

Clothes washing machines for household use — Methods for measuring the performance

The European Standard EN 60456:1999, with the incorporation of amendments A11:2001, A12:2001 and A13:2003, has the status of a British Standard

ICS 97.060

National foreword

This British Standard is the English language version of EN 60456:1999 including amendments A11:2001, A12:2001 and A13:2003. It was derived by CENELEC from IEC 60456:1998. It supersedes BS EN 60456:1995 which will be withdrawn on 1999-10-01.

The CENELEC common modifications have been implemented at the appropriate places in the text. The start and finish of each common modification is indicated in the text by tags [C] [C]. Where a common modification has been introduced by amendment, the tags carry the number of the amendment. For example, the common modification introduced by CENELEC amendment A11 are indicated by [C11] [C11].

The UK participation in its preparation was entrusted by Technical Committee CPL/59, Performance of household electrical appliances, to Subcommittee CPL/59/4, Home laundry appliances, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

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English version

Clothes washing machines for household use — Methods for measuring the performance

(including amendments A11:2001, A12:2001 and A13:2003)

(IEC 60456:1998, modified)

Machines à laver le linge pour usage domestique —
Méthodes de mesure de l'aptitude à la fonction
(inclut les amendements A11:2001, A12:2001
et A13:2003)
(CEI 60456:1998, modifiée)

Waschmaschinen für den Hausgebrauch —
Verfahren zur Messung der Gebrauchseigenschaften
(enthält Änderungen A11:2001, A12:2001
und A13:2003)
(IEC 60456:1998, modifiziert)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of the International Standard IEC 60456:1998, prepared by SC 59D, Home laundry appliances, of IEC TC 59, Performance of household electrical appliances, together with common modifications prepared by the Technical Committee CENELEC TC 59X, Consumer information related to household electrical appliances, was submitted to the formal vote and was approved by CENELEC as EN 60456 on 1999-05-01.

This European Standard supersedes EN 60456:1994 and its amendments.

Significant technical differences are:

- a) Agitator and impeller washing machines have been included.
- b) Tolerance limits have been specified for instrumentation, base loads and detergent.
- c) Instrumentation of measuring optical reflectance has been specified.
- d) The temperature of hot water supply has been raised from $(55 \pm 2) ^\circ\text{C}$ to $(60 \pm 2) ^\circ\text{C}$.
- e) A formula to calculate the energy consumption of washing machines without heating elements or with cold and hot water supply has been introduced (see common modifications).
- f) The tolerances for the declaration of the washing performance are changed.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1999-10-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1999-10-01

Annexes designated “normative” are part of the body of the standard.

Annexes designated “informative” are given for information only.

In this standard, Annex A, Annex B, Annex C and Annex ZA are normative and Annex D, Annex E, Annex F and Annex G are informative.

Annex ZA has been added by CENELEC.

Foreword to amendment A11

The amendment was prepared by the Technical Committee CENELEC TC 59X, Consumer information related to household electrical appliances. It improves the reproducibility of the test results on washing performance by means of an additional flowmeter attached to the Wascator reference machine.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as amendment A11 to EN 60456:1999 on 2000-08-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2001-08-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2001-08-01

Foreword to amendment A12

This amendment was prepared according to the decision made by the Technical Committee CENELEC TC 59X, Consumer information related to household electrical appliances, at the meeting on 20th July 1999. It specifies the new reference detergent CLC A* to replace the present IEC 60456 reference detergent A.

The text of the draft amendment was submitted to the Unique Acceptance Procedure and was approved by CENELEC as amendment A12 to EN 60456:1999 on 2001-07-03.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2002-02-01
- latest date by national standards conflicting with the amendment have to be withdrawn (dow) 2004-02-01

Introduction to amendment A12

The IEC 60456 reference detergent A to be used for testing washing machines according to EN 60456:1999 ran out at the end of 1999 and could no longer be produced. As a consequence, manufacturers have been faced with the problem of being obliged by law to label their washing machines whilst not being in the position to carry out the needed tests due to the lack of the reference detergent required by EN 60456:1999.

Because of missing financing CLC/TC 59X could not carry out an interlaboratory test for approving the new reference detergent A*. In order to resolve this unacceptable situation CECED, the European manufacturers association, carried out the interlaboratory test (13 labs) at their own expense. Having discussed the results of this interlaboratory test at the meeting on 20th July 1999, CLC/TC 59X approved the reference detergent A* (CLC A*) for the 60 °C cotton programme to replace the IEC 60456 detergent reference (IEC A).

Scope to amendment A12

This amendment specifies the composition of the new CENELEC reference detergent A* (CLC A*) which shall be applied in accordance with the Directive 95/12/EC implementing Council Directive 92/75/EEC with regard to energy labelling of electric washing machines for household use.

It replaces IEC 60456 reference detergent A, which must not be used for the purpose of energy labelling.

Foreword to amendment A13

This amendment was prepared by WG 1, Washing machines, of the Technical Committee CENELEC TC 59X, Consumer information related to household electrical appliances.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as amendment A13 to EN 60456:1999 on 2002-12-03.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2003-06-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2003-06-01

This amendment improves the reproducibility of the test method for the determination of the washing efficiency of washing machines. It does not modify the test procedure in principle but specifies much more precisely the test conditions. Modifications of IEC 60456 and IEC 61121 presently under consideration by IEC/SC 59D are taken into account as far as possible.

It additionally introduces the common ambient conditions for washing machines, tumble dryers and dishwashers.

In future the new reference detergent is called generally "IEC A*".

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this amendment, Annex ZA, Annex ZB, Annex ZC, Annex ZD and Annex ZE are normative and Annex ZF is informative.

Annex ZA to Annex ZF have been added by CENELEC.

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Introduction

Experience of the use of IEC 60456, second edition, together with some revised test conditions and a common base load with IEC 61121 are the reasons for a third edition.

The main changes are

- 1) Extent:
 - this edition encompasses also agitator washing machines and impeller washing machines.
- 2) Reproducibility:
 - repeatability of washing results has been improved by specifying tolerance limits for instrumentation, base loads and detergents;
 - instrumentation of measuring optical reflectance has been specified. Accuracy requirements for photocolimeters are under consideration.
- 3) Loads:
 - the test loads of cotton, of easy-care textiles and of polyester textiles have been revised, and the specifications of cotton and easy-care textile loads are now the same in IEC 60456 and IEC 61121. The three loads are named “cotton base load”, “easy-care textile base load” and “polyester textile base load”;
 - tolerances for size and mass per unit area of base load materials have been introduced;
 - the preparation of the base loads has been changed;
 - to minimize the influence of ageing of the textiles, a method of mixing old and new textiles is specified.
- 4) Reference washing machine:
 - the specifications and the programming instructions of the reference washing machine have been improved.
- 5) Other changes:
 - the temperature of hot water supply has been raised from $(55 \pm 2) ^\circ\text{C}$ to $(60 \pm 2) ^\circ\text{C}$;
 - the formula for the correction of consumption figures has been modified, but this method is still under consideration.
- 6) Methods under consideration:
 - the method of determination of creasing for both washing machines and tumble dryers is under consideration;
 - the need to specify the properties of water (water hardness and conductivity) is under consideration;
 - the use of a second water hardness is also under consideration;
 - soiling with blood is being reconsidered.

1 Scope

This International Standard deals with the methods for measuring the performance of clothes washing machines with or without heating devices, for household use. It also deals with appliances for water extraction by centrifugal force. It is also applicable to appliances for both washing and drying textiles (called washer-dryers) with respect to their washing performance.

The object is to state and define the principal performance characteristics of household electric **washing machines** and spin extractions and to describe the standard methods for measuring these characteristics. This standard is concerned neither with safety nor with performance requirements.

☐ This European Standard also specifies, as far as necessary, the test methods which shall be applied in accordance with the Commission's Directive 95/12/EC of 23 May 1995 implementing Council Directive 92/75/EEC with regard to energy labelling of household washing machines. It adds a subclause which specifies the determination of the energy consumption of washing machines without heating elements and clauses defining permitted tolerances to values declared by the manufacturer and control procedures for checking these declared values. ☐

NOTE This standard applies to cold and/or hot water connected **washing machines** for communal use in blocks of flats or in launderettes, but **washing machines** for commercial laundries are not included.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

☐ IEC 60704-2-4:1989, *Test code for the determination of airborne acoustical noise emitted by household and similar electrical appliances — Part 2: Particular requirements for washing machines and spin extractors*.

IEC 60704-3:1992, *Test code for the determination of airborne acoustical noise emitted by household and similar electrical appliances — Part 3: Procedure for determining and verifying declared noise emission values*. ☐

☐ IEC 60734 ☐, *Hard water to be used for testing the performance of some household electrical appliances*.

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

ISO 3801:1977, *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 comparative testing of performance*.

ISO 7211-2:1984, *Textiles — Woven fabrics — Construction — Methods of analysis — Part 2: Determination of numbers of threads per unit length*.

☐ DIN 53923, *Prüfung von Textilien — Bestimmung des Wasseraufnahmevermögens von textilen Flächengeweben (Testing of textiles — Determination of water absorption of textile fabrics)*. ☐

3 Definitions

For the purposes of this International Standard, the following definitions apply:

3.1

washing machine

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

3.2

agitator washing machine

washing machine in which the textiles are substantially immersed in the washing water, the mechanical action being produced by a device moving about or along its vertical axis with a reciprocating motion (an agitator)

this device usually extends above the maximum water level

3.3

horizontal drum washing machine

washing machine in which the textiles are placed in a horizontal drum and partially immersed in the washing water, the mechanical action being produced by rotation of the drum about its axis, the movement being either continuous or periodically reversed

3.4

impeller washing machine

washing machine in which the textiles are substantially immersed in the washing water, the mechanical action being produced by a device rotating about its axis continuously or which reverses after a number of revolutions (an impeller)

the uppermost point of this device is substantially below the minimum water level

3.5**washer-dryer**

washing machine which includes both a water extraction (spin) function and also a means for drying the textiles, usually by heating and tumbling

3.6**spin extractor**

water-extracting appliance in which water is removed from textiles by centrifugal action

3.7**spin extraction**

water-extracting function by which water is removed from textiles by centrifugal action

this is usually included as a function of a **washing machine** but may also be performed in a **spin extractor**

3.8**base load**

textile load without strips of standardized soiling

3.9**test load**

base load plus strips of standardized soiling

3.10**programme**

series of operations which are pre-defined within the **washing machine** and which are declared as suitable for washing certain textiles

3.11**cycle**

complete washing process, as defined by the **programme** selected, consisting of a series of different operations (wash, rinse, spin, etc.)

3.12**rated capacity**

maximum mass of dry textiles which the manufacturer declares can be treated in a specific **programme**

Ⓒ for measuring the performance of washing machines according to this standard the rated capacity shall correspond with the test load

the test load comprises the base load specified in 7.1 and the test strips specified in 7.3 Ⓒ

4 External dimensions

- Height a_1 = vertical dimension measured from the lower edge (on the floor) to a horizontal plane at the maximum height of the appliance, with the door 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 lower edge (on the floor) to a horizontal plane at the maximum height of the appliance with the door open.
- Width b = horizontal dimension, between the sides, as measured between two parallel vertical planes against the sides of the appliance including all projections.
- Depth c_1 = horizontal dimension as measured from a vertical rear plane against the appliance and the most prominent part of the front, knobs and handles not being taken into account, with the door closed.
- Depth c_2 = horizontal dimension as measured from a vertical rear plane against the appliance and the most prominent part of the front, knobs and handles also being taken into account, with the door open.

5 Rated capacity

☞ The rated capacity for measurements to determine values to be declared for the 60 °C cotton cycle according to the Commission's Directive on energy labelling is the value declared by the manufacturer as highest amount of cotton textiles to be washed, given in the instruction manual or on the energy label supplied with the machine, whatever is higher. ☞

If the **rated capacity** is not declared, the **rated capacity** for a cotton load shall be deduced from the volume of the drum according to the following ratios:

— horizontal drum washing machine	1 kg/13 l;
— agitator washing machine	1 kg/15 l;
— impeller washing machine	1 kg/20 l;
— spin extractor	1 kg/4,6 l.

If the **rated capacity** for easy-care textiles and woollens is not specified by the manufacturer, the load shall be respectively 40 % and 20 % of that for cotton.

Where the manufacturer gives a range for the **rated capacity**, for example 4,5 kg – 5 kg, maximum value shall be used.

The volume of a **horizontal drum washing machine** or **spin extractor** is determined as the inside volume, in litres, of the drum in which the textiles are placed, after the subtraction of ribs or other inward protrusions, etc. The volume of an **impeller or agitator washing machine** is the volume of the bowl, after the subtraction of ribs, agitator and/or other inward protrusions, to the maximum water level of the **washing machine** when filled without a load.

6 General conditions for measurements

6.1 General

Only tests which are in line with the manufacturer's instructions shall be carried out, except where these conflict with the requirements of this standard.

☞ The measurements shall be carried out on a new machine installed and used in accordance with the manufacturer's instructions, except if required otherwise by this standard.

Before commencing a series of tests machines shall run two complete cycles, at maximum temperature (e.g. 95 °C); the first cycle without load and with 50 g of the reference detergent IEC A*. The second one without load and without detergent.

Washing performance, spinning extraction, time and water and energy consumption shall be tested in the same cycle. ☞

☞ For the purpose of energy labelling according to the Commission Directive mentioned in Clause 1, Scope, the 60 °C cotton programme shall be used without pre-wash in accordance with the manufacturer's instruction. ☞

6.2 Resources and ambient conditions

6.2.1 Electrical supply

☞ The supply voltage shall be maintained at 230 V ± 1 %.

The supply frequency shall be 50 Hz ± 1 %. ☞

☞ The voltage stabilizer used shall ensure that the normal operation of the washing machine does not cause undue distortion of the voltage waveform. ☞

6.2.2 Water supply

A water hardness of (2,5 ± 0,2) mmol/l shall be used for all **programmes**. If water hardness needs to be adjusted, it shall be prepared according to ☞ IEC 60734 ☞.

NOTE 1 The influence of conductivity is under consideration.

NOTE 2 The use of a second water hardness of (0,5 ± 0,1) mmol/l is under consideration.

The temperature of the water supply shall be:

- for cold water $(15 \pm 2) ^\circ\text{C}$;
- for hot water temperature indicated by the manufacturer $\pm 2 ^\circ\text{C}$, or $(60 \pm 2) ^\circ\text{C}$ if a value is not given.

The dynamic pressure of the water supply at each water inlet shall be maintained at (240 ± 50) kPa throughout the test. The measured water pressure shall be reported.

Ⓒ When carrying out measurements to determine values to be declared for the $60 ^\circ\text{C}$ cotton cycle according to the Commission Directive on energy labelling the temperature of the water supply shall be $(15 \pm 2) ^\circ\text{C}$. For appliances without heating elements hot water is permitted to be used and the temperature shall be reported. Ⓒ

6.2.3 Ambient temperature

The ambient temperature of the room shall be maintained at Ⓒ $(23 \pm 2) ^\circ\text{C}$ Ⓒ throughout the test. The measured ambient temperature shall be reported.

6.3 Reference washing machine

A reference **washing machine** shall be run in parallel with a **washing machine** to be tested to provide reproducible results. Specifications for the reference **washing machine** are given in Annex A.

Ⓒ At each run it shall be checked that no detergent remained in the detergent dispenser. Ⓒ

7 Materials

7.1 Base loads

7.1.1 Cotton base load

The cotton **base load** shall consist of sheets, pillowcases and hand-towels conforming with the following specifications Ⓒ given in Annex ZB Ⓒ.

Sheets and pillowcases:

Bleached cotton 1/1 plain weave

Mass per unit area	(185 ± 10) g/m ² (of finished fabric)
Warp	(23 ± 1) threads/cm of (36 ± 1) tex
Weft	(23 ± 1) threads/cm of (36 ± 1) tex
Sheet size	$(1\ 500\ \text{mm} \times 2\ 600\ \text{mm}) \pm 2\ %$
Pillowcase size	Pieces of $(1\ 600\ \text{mm} \times 800\ \text{mm}) \pm 2\ %$ folded in half and sewn along the three open edges thus forming double thickness (finished size of $800\ \text{mm} \times 800\ \text{mm}$, approximately)

Hand-towels:

Bleached cotton weave-huckaback

Mass per unit area	(230 ± 12) g/m ² (of finished fabric)
Warp	(19 ± 1) threads/cm of (36 ± 1) tex
Weft	(13 ± 1) threads/cm of (90 ± 1) tex
Size	$(1\ 000\ \text{mm} \times 460\ \text{mm}) \pm 2\ %$

The number of sheets, pillowcases and hand-towels in the cotton **base load** for various **rated capacities** is given in Table 1.

Table 1 — Number of items of cotton base load for various rated capacities

Rated capacity kg	Number of sheets	Number of pillowcases	Number of hand-towels
2	1	2	Number required to make up rated capacity
2,5	1	3	
3	1	4	
3,5	2	3	
4	2	4	
4,5	2	6	
5	2	6	
5,5	2	8	
6	2	8	
6,5	2	10	
7	2	12	
7,5	3	12	
8	3	14	
8,5	3	16	
9	3	18	
9,5	3	20	
10	3	22	

An item shall not be used more than **80 cycles** (not counting pre-treatment and the normalization between two test series).

☞ To minimize the influence of ageing of the textiles, the **base load** shall consist of items that are evenly distributed in age for all different parts (sheets, pillowcases and hand towels) to give a weighted average age of the load between 30 and 50 cycles, using the nominal weights given in Annex ZB. How the average age of the load can be calculated is given in Annex ZE, examples of how the textiles may be exchanged are given in Annex ZF.

The age-distribution is to be reported. ☞

7.1.2 Easy-care textile base load

Easy-care textiles are produced using fibres and treatments aimed to decrease the need for ironing.

The easy-care textile **base load** shall consist of men's shirts and pillowcases conforming with the following specifications. The values below are for new (unwashed) textiles.

Men's shirts, long arm, white:

Polyester/cotton blended textile with the proportion of polyester of $(65 \pm 3) \%$

Mass $(215 \pm 35) \text{ g}$

Mass per unit area 115 g/m^2 , approximately

Pillowcases:

White cross-linked polyester/cotton blended textile with the proportion of polyester of $(65 \pm 3) \%$

Mass per unit area $(125 \pm 25) \text{ g/m}^2$

Size Pieces of $(1\,600 \text{ mm} \times 800 \text{ mm}) \pm 2 \%$ folded in half, and sewn along the three open edges, thus forming a double thickness finished size of $800 \text{ mm} \times 800 \text{ mm}$, approximately.

The easy-care textile **base load** is made up of an equal number of shirts and pillowcases. Final adjustment of the **base load** is made by adding one shirt or one pillowcase whichever adjusts closest to the **rated capacity**.

If the manufacturer declares the easy-care textile load as a "number of shirts", the **rated capacity** (kg) shall be the number of shirts multiplied by 0,2.

An item shall not be used more than **80 cycles**. To minimize the influence of the ageing of the textiles, half the **base load** shall consist of items used less than 40 times and the remainder used more than 40 times.

7.1.3 Polyester textile base load for wool programme

The **base load** shall consist of double knitted polyester textile test pieces conforming with the following specification.

Knitted polyester textile:

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

The **base load** consists of the number of test pieces that is closest to the **rated capacity**.

7.2 Preparation of the base load

7.2.1 Preparation of textiles

☞ New textile items shall be pre-treated before their first use by five normalization processes according to 7.2.2 but using 15 g/kg of the reference detergent IEC A* followed by conditioning according to 7.2.3. ☞

☞ After every five test cycles, the **base load** shall be normalized according to 7.2.2, but without detergent (to avoid detergent accumulation) and ironed (to avoid wrinkles). This is followed by conditioning according to 7.2.3. ☞

7.2.2 Normalization of textiles

☞ Wash the textiles in the Cotton 60 °C program of a reference **washing machine** without detergent. ☞

For cotton textiles, use a 60 °C cotton **programme** without prewash but including rinsing and spinning and then dry to a final moisture content of about 0 % in a tumble dryer.

For easy-care textiles, use a 60 °C easy-care textile **programme** without prewash but including rinsing and spinning and then dry to a final moisture content of about 2 % in a tumble dryer.

7.2.3 Conditioning of textiles

☞ The textiles are left for at least 15 h in an ambient temperature of (20 ± 2) °C and at an ambient humidity of (65 ± 5) % RH unless the weight of the load has changed less than 0,5 % between two successive measurements. These measurements are carried out at two-hour intervals.

As an alternative the bone-dry method of Annex F of BS 60456 may be used. After drying the textiles have to be left at least 5 h at ambient temperature according to 6.2.3 to take up water before being used for tests.

If the bone-dry method is used, it shall be reported. ☞

7.3 Soiled test strips

7.3.1 Characteristics

Different types of soiling are used to enable the following characteristics to be measured:

- the scouring effect, chiefly due to mechanical and thermal action, the test piece used being soiled 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 chocolate and milk;
- the bleaching effect, the test piece used being soiled with red wine;
- the definitions of test pieces with standardized soiling (supporting fabric, the nature and application of the various kinds of soil) are given in Annex C.

☞ Washed soiled test strips shall fulfil the performance limits (ratios of Y-values) as defined in Annex ZC.

The storage conditions including deadline of use for soiled test strips shall be given by the manufacturer. If no conditions are given the soiled test strips shall be kept vacuum packed in a refrigerator and shall be used within 1 year after production. ☞

NOTE 1 Strips with the proper characteristics can be obtained from EMPA, St. Gallen, Switzerland. EMPA, the Eidgenössische Materialprüfungs- und Forschungsanstalt is a testing laboratory. The information given is for the convenience of users of this standard and does not constitute an endorsement by IEC of this product. Other strips may be used if they can be shown to lead to equivalent results.

NOTE 2 The use of blood is being reconsidered.

7.3.2 Preparation and fixing of test strips

Test strips consist of square specimens measuring $(150 \pm 5) \text{ mm} \times (150 \pm 5) \text{ mm}$, cut from the fabric, carrying different types of standard artificial soil and joined together into a strip with the different kinds of soil in the following order:

- carbon black/mineral oil;
- blood;
- chocolate and milk;
- red wine.

NOTE It is recommended that an unsoiled cloth specimen should be attached along the strip as a blank control for the supporting fabric.

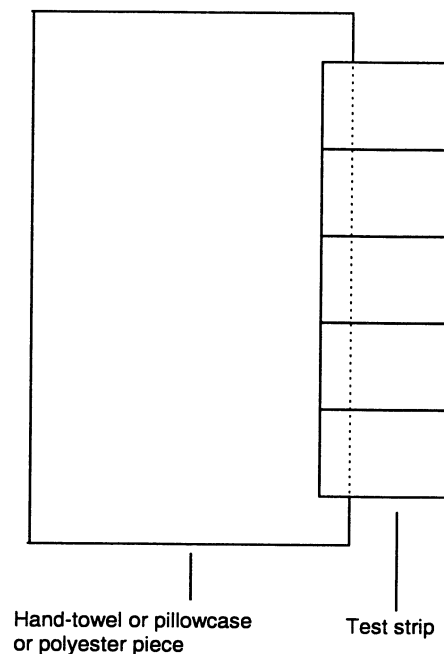
The strips have to be fixed with non-metallic fasteners, as follows:

- on the hand-towels of a cotton **base load**; or
- on the pillowcases of an easy-care textile **base load**; or
- on pieces of a polyester textile **base load**.

See Figure 1 for the attachment orientation.

The number of test strips used for a washing test is proportional to the **rated capacity**, and is determined as follows:

- two test strips for **rated capacities** up to 2,4 kg;
- three test strips for **rated capacities** from 2,5 kg to 3,4 kg;
- four test strips for **rated capacities** from 3,5 kg to 4,4 kg;
- five test strips for **rated capacities** from 4,5 kg to 5,4 kg;
- six test strips for **rated capacities** from 5,5 kg to 6,4 kg;
- seven test strips for **rated capacities** from 6,5 kg to 7,4 kg;
- eight test strips for all **rated capacities** greater than 7,4 kg.



IEC 1 301/97

Figure 1 — Attachment of test strips

7.4 Detergents

7.4.1 General

Ⓒ12 The specification for reference detergents CLC A* and IEC C are given in 7.4.2 and 7.4.3. Ⓒ12

Ⓒ When carrying out measurements to determine the performance of washing machines according to the Commission's Directive only detergent A shall be used. Ⓒ

NOTE 1 A previous IEC 60456 reference detergent B containing phosphates is no longer in use. It is however specified in informative Annex E.

Ⓒ12 NOTE 2 The comparability of the test results of the new reference detergent CLC A* to those of the old IEC 60456 reference detergent A are only guaranteed with regard to the 60 °C washing cycle. However, the new reference detergent CLC A* can also be used for other test procedures specified in EN 60456, but there is no guarantee concerning comparability of the test results to those of the old detergent A. Ⓒ12

7.4.2 Ⓒ12 Reference detergent CLC A*

Table 2 — Composition of the reference detergent CLC 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 (granules)	2,4	0,2
Sodium silicate (SiO ₂ :Na ₂ O = 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	20,0	1
Tetra-acetylenediamine (100 %)	3,0	0,2

NOTE 1 The reference detergent is distributed in three separate parts:

- a) basic powder with enzyme and foam inhibitor;
- b) sodium perborate tetrahydrate;
- c) bleach activator tetraacethylen-ethylene-diamine.

The proportions of ingredients of the ready detergent are:

- 77 % basic powder with enzyme and foam inhibitor;
- 20 % sodium perborate tetrahydrate;
- 3 % bleach activator tetraacethyl-ethylene-diamine.

NOTE 2 Due to variability, which may result from the manufacturing procedure of the detergent or of its ageing, for comparative measurements, use of a reference detergent supplied by a single manufacturer from a recent production batch is recommended. It is also recommended that the detergent and perborate be kept separately in small quantities (e.g. 1 kg) and used within a limited time.

NOTE 3 It is recommended that the detergent manufacturer should indicate the pH of the product supplied. Further product specifications are under consideration.

NOTE 4 The ingredients shall be thoroughly mixed prior to use. The maximum storage time after mixing is seven days.

NOTE 5 The amount of detergent shall be determined according to the following formula:

$$\text{Amount} = 54 \text{ g} + 16 \text{ g/kg of rated capacity}$$

NOTE 6 If a prewash is to be included, the total quantity of detergent used shall be 1,25 times the figures above. The total detergent quantity is to be split between prewash and main wash in accordance with the manufacturer's instructions. If there are no instructions, the split shall be 1 : 2 for prewash : main wash.

NOTE 7 Information about analytical methods for checking the component of the detergent are available from the wfk web-site: www.testgewebe.de.

The deadline for the use of the new detergent CLC A* and the storage conditions shall be given by the manufacturer when supplied. If no deadline for the use of the detergent is given it shall be used within one year of production. [C12](#)

7.4.3 IEC 60456 reference detergent C

Reference detergent C is for use in **agitator** and **impeller washing machines**.

Table 3 — Composition of reference detergent C

Ingredient	%
Sodium dodesylbenzene sulfonate	13 ± 0,2
Sodium tripolyphosphate	30 ± 0,5
Alkaline sodium silicate (Na ₂ O, 2SiO ₂)	10 ± 0,1
Sodium carboxymethylcellulose	0,8 ± 0,1
Sodium sulfate	36,2
Water	10

The amount of detergent shall be 1,5 g/l of wash water volume for water hardness 0,5 mmol/l.

8 Instrumentation and accuracy

Instruments fulfilling the following specifications and requirements shall be used for tests.

8.1 Mass

Measurements shall be accurate to [C13](#) ±0,1 % [C13](#).

8.2 Ambient temperature

Ambient temperature measurements shall be accurate to ±0,5 K including non-linearity error in the temperature range 10 °C to 50 °C.

8.3 Ambient humidity

Measurements of relative humidity shall be accurate to ±3 % over the temperature range 15 °C to 25 °C.

8.4 Water temperature

[C](#) The temperature measuring device shall have a resolution of at least 0,2 K and an accuracy of ±1 K including non-linearity error, in the temperature range 0 °C to 60 °C. [C](#)

NOTE The temperatures (60 ± 2) °C and (15 ± 2) °C should be measured to within ±1,5 K of the nominal values.

8.5 Water volume

Measurements shall be accurate to ±1 %.

NOTE Devices using viscosity should be calibrated at the actual nominal temperature ±5 K, and the nominal flow rate.

8.6 Water pressure

Measurements shall be accurate to ±5 %.

8.7 Water hardness

Measurements shall be accurate to ±0,1 mmol/l.

8.8 Electrical energy

[C](#) The measurement shall have an accuracy that provides less than 2 % inaccuracy of the highest nominal value according to rated power input data specified by the manufacturer. [C](#)

[C13](#) Energy meters shall fulfil EN 61036 type 1 specification(s). [C13](#)

8.9 Time

Measurements shall be accurate to ±5 s.

8.10 pH

Measurements shall be accurate to pH ± 0,1 over a temperature range 10 °C to 20 °C.

8.11 Reflectance measurement for soiled test strips

Optical measurements of the different types of washed test strip specimens are made with a spectral photometer. The measuring conditions are as indicated below:

Measuring instrument	: spectral photometers that provide 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 (CEI Nr. 15.2, 1986)
Illuminant/observer	: D65/10°
Measuring geometry	: D/8°
UV filter	: UV barrier at 420 nm, i.e. measurement without UV radiation
Measuring diameter	: minimum 20 mm
Gloss/specular	: excluded, i.e. measurement with open gloss/specular trap
Calibration	: has to be done each time the spectral photometer is switched on or at least once per working day: : white standard: barium sulfate tablet or ceramic tile; black standard: black body For general handling of the device and for further information about calibration the operation instruction for use shall be observed.

NOTE 1 The spectral photometer should be tested at least once a year for its operation efficiency.

NOTE 2 CIE = Commission Internationale de l'Eclairage (International commission on illumination), CIE Central Bureau, Kegelgasse 27, A-1030 Vienna/Austria, Tel: +43 (01) 714 31 87, Fax: +43 (01) 713 0838, E-mail: iecb@ping.at 

9 Washing performance

9.1 General

This clause contains specifications for the test procedure using soiled test strips, which are washed together with a **base load**. The purpose of this test is to evaluate the typical soil removal performance of the **washing machine** under test, in relation to the reference **washing machine**, see 6.3.

NOTE 1 The test in this clause may be combined with the rinsing test in Clause 10, the **spin extraction** test in Clause 11, and the consumption measurements in Clause 12.

NOTE 2 A test using naturally soiled textiles is dealt with in ISO 4319. A description is given in Annex D.

9.2 Material and equipment

The **test load** consists of a **base load** of either cotton, easy-care textiles or polyester textiles in accordance with 7.1 and test strips in accordance with 7.3. The total mass of the **test load** shall correspond to the **rated capacity**.

The detergent and dosage is in accordance with 7.4.

An iron or an ironing appliance with a surface temperature between 130 °C and 150 °C is provided.

9.3 Procedure

9.3.1 General

For the determination of the washing performance the **washing machine** shall be loaded with the **test load** in the order indicated in 9.3.2 and 9.3.3.

 The load shall be distributed evenly from the bottom of the drum to the top. 

 Soiled test strips from the same batch shall be used for reference machine and for the washing machine under tests.

All handling of the load and the strips shall be equal. Both the reference machine and the machine under test shall be loaded in the same way from bottom to top putting in all articles in a flat way. The detailed procedure is described in ZD.4. 

9.3.2 Cotton test load

- First two pillowcases
- Second half of the amount of test strips fixed on hand-towels, see Figure 1
- Third one sheet
one pillowcase (if applicable)
half of the amount of hand-towels
- Fourth half of the amount of test strips fixed on hand-towels
- Fifth rest of the pillowcases, sheets and hand-towels

NOTE If there are an odd number of test strips, the extra strip is put in the drum with the first load of test strips.

☐ The machines are loaded in the way as described in Annex ZD. ☐

9.3.3 Easy-care textile test load and wool test load

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

9.3.4 Test

☐ The reference machine shall perform a start up cycle before each cycle.

The machine under test shall be at ambient temperature before starting a cycle.

For energy label purposes only one cycle per day shall be done, unless it is verified that all parts of the machine under test are at ambient temperature.

The dispenser, if any, of the machine under test and of the reference machine is cleaned and dried before each cycle. It shall be ensured that in the reference machine the detergent is totally dispensed during the water intake for the main wash. ☐

☐ The **programme** shall be selected in accordance with the manufacturer's instructions for normal soiled clothes. ☐

NOTE 1 If there are several options or if the instructions are not clear, the manufacturer should be consulted.

☐ Parallel to each test cycle of the washing machine a cycle is performed on the reference washing machine (always with a 5 kg load according to Table A.2) under the same conditions with a reference programme cotton 60 °C (according to Table B.4 or Table B.5). ☐ The reference **programme** and its detergent dosage is specified in Annex B.

☐ If a detergent dispenser is incorporated in the washing machine the detergent shall exclusively be filled into the dispenser in accordance with the manufacturer's instructions, if any, for normal use. If some detergent remained in the dispenser the dispenser shall be cleaned before the next run. ☐

At least five complete **cycles** shall be carried out using the selected **programme**. For each **cycle**, new soiled test strips shall be used.

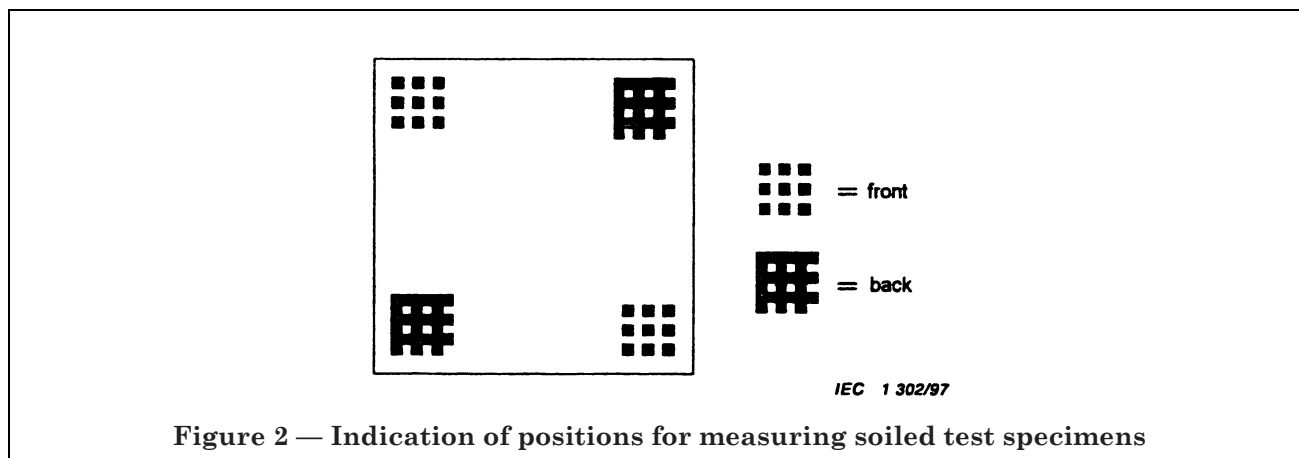
After the completion of the washing **programme**, all test strips are dried by ironing using a method which avoids surface "shine" (i.e. ironed between two pieces of fabric, or with an ironing appliance or press).

☐ Washed and ironed soiled test strips are to be stored in the absence of light at ambient temperature according to 6.2.3, until reflectance measurements are done. ☐

NOTE 2 Residual humidity in the strips will influence the measurement results, as will overheating during ironing.

☐ NOTE 3 Instead of ironing, the strips can be stretched and rolled on any airy roll between two pieces of fabric, or be fastened to hang in the dark. ☐

The reflectance measurements, ☐ performed according to 8.11 ☐, are carried out with a minimum of four layers of the same washed soiled type specimen as backing for the specimen being measured. Every washed specimen is measured twice on both sides, at the positions indicated in Figure 2. The average value of the four readings is reported as the value for that soiled test specimen.



9.4 Evaluation

The following calculation is carried out for each type of soiled test specimen.

- a) Average reflectance values for each soil type is given as the mean value of the readings for each of the n soiled test specimens used in the test as follows:

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

where

x_i is the average of the individual readings for each soiled test specimen;

n is the number of test strips in the wash.

- b) The sum of the soiling values in each wash, C , for each wash the four soiling types are calculated as follows:

$$C = \sum_{i=1}^4 \bar{x}_i$$

- c) The average sum of the soiling values for each of the four soiling types for all cycles, $\bar{C}$

$$\bar{C} = \frac{\sum_{i=1}^k C_i}{k}$$

where

k is the number of cycles.

- d) Ratio, q , between the **washing machine** under test, $\bar{C}_{\text{test}}$, and the reference **washing machine**, $\bar{C}_{\text{ref}}$ is calculated as follows:

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

- e) Standard deviation, S , between tests

$$S = \sqrt{\frac{\sum_{n=1}^k (q_n - q)^2}{k-1}}$$

where

q_n is the ratio between C_{test} and C_{ref} for the i th test **cycle**;

q is the ratio for all test **cycles** as in d) above;

k is the number of test **cycles**

NOTE 1 The standard deviation for each soiling within a given washing **cycle** may be calculated by

$$S_i = \sqrt{\sum_{i=1}^n (x - \bar{x})^2 / n_i - 1}$$

f) Confidence interval, p , for q

$$p = \pm \frac{S}{\sqrt{k-1}} \times t_{k-1, 0,05}$$

where

k is the number of **cycles**.

$t_{k-1, 0,05}$ is the "Student T" factor for $(k-1)$ degrees of freedom for a confidence of 95 %.

NOTE 2 The equation assumes parallel running of the test **washing machine** and the reference **washing machine**.

10 Rinsing test

10.1 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.

NOTE The test in this clause may be combined with the cleaning test in Clause 9, the **spin extraction** test in Clause 11 and the consumption measurements in Clause 12.

10.2 Material, equipment and instrumentation

A **spin extractor** shall be used. It shall have an inner drum diameter between 250 mm and 300 mm and a rotational frequency of about 2 800 r/min. The diameter and spin speed shall be reported.

A digital balance, a microburette, and a pH meter are also used.

10.3 Procedure

10.3.1 Initial test procedure

*The test of Clause 9 is repeated, except that the parallel **cycle** of the reference **washing machine** is performed with a 60 °C cotton **programme**.*

*After the completion of the washing **programme**, the extraction and sampling is carried out in accordance with 10.3.2.*

*At least five complete **cycles** shall be carried out using the selected **programme**. For each **cycle** new soiled specimens shall be used.*

10.3.2 Extraction and sampling

*A water sample of one litre is taken from the **washing machine** water supply (tap water) in connection with the performance of a rinsing test.*

*After a complete **programme** of washing, rinsing and, if possible, water extraction operations, the **test load** is removed immediately and only the **base load** (with any test strips removed) is weighed. If there is no water extraction operation at the completion of the washing **programme**, weighing is not necessary.*

*The **base load** is transferred, in parts, if necessary, to the **spin extractor** and spun for 5 min. All the extracted water is collected, the last amount by tilting the **spin extractor** towards the outlet, and thoroughly mixed. These steps are carried out quickly, without any pause.*

To prepare the **spin extractor** for subsequent use, the inner and outer tubs are rinsed with tap water and completely emptied as described above.

10.3.3 Alkalinity measurements

Carry out the following procedure to check the alkalinity of both the sample of water taken from the **spin extractor** and from the tap water.

Take 100 ml of water (or 50 ml, if the extraction amount is small) and titrate quickly within about 90 s in one operation with N/10 HCl to pH 4,0. Record the amount of acid used (in ml to two decimal places).

The alkalinity of the water is expressed in milliequivalents per litre.

10.4 Evaluation

The increased alkalinity concentration of rinse water relative to tap water is calculated as:

$$A_r = W_r - W_t \text{ [milliequivalents per litre]}$$

where

A_r is the increased concentration of alkalinity of water extracted during rinsing;

W_r is the concentration of alkalinity in water extracted during rinsing;

W_t is the concentration of alkalinity in tap water.

The amount of wash alkali remaining in the textiles 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 textiles;

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** after extraction.

A rinsing index, R , is determined by:

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

where

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

$A_{m,\text{ref}}$ is measured in the reference **washing machine** with the **programme** 60 °C cotton, as described in Annex A.

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

The result of the first test **cycle** after normalizing shall not be used for the assessment of the rinsing efficiency, thus only the last four **cycles** will be used for the determination of the rinsing efficiency.

The standard deviation is calculated as

$$S = \sqrt{\frac{\sum_{i=1}^k (R_i - \bar{R})^2}{k-1}}$$

where

R_i is the rinsing index from one **cycle**;

$\bar{R}$ is the mean of rinse indices for all **cycles**;

k is the number of **cycles**.

11 Spin extraction

11.1 General

This clause contains specifications for the measurement of the residual water in the **base load**.

The water extraction efficiency is expressed as the amount of moisture remaining in the **base load** after spinning relative to the conditioned mass of the same load.

The purpose is to evaluate effectiveness of water removal from a typical textile load at the end of a washing **cycle**.

NOTE The test in this clause may be combined with the cleaning test in Clause 9, the rinsing test in Clause 10, and the consumption test in Clause 12.

11.2 Procedure

11.2.1 Washing machines with a spinning operation

*The conditioned mass, M , of the **base load** is determined. It is then submitted to the same procedure as Clause 9; however, instead of soiled test strips, cleaned ones may be used.*

*After the completion of the **spin extraction**, the mass, M_r , of the **base load** is determined (with any test strips removed), and the following ratio is calculated for each test **cycle**:*

$$\text{ratio} = \frac{M_r - M}{M}$$

where

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

M_r is the mass of the **base load** after extraction.

*At least five complete **cycles** shall be carried out of the selected **programme**.*

11.2.2 Separate spin extractors

*The tests, calculation and the number of **cycles** are carried out in accordance with 11.2.1. However, the washing and rinsing operations are performed in a **horizontal drum washing machine** with the reference detergent and the washing temperature being not less than 60 °C.*

*After washing and rinsing, the **spin extractor** is loaded evenly, with the items placed along the drum wall of the 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 standard textile which is folded over double for this purpose.*

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

11.3 Evaluation

The water extracting efficiency is the arithmetic mean of the five values obtained in 11.2. It is expressed as a percentage, rounded to the nearest even integer.

12 Water and energy consumption and programme time

12.1 General

This clause specifies the procedure and evaluation for the determination of water and energy consumption during typical operations of washing, rinsing and **spin extraction**. It also specifies the method for determination of the duration of the complete **programme**.

The purpose is to obtain reproducible data for the calculation of environmental impact and cost of operation.

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

NOTE 2 The tests in this clause may be combined with the tests in Clauses 9, 10, and 11.

12.2 Procedure

The tests in this clause are performed as in Clauses 9, 10, and 11 but with instrumentation for the measurement of water volume and electrical energy. A time measurement is started when the appliance is started as in normal use. It is stopped when the power consumption of the appliance drops to that in stand-by condition.

*At least five complete **cycles** shall be carried out using the selected **programme**.*

NOTE The time measured does not include any deliberate starting delay programmed by the user.

12.3 Evaluation

The arithmetic mean of the measured values is calculated.

Water volumes are expressed in litres, and rounded to the nearest integer.

Programme duration is rounded to the nearest minute.

Electrical energy is expressed in kWh to two decimal places.

Cold water supply energy correction factor: if the inlet temperature of the cold water deviates from 15 °C, the cold water energy correction factor shall be determined using the following formula:

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

where

- W_c is the cold water energy correction in kWh during a complete test;
- t_c is the measured inlet temperature of the cold water in degrees Celsius;
- V_c is the volume of the cold water used during the prewash and main wash only, in litres;
- 1/860 is the energy equivalent.

NOTE The correction should be done when the temperature of the 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.

12.101 Energy consumption for machines without heating elements

12.101.1 Procedure

The procedure is the same as described in 12.2 including the NOTE.

The temperature and the volumes of cold and hot water used during the cycle are measured separately.

For the purpose of measuring the energy, machines without heating elements should be loaded before the addition of water.

NOTE It is common practice to put water into the agitator machines before the addition of the load.

12.101.2 Evaluation

The arithmetic mean of the measured values is calculated.

The water volumes, program duration and energy consumption are expressed and rounded according to 12.3.

The total energy consumption E_T of washing machines having no heating elements or with cold and hot water supply is the energy consumption measured during the cycle E_c plus the calculated energy E_h needed to heat the hot water used during the cycle. Cold water supply energy corrections shall not be calculated.

$$E_T = E_c + E_h$$

$$E_h = \frac{V_h \times (t_h - 15)}{860}$$

where

- V_h is the volume of hot water in litres used during the cycle;
- t_h is the temperature of the hot water entering the appliance being tested;
- 1/860 is the energy equivalent. 

13 VOID

14 Shrinkage during the wool wash programme

14.1 General

This clause contains specifications for measuring the shrinkage rate (SR) during the wool wash programme.

14.2 Material and equipment

The load consists of **base load** as specified in 7.1.3 and test pieces with the specifications indicated below.

Wool quality	100 % wool fabric — plain weave
Mass per unit area	(150 ± 10) g/m ² (ISO 3801)
Warp	(114 ± 10) ends per 10 cm (ISO 7211-2)
Weft	(118 ± 10) picks per 10 cm (ISO 7211-2)
Size of test pieces	(34 × 35) cm (approximately), with marker threads along the edges

NOTE A suitable test fabric conforming to these characteristics is produced for the Standards and Testing Department of the International Wool Secretariat Technical Centre, Valley Drive, Ilkley, West Yorkshire, England, and carries the reference IWS SM 12. The information given is for the convenience of users of this standard and does not constitute an endorsement by IEC of this product. Equivalent fabrics may be used if they can be shown to lead to the same results.

Detergent and dosage as specified in 7.4.

Tray with flat bottom about 50 cm × 50 cm and with about 5 cm high sides.

Steel ruler accurate to ±0,5 mm.

14.3 Procedure

14.3.1 Preparation of test pieces

Three test pieces are prepared for each test cycle.

0,5 cm is frayed round all four sides in order to reduce edge felting, which can cause distortion of the fabric. Make “V” cuts into each side of the fabric as shown in Figure 3. The test piece has marker threads in both the weft and warp directions, as illustrated in Figure 3.