of the machine which adjusts the wash **programme** parameters in response to programme selection or in response to parameters such as water supply temperatures, sensed soil load, fabric type or perceived load size (adjustment of fill volume). Other variations from run to run may occur in response to specific situations (e.g. some machines refill with water where an “out of balance” condition occurs, which may only occur on some runs).

This standard currently only addresses performance testing of single machines, i.e. a single sample of a particular model. Assessing production variability is a highly complex matter that is currently not covered in this standard.

Tests using non-complying test conditions or number of repetitions cannot be compared to results from other laboratories.

P.9 Other important sources of information on testing

The following documents provide useful guidance on testing issues (see Bibliography): IEC/TR 61923, IEC/TR 61592, ISO/IEC 17025, ISO/IEC Guide 43-1, ISO/IEC Guide 43-2, ISO/IEC Guide 46, ISO/IEC Guide 58 and ISO/IEC Guide 98-3.

Annex Q
(informative)

Uncertainty of measurements in IEC 60456

Q.1 Why is uncertainty important?

When a measurement has been performed giving a figure as a result for some quantity (also known as the measurand) we may ask how sure can we be about this figure. In other words,

– if we repeat the measurement, will we then get the same result?

– if another group or another laboratory performs the measurement, how close will we ex- pect the results to be?

By means of an uncertainty budget we may calculate an uncertainty interval $y \pm U$, where y is the measurement result and U the expanded uncertainty that is estimated to give the interval a high probability (often 95 %) to cover the true value, Y, of the measurand. U is said to be the uncertainty associated with the result y.

The uncertainty interval of a measurement is therefore a basis for qualifying the measure- ment. The more narrow we want the confidence interval i.e. the smaller we want the value of the uncertainty U, the more careful we often have to be about the measurement method, the measuring equipment, the training of the operators and the number of repetitions of the same experiment.

NOTE ISO/IEC GUIDE 98-3, the ISO 5725 series and IEC/TR 61923 should be consulted when examining the issue of uncertainty of measurement in any detail.

Q.2 Ways to access uncertainty

Q.2.1 General

There are in principle two ways to estimate uncertainty: a bottom up method and a top down method. It is generally recommended that the two methods be used in parallel to achieve a reliable estimate of the uncertainty budget.

Q.2.2 The bottom up method

This method is set out in ISO/IEC Guide 98-3.

In this method the test result *y* is expressed as a function of input quantities. This function is often the formula used for the calculation of the result.

In our case the *y* may be one of the final test results like water consumption, energy con- sumption, washing performance, spin speed, spin drying performance, program duration or rinsing efficiency. The input quantities may be temperature, masses, times, power etc.

The magnitude of all the uncertainty contributions of each input quantity is estimated. The maximum permitted uncertainty is normally defined in the standard. However, the actual un- certainty of measurement for the equipment used during the test should be used.

By combining the uncertainties of the input quantities according to the law of propagation of uncertainty (see ISO/IEC Guide 98-3 for details), the uncertainty of the result y can be calcu- lated.

With this calculation it can be seen how a specific uncertainty contribution from an input quantity influences the combined uncertainty of the final result and therefore how a reduction in an uncertainty contribution from an input quantity will influence the combined uncertainty of the final result. Uncertainties may usually be reduced through a number of strategies including making more measurements, using other methods or other equipment, but these usually have an additional cost associated with them. We can use this information to put our effort into those aspects that reduce the uncertainty of the final result in the most cost effective way.

Q.2.3 The top down method

This method is set out in IEC/TR 61923.

In this method the reproducibility standard deviation is estimated from testing of the same machine (or the same model) in different laboratories using the same standard method. This type of testing is normally called a "ring-test" or "round-robin test". The reproducibility standard deviation of the test results can then be seen as the inherent uncertainty of the measurement method as it may be influenced by remaining differences in the ambient, the people and whatever else may be different between different measurements at different laboratories. In principle it is only valid for the machine investigated in this ring-test, but results may also be extended to similar types of machines. It is important to note that this type of estimate also includes the inherent variability of the **test washing machine**, which can be particularly problematic if there are sophisticated electronic controls or fuzzy logic programmes in operating during tests. Factors such as overloading can also increase the variability (and increase uncertainty) of the results. Where different machines are tested for comparison in different laboratories, there will also be some differences arising from production variability, so great care needs to be exercised.

Therefore the two methods "bottom up" and "top down" may be used in parallel to achieve a reliable estimate of the uncertainty budget. But both methods depend on the validity of the model or the data used.

Q.3 Uncertainty of measurement in IEC 60456

Reviewing actual round-robin test results, where machines are tested in different laboratories, will allow an estimate of the relative expanded uncertainties to be made. This data illustrates the best achievable result in using this standard in selected laboratories.

Measured property	**Relative expanded uncertainty of measured value (k=2)**
Washing performance Energy consumption Water consumption Final moisture Programme time Wool shrinkage	Values are reported in IEC/TR 62617 and regularly updated

The values in IEC/TR 62617 define the level of uncertainty of the measurement when the same machine is tested in a number of laboratories which follow this standard. They are only valid for those type of machines assessed in the technical report; other machine types may behave differently, also affecting these uncertainty values.

It is critical that laboratories meet the requirements of the relevant standard whenever results are reported. Additional details may need to be reported during round robin tests. Laborato-

ries are encouraged to check their alignment with other laboratories through participation in inter-laboratory testing whenever possible.

Q.4 Reporting uncertainty

In summary, the uncertainty of measured results has two sources:

1) the statistical uncertainty of what is measured as expressed in the sample standard devia- tion as calculated below, showing the accuracy of the measurement in the laboratory hav- ing done the measurement (noting that this measurement also includes machine variabil- ity). The calculation of standard deviation for a number of parameters is set out in Clause 9;
2) the uncertainty of the measuring method itself. This is expressed as expanded uncer- tainty, where it is common to set the borders at a 95 % confidence interval, which gives the minimum and maximum value within which the average measured result undertaken at any other laboratory following this standard could be expected to fall.

Standard deviation of any parameter is set out as follows:

$$s = \sqrt{\sum_{i=1}^{n} \frac{(x_i - \bar{x}_i)^2}{n-1}}$$

where

x_i is the i^{th} term of parameter x;

$\bar{x}_i$ is the mean of all n terms of parameter x;

n is the number of measurements of parameter x.

Reporting of test results needs to have all of this information to allow a full judgement of the measured result: average measured value, standard deviation (across all **test runs**) and ex- panded uncertainty.

As an example, where the expanded uncertainty on energy consumption was found to be 10 %, the data should be reported in the following form.

Average energy measured	1,44 kWh
Standard deviation of measurement:	0,05 kWh
Expanded uncertainty:	10 % of 1,44 kWh = 0,14 kWh
Reporting: energy consumption	
Average measured:	1,44 kWh
Standard deviation:	± 0,05 kWh
Expanded uncertainty:	± 0,14 kWh

Interpretation: testing the same machine in another laboratory following this standard, the ex- pected average value (at 95 % confidence) should lie between 1,30 kWh and 1,58 kWh.

Annex R
(informative)

Environmental aspects of washing machine use determined in IEC 60456

R.1 General

IEC Guide 109 sets out the detailed rationale for the consideration of the environmental impact of appliances and equipment. This annex considers the relevant aspects that can be quantified through testing to this document and also sets out the elements that are not covered or cannot be assessed using this standard.

The purpose of IEC Guide 109 is

a) to raise awareness that provisions in product standards can affect the environment in both negative and positive ways;

b) to outline the relationship between product standards and the environment;

c) to help avoid provisions in product standards that may lead to adverse environmental im- pacts;

d) to emphasize that addressing environmental aspects during the development of product standards is a complex process and requires balancing competing priorities;

e) to recommend the use of life-cycle thinking when addressing environmental aspects in the context of product standardization.

IEC 60456 is a standard for the assessment of **washing machine** performance and only covers a limited number of these issues.

R.2 Environmental aspects of washing machines covered by IEC 60456

R.2.1 General

IEC 60456 is a standard to determine the performance of **washing machines** – that is, how clothes loads are treated in terms of washing (cleaning), rinsing and water extraction. The standard does not set out any requirements for design and construction of **washing machines**. It does specify the measurement of water consumption and energy when performing the above tasks. Therefore, a number of measurements when testing in accordance with IEC 60456 can provide estimates of the environmental impact of **washing machine** use. This document provides measurements which could form a suitable basis for the comparison of energy and water consumption of **washing machines** and as such could form the basis of environmental labelling, energy labelling, information programmes and data included in operation manuals on these aspects.

The measurements of relevance are set out below.

R.2.2 Water consumption

One of the most important resource impacts of **washing machine** use is the consumption of water as a result of the process of washing clothes. Water consumption is one of the measurements taken under IEC 60456 and testing to this document can provide good estimates of water consumption.

However, some caution needs to be exercised with using measured or declared data which has been determined in accordance with this document. The main issue is that much of the

measured and declared data will be for **rated capacity** for a particular textile type – this is the maximum mass of textile that the manufacturer declares that the **washing machine** can treat. In reality, it is known that many consumers load their **washing machines** at somewhat less than **rated capacity** during normal use; in reality a wide distribution of load sizes will occur. The response of different **washing machines** (and consumers) to different load sizes varies: some machines have a manual (consumer operated) adjustment for water level, but many modern **washing machines** will have load sensing capability and will adjust the water level in response to the actual load size. A few machines will not respond significantly to changes in load size. These factors, together with the distribution of different load sizes in different regions needs to be understood when analysing the relevant data for water consumption and assessing the environmental impact.

R.2.3 Discharge of water

The discharge of water to waste is an important environment impact but is not a measurement that is directly made as part of this document. However, a good estimate of the volume of water discharged can be made from the water consumed (refer to R.2.2) less the water retained in the load at the completion of the programme (**remaining moisture content** or RMC, refer to 8.4 and 9.3 for water extraction performance).

This standard does not measure the load of chemicals that are contained in the discharge water (refer to R.3 for a discussion on detergent issues).

R.2.4 Energy consumption

Energy consumption is also a resource impact of **washing machine** use. Energy consumption is one of the measurements taken under IEC 60456, and testing to this document can provide good estimates of energy consumption. The conditions for energy measurement in IEC 60456 are highly standardised and are intended to provide a suitable basis for comparison of **washing machines**. This data can provide estimates of energy consumption in the field but a good understanding of how **washing machines** are used and great care is required to make such estimates.

As for water consumption (refer to R.2.2), some understanding of how declared values compare with typical in-use energy consumption is required to make good resource impact estimates. IEC 60456 provides estimates of electricity consumed (power required for pumps and motors as well as internal water heating) and the energy embodied in any external hot water drawn into the **washing machine**.

The most important factor with respect to energy consumption of a **washing machine** is wash temperature. For a warm wash, more than 80 % of the total energy consumption is energy re- quired to heat water (internally or externally imported hot water). For a cold wash (no internal heating and no external hot water), the energy consumed by the **washing machine** is usually fairly small. There will always be a distribution of wash temperatures selected by users across different households within a region and average wash temperatures can vary substantially by region.

Another important factor that affects the energy consumption is the volume of water consumed, so water consumption (refer to R.2.2) also has an influence on energy consumption where external hot water is used in the washing process or where water is internally heated. The same factors (distribution of load sizes and response of consumers and machines to variations in load size) also affect energy where there is any water heating (internal or external).

IEC 60456 sets a constant cold water supply temperature of 15 °C and a hot water temperature of 60 °C for testing. Actual cold water temperatures vary by region and even throughout the year. It is possible to make some estimates of the energy impact of changes in cold and hot water supply temperatures on energy consumption (refer to 9.5 for equations to correct water temperatures for heated operations) but this means that the field performance will also

be slightly different to that measured in a laboratory. Detailed test report data would be required to make such calculations – total energy consumption information would not provide sufficient information for making such estimates.

Any energy consumption in off mode and left on mode may influence the total energy con- sumption of a **washing machine** if these values are significant (refer to Annex L).

In summary, many of the main energy elements are determined in IEC 60456, but great care and skill, as well as a good understanding of normal use, is required when using this data to estimate the energy consumption and hence the environmental impact of **washing machine** use.

R.3 Environmental aspects of washing machines not covered by IEC 60456

IEC 60456 does not define requirements or methods of measurement for other aspects of the environmental impact of **washing machines**. Aspects which are not covered by this document include

- the inputs and outputs associated with manufacturing processes of the product;
- the inputs and outputs associated with packaging, transportation, distribution of the prod- uct;
- the options for re-use and recovery, including recycling of the product, as well as its ease of disassembly, repair and restoration;
- the options for disposal of the product and associated waste. Some

of these aspects may be covered by other standards.

Dimensions of the product are specified in this standard, but not of the packaging for transport purposes. The mass of the product as shipped is not specified in this standard, although many manufacturers provide this data as a matter of course.

The consumption of detergent is specified in this document. However, this is not considered to be suitable as the basis for estimating the environmental impact of **washing machines** for a number of reasons. The reference detergent specified in this document is intended to provide consistent comparative results and its composition may not be reflective of the range of commercial detergents available – these are known to vary widely in different regions of the world. The reference detergent is designed to provide a stable basis for comparison of products over time while commercial detergents are continually evolving in response to consumer demands and new chemical components which become available. The other aspect is that the dose of detergent specified in this standard is fixed on the basis of load size and water hardness to provide a consistent basis for comparison of **washing machine** performance across a range of standardised conditions. This dose may not be reflective of actual dose used by consumers in response to actual load size and local water quality.

Therefore the detergent consumption specified in this document should not be used as the basis for estimating the environmental impact of detergent use for **washing machines**. The only way to estimate this impact with any accuracy is to undertake analysis of local detergent compositions and typical detergent doses selected by consumers during normal use. It could be assumed that the vast majority of detergent used during normal use would be dissolved in the water discharged from the **washing machine**. However, most detergents undergo complex chemical changes in response to soil and water hardness so any estimate environmental impact would need to take these changes into account.

Washing machines are generally not considered to have any gas or particulate emissions during normal use. Any vibrations from **washing machine** use are highly localised and would not normally be considered a significant environmental impact.

Annex S
(normative)

Test report – data to be reported

This annex presents the data to be reported for the **reference machine** and the **test washing machine**.

The layout of the following Tables from S.1 to S.6 is recommended. Only the tables and parameters that are relevant for the **test series** need be included.

Title: "**Test Report of IEC 60456**" (state edition and year used)

S.1 Data for test washing machine

Table S.1 – Data for test washing machine

Brand:		**Model:**	
Country of manufacture (if indicated):			
Product number code:		**Serial number:**	
Source of machine:		**Internal heater (yes/no):**	
Appliance dimension declared:		**Appliance dimension measured:**	
Rated capacity	**Cotton:**	**Synthetics/blends:**	**Wool:**
Drum volume declared:		**Drum volume measured:** (if required)	
Washer axis (see 3.1.7, 3.1.8 and H.3.1):		**Washer loading (top/front):**	
Water connections (hot, cold, hot & cold):		**Rated input power:**	
Rated voltage:		**Test voltage:**	
Rated frequency:		**Test frequency:**	
Rated current:			
Additional information:			

S.2 Data, parameters and results for the test series

The following data (Tables S.2a and S.2b) shall be reported for a **test series** used to deter- mine the performance of a **test washing machine** when using a cotton or synthetics/blends **base load**. The same table may be used for the **reference machine** and the **test washing machine**.

Table S.2 – Data, parameters and performance results, cotton or synthetics/blends base loads

Table S.2a – Data, parameters and results, cotton or synthetics/blends base loads

Laboratory
Checked / approved by
Internal test identifier
Machine identification
'End of programme' indication (see 3.1.18)
Programme selected
Options selected
Load type
Nominal required test load mass
Reference machine programme
Reference machine test series identifier
Reason for extra test run (if applicable)

Test runs					1	2	3	4	5	average	standard deviation
	symbol (refer to 3.2)	unit	noted (n) measured (m) calculated (calc)	accuracy							
Date of test run		yr.m.d.	n	-							
Mass of conditioned base load (without test strips) (see note 2)	M	g	m	1							
Mass of base load before each test run (without test strips) (see note 2)	M_{dry}	g	m	1							
Mass of detergent used	M_{det}	g	m	0,1							
Cold water consumption during main wash (see note 1)	V_{cm}	l	m	0,1							
Hot water consumption during main wash (see note 1) (if connected)	V_{hm}	l	m	0,1							
Water consumption during main wash (cold + hot if connected) (see note 1)	V_w	l	calc	0,1							
Total cold water consumption	V_{ct}	l	m	0,1							
Total hot water consumption (if connected)	V_{ht}	l	m	0,1							
Total water consumption (cold + hot if connected)	V_t	l	calc	1							
Total electrical energy metered during the test	W_{et}	kWh	m	0,01							
Total cold water energy correction determined during the test (see note 1)	W_c	kWh	calc	0,01							
Calculated total hot water energy determined during the test (see note 1)	W_{ht}	kWh	calc	0,01							
Total energy (programme energy)	W_{total}	kWh	calc	0,01							
Ambient temperature (test room)	t_a	°C	m	0,5							
Laboratory supply water pressure cold	p_c	kPa	m	10							
Laboratory supply water pressure hot (if connected)	p_h	kPa	m	10							
Laboratory supply water total hardness cold		mmol/l	m	0,1							
Laboratory supply water total hardness hot (if connected)		mmol/l	m	0,1							
Date of water preparation cold (if appropriate)		yr.m.d.	n	-							
Date of water preparation hot (if appropriate)		yr.m.d.	n	-							
Laboratory supply cold water inlet temperature (see note 1)	t_c	°C	m	0,1							
Laboratory supply hot water inlet temperature (see note 1) (if connected)	t_h	°C	m	0,1							
Main wash duration (note 3)	t_m	min	m	1							
Programme time	t_t	min	m	1							
Mass of base load after spin extraction	M_c	g	m	1							
Remaining moisture content	RMC	%	calc	1							
Mass of whole base load after treatment in the standard extractor (rinsing) (note 4)		g	calc	1							
Remaining moisture content after standard extraction m % (note 4)		%	calc	1							
Mass of titration sample of tap water	m_t	g	m	0,01							
Total amount of HCl 0,1N for tap water	n_t	ml	m	0,01							
Mass of titration sample of extracted water	m_e	g	m	0,01							
Total amount of HCl 0,1N for extracted water	n_e	ml	m	0,01							
Reflectance after wash: Sebum	r_1	%	m	0,01							
Reflectance after wash: Carbon black/Oil	r_2	%	m	0,01							
Reflectance after wash: Blood	r_3	%	m	0,01							
Reflectance after wash: Cocoa	r_4	%	m	0,01							
Reflectance after wash: Red Wine	r_5	%	m	0,01							
Reflectance after wash: Sum	C_s	%	calc	0,01							
Notes											
Note 1: temperature and water volume to be integrated for each relevant operation to give total cold water correction and calculated total hot water energy											
Note 2: mass of conditioned base load (without test strips) is recorded before the first test run in a test series – values prior to subsequent test runs would be after drying (but not necessarily the conditioned mass).											
Note 3: main wash duration is defined differently: For the reference machine refer table E1, for the test washing machine refer to 3.1.20											
Note 4: The base load is spun in bundles; the total mass given here includes the weight of all bundles and the remaining items after treatment in the standard extractor											

Table S.2b – Performance results, cotton or synthetics/blends base loads

Laboratory					
Checked / approved by					
Internal test identifier					
Machine identification					
'End of programme' indication (see 3.1.18)					
Programme selected					
Options selected					
Load type					
Nominal required test load mass					
Reference machine programme					
Reference machine test series identifier					
Reason for extra test run (if applicable)					
Date of test run					
	symbol (refer to 3.2)	unit	accuracy	average	standard deviation
Total water consumption (cold + hot if connected)	V_t	l	1		
Total energy (programme energy)	W_{tcy}	kWh	0,01		
Off mode power	P_{off}	kWh	0,01		
Left on mode power	P_{to}	kWh	0,01		
Programme time	t_t	min	1		
Remaining moisture content	RMC	%	1		
Rinsing index	R	-	0,01		
Washing performance: Ratio	q	-	0,001		

The following data (Table S.3) shall be reported for a **test series** used to determine the wool shrinkage performance of a **test washing machine** when using a polyester **base load**.

Table S.3 – Data, parameters and results – wool shrinkage – polyester base load

Laboratory

Checked / approved by

Date of test series

Internal test identifier

Machine identification

Programme selected

Options selected

Load type

Nominal required test load mass

Reference machine programme

Reference machine test series identifier

Reference Shrinkage Rate

Date Reference Shrinkage Rate determined

Reference Shrinkage Rate

Wool Shrinkage specimens
(Supplier, Batch, Date of Delivery, Storage conditions)

Mass of base load

Mass of detergend used

detergent

Initial Dimensions of wool shrinkage

	Specimen 1			Specimen 2			Specimen 3			Average
	A-B	*C-D*	*E-F*	*A-B*	*C-D*	*E-F*	*A-B*	*C-D*	*E-F*	
Width										
	A-E	*G-H*	*B-F*	*A-E*	*G-H*	*B-F*	*A-E*	*G-H*	*B-F*	
Length										

Final dimension of wool shrinkage

	Specimen 1			Specimen 2			Specimen 3			Average
	A-B	*C-D*	*E-F*	*A-B*	*C-D*	*E-F*	*A-B*	*C-D*	*E-F*	
Width										
	A-E	*G-H*	*B-F*	*A-E*	*G-H*	*B-F*	*A-E*	*G-H*	*B-F*	
Length										

Width shrinkage rate (WS): Length shrinkage rate (LS):

Shrinkage Rate (SR):

Cycle Felting Severity (CFS):

Shrinkage Rate Index (SRi):

S.3 Age distribution of the load

S.3.1 Cotton base load

The following data (Table S.4) for the cotton **base load** shall be reported at the start of the **test series**. The weighted average age of the cotton **base load** is calculated in accordance with I.1. Refer to 6.4.4.2 for details of requirements.

Table S.4 – Weighted average age – cotton load

	Number of items in given range of age at the start of the test series				Weighted average age per type
	0 – 19	20 – 39	40 – 59	60 – 80	
Towels					
Pillowcases					
Sheets					
	Weighted overall average age				

S.3.2 Synthetics/blends base load

The following data for the synthetics/blends **base load** shall be reported at the start of the **test series**. Refer to 6.4.4.3 for details of requirements:

– number of shirts > 40 test runs:

– number of shirts ≤ 40 test runs:

– number of pillowcases > 40 test runs:

– number of pillowcases ≤ 40 test runs:

S.4 Materials used for the test series

The following data (Table S.5) is recommended for inclusion in the test report.

Table S.5 – Materials

Cotton base load	Supplier		Batch		Number of items used in this **base load**	
Sheets						
Pillowcases						
Towels						
Conditioning method cotton						
Synthetics/blends base load	Supplier		Batch		Number of items used in this **base load**	
Shirts						
Pillowcases						
Conditioning method synthetics/blends						
Wool shrinkage base load	Supplier		Batch		Number of items used in this **base load**	
Polyester						
Detergent	Supplier	Batch	Date of delivery	Storage condition	Target mass in g for this **test load** (**nominal test load mass**)	
Base detergent A*						
Perborate						
TAED						
Stain test strips	Supplier	Batch	Date of delivery	Storage condition	Identification of test strips used for this **test load**	
Water hardness preparation	Natural	IEC 60734 Type A	IEC 60734 Type B	IEC 60734 Type C1	IEC 60734 Type C2	Other (specify)

S.5 Standard equipment used for the test series

The following data (Table S.6) is recommended for inclusion in the test report.

Table S.6 – Equipment

	Brand	Model	Accuracy	Laboratory registration No	Calibrated until
Reference washing machine / flow meter					
Spectral photometer	parameter: optical geometry: wavelength resolution: spectral range: light source:		UV-filter gloss/specular: aperture: measuring time: calibration:		
Variable voltage regulator (test- system)					
Energy meter					
Energy meter (low power)					
Temperature recorder					
Water meter					
Scale (loads)					
Scale (detergent)					
pH-meter					
Titration equipment					
Moisture meter					
Conditioning room / chamber details					
Dryer used for drying between test runs					
Dryer used for bone- dry (where applica- ble)					
Iron (where applica- ble)					

Annex T
(normative)

Wool shrinkage specimens

The wool shrinkage specimens shall fulfil the following specifications:

- wool quality: 100 % wool fabric – plain weave
- wool fibre diameter: (21,0 ± 0,5) microns
- warp: (114 ± 10) ends per 10 cm (ISO 7211-2)
- weft: (118 ± 10) picks per 10 cm (ISO 7211-2)
- yarn linear density: 2 fold resultant 60 tex (ISO 2060)
- single yarn twist: warp/weft (475 ± 40) Tours per metre (Tpm) (ISO 2061)
- folded yarn twist: warp/weft (390 ± 30) Tpm (ISO 2061)
- size of wool shrinkage specimens: (34 × 35) cm (approximately) with marker threads along the edges

For suppliers, see Annex U.

Annex U
(informative)

Sources of materials and supplies

U.1 General

NOTE The information given is for the convenience of users of this document and does not constitute an endorsement by IEC of these products.

U.2 Suppliers for reference machine and large extractor

Suppliers for reference machines, reference programmes, flowmeter and large extractor:

Electrolux Laundry systems Sweden AB
S-341 80 Ljungby
Phone +46 372 66100
Fax +46 372 13390
E-mail els.info@electrolux.com
Web site http://laundrysystems.electrolux.com

Other machines of equivalent characteristics may be employed after correlation tests with the machines described in Annex D.

U.3 Suppliers for test materials

EMPA Testmaterials
Mövenstrasse
CH-9015 St.Gallen
Switzerland
Phone +41 71311 8055
Fax +41 71311 8057
E-mail testmat@empa-testmaterials.ch
Web site http://www.empa-testmaterials.com

WFK – Testgewebe GmbH
Christenfeld
D-41379 Brüggen
Germany
Phone +49 2157 871977
Fax +49 2157 90667
E-mail info@testgewebe.de
Web Site http://www.testgewebe.de

A suitable test fabric for the wool shrinkage specimens conforming to the characteristics specified in 5.3.4 is produced for the standards and testing department of the Wool Mark Company, and carries the reference IWS SM 12.

Wool Mark Company
Valley Drive
Ilkley
West Yorkshire LS29 8PB
England
Phone +44 1943 601 555
Fax: +44 1943 601 521
Web Site http://www.woolmark.com

Equivalent fabrics may be used if they can be shown to lead to the same results.

Bibliography

EN 50229, *Electric clothes washer-dryers for household use. Methods of measuring the per- formance*

IEC 60704-1:1997, *Household and similar electrical appliances – Test code for the determina- tion of airborne acoustical noise – Part 1: General requirements*

IEC 60704-2-4:2001, *Household and similar electrical appliances – Test code for the determi- nation of airborne acoustical noise – Part 2-4: Particular requirements for washing machines and spin extractors*

IEC 60734, *Household electrical appliances – Performance – Hard water for testing*

IEC 61121:2002, *Tumble dryers for household use – Methods for measuring the performance*

IEC/TR 61592, *Household electrical appliances – Guidelines for consumer panel testing*

IEC/TR 61923, *Household electrical appliances – Method of measuring performance – As- sessment of repeatability and reproducibility*

IEC/TR 62617, *Home laundry appliances – Uncertainty reporting of measurements*

IEC/PAS 62473, *Clothes washing machines for household use – Method for measuring the mechanical action in household washing machines*

ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories*

ISO/IEC Guide 43-1:1997, *Proficiency testing by interlaboratory comparisons – Part 1: Devel- opment and operation of proficiency testing schemes*

ISO/IEC Guide 43-2:1997, *Proficiency testing by interlaboratory comparisons – Part 2: Selec- tion and use of proficiency testing schemes by laboratory accreditation bodies*

ISO/IEC Guide 46, *Comparative testing of consumer products and related services – General principles*

ISO/IEC Guide 58, *Calibration and testing laboratory accreditation systems – General re- quirements for operation and recognition*

ISO/IEC Guide 98-3*, Uncertainty of measurement – Part 3: Guide to the expression of uncer- tainty in measurement (GUM:1995)*

ISO 3759:2007, *Textiles − Preparation, marking and measuring of fabric specimens and gar- ments in tests for determination of dimensional change*

ISO 3801, *Textiles – Woven fabrics – Determination of mass per unit length and mass per unit area*

ISO 4319:1977, *Surface active agents – Detergents for washing fabrics – Guide for compara- tive testing of performance*

ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions*

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of repeatability and reproducibility of a standard meas- urement method*

ISO 5725-3, *Accuracy (trueness and precision) of measurement methods and results – Part 3: Intermediate measures of the precision of a standard measurement method*

ISO 5725-4, *Accuracy (trueness and precision) of measurement methods and results – Part 4: Basic methods for the determination of the trueness of a standard measurement method*

ISO 5725-5, *Accuracy (trueness and precision) of measurement methods and results – Par 5: Alternative methods for the determination of the precision of a standard measurement method*

ISO 5725-6, *Accuracy (trueness and precision) of measurement methods and results – Part 6: Use in practice of accuracy values*

ISO/TR 22971, *Accuracy (trueness and precision) of measurement methods and results – Practical guidance for the use of ISO 5725-2:1994 in designing, implementing and statistically analysing interlaboratory repeatability and reproducibility results*

DIN 53923, *Testing of textiles; Determination of water absorption of textile fabrics*

CIE No. 15.2:1986, *Colorimetry, 2nd edition (International Commission on Illumination)* [1)]

ISO/CIE 10526, *CIE standard illuminants for colorimetry*

International Table Tennis Federation, ITTF Technical Leaflet T3 (May 2001) (Technical specification for table tennis balls – 40mm diameter). See also: http://www.sizes.com/sports/table_tennis.htm

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