BS EN 61121:2013

BSI Standards Publication

Tumble dryers for household use — Methods for measuring the performance

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National foreword

This British Standard is the UK implementation of EN 61121:2013. It is derived from IEC 61121:2012. It supersedes BS EN 61121:2005 which is withdrawn.

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].

BSI, as a member of CENELEC, is obliged to publish EN 61121 as a British Standard. However, attention is drawn to the fact that the UK committee voted against its approval as a European standard. The technical reason for this is given below.

It is the opinion of the UK committee that Annex ZB contains potentially confusing information.

Annex III of EU Regulation 932/2012 (ecodesign requirements for household tumble driers) and Annex V of EU Regulation 392/2012 (energy labelling of household tumble driers) both describe verification procedure for market surveillance purposes. These requirements are for use by market surveillance authorities only; they should not be utilized by manufacturers or other economic operators.

However, Annex ZB of this standard gives the impression that manufacturers should take these verification tolerances into account. Manufacturers are advised to record and report the results of measurements and calculations directly without making any adjustments for 'tolerances', as implied by Annex ZB.

Whenever the provisions of the law, including EU Regulations, conflict with those of a standard, the law takes precedence.

The UK participation in its preparation was entrusted by Technical Committee CPL/59, Performance of household electrical appliances, to Subcommittee CPL/59/1, Dishwashers and washing machines.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Wäschetrockner für den Hausgebrauch - Verfahren zur Messung der Gebrauchseigenschaften (IEC 61121:2012, modifiziert)

CENELEC
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Foreword

This document (EN 61121:2013) consists of the text of IEC 61121:2012 prepared by IEC/SC 59D "Home laundry appliances" of IEC/TC 59 "Performance of household and similar electrical appliances", together with the common modifications prepared by CLC/TC 59X "Performance of household and similar electrical appliances".

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2013-12-31
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2015-12-31

This document supersedes EN 61121:2005.

EN 61121:2013 includes the following significant technical changes with respect to EN 61121:2005:

a) a test procedure for a combined test sequence of full and **partial load** was introduced;

b) a test procedure for measuring power consumption in low power modes is introduced;

c) a formula to calculate the energy consumption of **tumble dryers** including low power modes was added;

d) control procedures for checking measured values in comparison to values declared by the manufacturer under consideration of permitted tolerances are updated.

Clauses, subclauses, notes, tables and figures which are additional to those in IEC 61121:2012 are prefixed “Z”.

Words in **bold** in the text are defined in Clause 3.

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

This European Standard specifies, as far as necessary, the test methods which shall be applied in accordance with the COMMISSION DELEGATED REGULATION (EU) No 392/2012 implementing Directive 2010/30/EU the European Parliament and of the Council with regard to energy labelling of household **tumble dryers** and in accordance with the COMMISSION REGULATION (EU) No 932/2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for household **tumble dryers**.

The procedures described in this European Standard were modified substantially compared to the previous version, e.g. with regard to **partial load**. Therefore, results of tests according to this standard cannot and shall not be directly compared to results of similar procedures of previous versions. In addition, results based on a specific reference **programme** shall not be compared to results based on other reference programs.

Annex ZA sets out the procedure to be applied for testing according to Commission Regulations with regard to energy labelling and ecodesign and provides all necessary links to all relevant clauses of this European Standard.

Annex ZB provides control procedures for checking measured values in comparison to values declared by the manufacturer under consideration of permitted tolerances.

Annex ZC lists normative references.

Endorsement notice

The text of the International Standard IEC 61121:2012 was approved by CENELEC as a European Standard with agreed common modifications

Annex ZA
(normative)

Test procedure for a combined test sequence of cotton dry with full load and partial load

ZA.1 General

This annex sets out the procedure for the determination of performance and related parameters for **full load** and for **partial load** for a **cotton dry programme** of the **tumble dryer**.

The combined test sequence to measure performance parameters is defined as a **test series** consisting of 7 **test runs** with two different **treatments** as follows:

– **Treatment full**: 3 **test runs**

– **Treatment half**: 4 **test runs**

The two low power modes (Left-on mode and Off-mode) shall be determined for **treatment full**.

The airborne acoustical noise shall be measured according with EN 60704-1 and EN 60704-2-6 and determined and verified according with EN 60704-3.

ZA.2 Preparation for testing – Test loads

Subclause 6.5 sets out requirements for the preparation of the **test loads** used in the **tumble dryer**.

All requirements of 6.4 shall be applied to define the **full load** for a **test series**. For the **test runs** with **partial load,** a full **test load** shall be split into two parts. This clause defines the splitting of a **full load** into the two **partial loads** (part A and part B) as detailed in Table ZA.1.

Table ZA.1 – Partial loads: number of items in part A and part B of the cotton test load

Nominal mass of full load kg		Nominal mass of half the full load kg	Number of sheets	Number of pillowcases	Number of towels	Mass of half load kg
1	Part A	**0,5**	0	1	2	0,46
	Part B	**0,5**	0	1	3	0,57
1,5	Part A	**0,75**	0	1	5	0,79
	Part B	**0,75**	0	2	2	0,70
2	Part A	**1**	0	2	5	1,03
	Part B	**1**	0	2	4	0,92
2,5	Part A	**1,25**	0	2	7	1,25
	Part B	**1,25**	0	3	5	1,27
3	Part A	**1,5**	1	2	3	1,54
	Part B	**1,5**	1	2	2	1,43
3,5	Part A	**1,75**	1	2	5	1,76
	Part B	**1,75**	1	2	5	1,76
4	Part A	**2**	1	2	7	1,98
	Part B	**2**	1	2	7	1,98
4,5	Part A	**2,25**	1	3	7	2,22
	Part B	**2,25**	1	3	8	2,33
5	Part A	**2,5**	1	3	10	2,55
	Part B	**2,5**	1	3	9	2,44
5,5	Part A	**2,75**	1	4	10	2,79
	Part B	**2,75**	1	4	9	2,68
6	Part A	**3**	1	4	12	3,01
	Part B	**3**	1	4	12	3,01
6,5	Part A	**3,25**	1	5	12	3,25
	Part B	**3,25**	1	5	12	3,25
7	Part A	**3,5**	1	6	12	3,49
	Part B	**3,5**	1	6	12	3,49
7,5	Part A	**3,75**	2	6	8	3,77
	Part B	**3,75**	1	6	14	3,71
8	Part A	**4**	2	6	10	3,99
	Part B	**4**	1	6	17	4,04
8,5	Part A	**4,25**	2	7	10	4,23
	Part B	**4,25**	1	7	17	4,28
9	Part A	**4,5**	2	7	12	4,45
	Part B	**4,5**	2	7	13	4,56
9,5	Part A	**4,75**	2	7	15	4,78
	Part B	**4,75**	2	7	14	4,67
10	Part A	**5**	2	8	15	5,02
	Part B	**5**	2	8	15	5,02
10,5	Part A	**5,25**	3	7	13	5,29
	Part B	**5,25**	2	8	17	5,24

Nominal mass of full load kg		**Nominal mass of half the full load** kg	**Number of sheets**	**Number of pillowcases**	**Number of towels**	**Mass of half load** kg
11	Part A	**5,5**	3	7	15	5,51
	Part B	**5,5**	2	8	19	5,46
11,5	Part A	**5,75**	3	8	15	5,75
	Part B	**5,75**	2	8	22	5,79
12	Part A	**6**	3	8	17	5,97
	Part B	**6**	3	9	15	5,99
12,5	Part A	**6,25**	3	8	20	6,30
	Part B	**6,25**	3	9	17	6,21
13	Part A	**6,5**	3	9	20	6,54
	Part B	**6,5**	3	9	19	6,43
13,5	Part A	**6,75**	3	9	22	6,76
	Part B	**6,75**	3	10	20	6,78
14	Part A	**7**	3	9	24	6,98
	Part B	**7**	3	10	22	7,00
14,5	Part A	**7,25**	4	10	18	7,28
	Part B	**7,25**	3	10	24	7,22
15	Part A	**7,5**	4	10	20	7,50
	Part B	**7,5**	3	11	24	7,46

NOTE The number of towels in each half load A and B may differ from the number indicated above. In this case the formulas below shall be used to evaluate the number of towels in each test load.

Part A and Part B shall be made entirely from the **full load** without adding or subtracting any towels. For each **partial load**, the conditioned **test load mass** shall be recorded.

The requirement for **test load mass** to be within ± 60 g of the **nominal test load mass** shall not apply to **partial loads**.

For **test load masses** which are greater than those specified in the Table 3 (> 15 kg), the number of items for part A and part B is defined as follows:

Part A:

Number of sheets: is the half of the number of sheets at rated **test load mass** rounded to the next whole sheet (always round up)

$$n_{A,SH} = \left\lfloor \frac{n_{SH}}{2} \right\rfloor$$

where

n_{SH} is the number of sheets at rated **test load mass.**

Number of pillowcases: is half the number of pillowcases at rated **test load mass** rounded to the next whole pillowcase (always round down).

$$n_{A,PC} = \left\lceil \frac{n_{PC}}{2} \right\rceil$$

where

n_{PC} is the number of pillowcases at rated **test load mass.**

Number of towels: is the nominal partial **test load mass** minus the number of pillowcases from part A multiplied by 0,240 minus the number of sheets from part A multiplied by 0,725 and divided by 0,109 rounded to the nearest whole towel.

$$n_{A,T} = \left\lceil \frac{W_{n,part} - (n_{A,PC} \times 0{,}240) - (n_{A,SH} \times 0{,}725)}{0{,}109} \right\rceil$$

where

$W_{n,part}$ is the nominal partial **test load mass;**

$n_{A,PC}$ is the number of pillowcases in part A;

$n_{A,SH}$ is the number of sheets in part A.

Part B:

Number of sheets: is the number of sheets at rated **test load mass** minus the number of sheets from part A.

$$n_{B,SH} = n_{SH} - n_{A,SH}$$

where

n_{SH} is the number of sheets at rated **test load mass;**

$n_{A,SH}$ is the number of sheets in part A.

Number of pillowcases: is the number of pillowcases at rated **test load mass** minus the number of pillowcases from part A.

$$n_{B,PC} = n_{PC} - n_{A,PC}$$

where

n_{PC} is the number of pillowcases at rated **test load mass;**

$n_{A,PC}$ is the number of pillowcases in part A.

Number of towels: is the number of towels at rated **test load mass** minus the number of towels from part A.

$$n_{B,T} = n_T - n_{A,T}$$

where

n_T is the number of towels at rated **test load mass;**

$n_{A,T}$ is the number of towels in part A.

ZA.3 Performance measurements – general requirements

Performance parameters shall be measured for the **tumble dryer** using a common single **test series** consisting of a total of 7 runs as set out in ZA.4. The evaluation of these parameters for the **tumble dryer** is specified in ZA.5.

ZA.4 Procedure for performance tests

ZA.4.1 General

This sub-clause sets out the additional requirements for the test procedure as defined in Clause 8 for the determination of the following parameters for a cotton load related to the combined test sequence for the **tumble dryer**:

- Final moisture content;
- Energy consumption;
- **Programme time;**
- Condensation efficiency.

ZA.4.2 Test load

Prior to a **test series**, the following **test loads** shall be prepared for the **tumble dryer**.

- A treatment full load having a conditioned mass equal to the rated capacity of the tumble dryer.
- A treatment half part A load as specified in Table ZA.1 for the nominal mass of the treatment full load of the tumble dryer.
- A treatment half part B load as specified in Table ZA.1 for the nominal mass of the treatment full load of the tumble dryer.

NOTE 1 Part A and part B may be made from the load used for treatment full tests or from other treatment full loads having the same nominal mass.

NOTE 2 For a test series one or more test loads each fulfilling the specifications above may be used.

ZA.4.3 Programmes

Programmes to be tested on the **tumble dryer**:

A **cotton dry programme** shall be selected in accordance with the manufacturers' instruction. For **automatic tumble dryers** exactly the same **programme** setting for **cotton dry programme** shall be used for the tests with **full load** and for the tests with **partial load**.

ZA.4.4 Test runs to be carried out on the tumble dryer

The following 7 **test runs** shall be carried out on the **tumble dryer**:

– 3 **test runs** with **treatment full**;

– 2 **test runs** with **treatment half using part A of a load**;

– 2 **test runs** with **treatment half using part B of a load.**

Care is required to ensure that the temperature of the **tumble dryer** is within the range specified in 6.4 before the start of every test.

Care is required to ensure that **test load** part A and part B are not mixed up and no items are lost, gained or exchanged between **test runs**.

A **test run** shall be considered to be invalid if one or more of the following occurs:

– laboratory conditions fail to remain within the tolerances specified in this European standard during the **test run;**

– laboratory test equipment or recording systems fail during the **test run;**

– a relevant test procedure specified in this European standard has not been followed correctly;

– the final moisture of the **test load** does not meet the requirement according 8.2.2.

If an invalid **test run** occurs, then the following four rules shall be followed.

1) If only one test run in a test series is invalid regardless of whether it is treatment full or treatment half, it may be repeated using the same programme settings.

   NOTE If a **test run** of **treatment half** is repeated, the second part of the full **test load** is treated separately to ensure the average age for all items of the full **test load**.

2) The reason for carrying out additional **test run** shall be reported.

3) The results from the invalid **test run** shall be eliminated completely from any subsequent evaluation.

4) All **test runs** started shall be included when recording the age of the load.

ZA.4.5 Measurement of power and energy consumption in left-on mode

ZA.4.5.1 General

Left-on mode power and energy consumption measurements shall be made on one run per **treatment full**. The measurement shall be started after the **end of the programme** as explained below.

1) This measurement shall be made using one of the two following procedures: Whilst carrying out the test series of 7 runs described in ZA.4.4 measurements of power and energy consumption in left on mode shall be made following one **treatment full** run according to the procedure described in ZA.4.5.2.

2) Carry out one **treatment full** run and measure power and energy consumption in left on mode according to the procedure described in ZA.4.5.2.

ZA.4.5.2 Measurement procedure

Power measurements for the **left on mode** shall be made in accordance with the requirements of EN 50564, except the requirement defining air speed (EN 50564:2011, 4.2). The air speed close to the appliance under test shall not be limited to ≤ 0,5 m/s.

During these tests the instrumentation for the measurement of electrical energy according to EN 50564 shall record the required parameters (power and energy consumption):

– in the case of the first procedure explained above for the **programme** and the left-on mode, measurements for energy consumption of the **tumble dryer** shall be commenced when the **programme** is initiated (without any user programmed delay) and not stopped at the completion of the **programme**.

– in the case of the second procedure explained above for the left-on mode only, measurements for energy consumption of the **tumble dryer** shall be commenced at the **end of the programme**.

The **tumble dryer** shall not be disconnected from the power supply after the **end of the programme**. The electrical power supplied during the **left on mode** power and energy measurement shall meet the quality requirements given in EN 50564. No user intervention, besides unloading, shall take place on the **tumble dryer** before or during the **left on mode** power and energy measurement.

Data for the required parameters shall be recorded at regular intervals of 1 s or less throughout the test using a data logger or computer.

The two **post programme phases LU and LO** for measurement and calculation of **left on mode** power and energy consumption shall be measured as follows (see also Figure ZA.1):

– **Post programme phase LU** (**unstable left on mode**) shall start after the **end of the programme** when the door has been opened. This phase shall last for 30 min.

NOTE 1 The energy consumption of this phase is included in the annual energy consumption.

– **Post programme phase LO** (**left on mode**) shall start immediately after **LU** is finished. Its measurement shall last for 10 min.

NOTE 2 The power of this phase is used to calculate total annual energy consumption while in **left on mode**.

When the **tumble dryer** is equipped with a power management system to revert it automatically to ‘off-mode’ after the **end of the programme** and the **left on mode duration** is declared by the manufacturer to last longer than 30 min, the measurements of the **post programme phase LU** shall be prolonged to the declared duration.

When the **tumble dryer** is equipped with a power management system to revert automatically the machine to ‘off-mode’ after the **end of the programme** and the **left on mode duration** is declared by the manufacturer to last less than 30 min, the measurements of the **post programme phase LU** shall be made for 30 min, irrespective of the declared duration.

The duration of the **post programme phase LU** t_{mLU} used for the calculation of the annual energy consumption described in ZA.5.9 shall be equal to the time taken to make the measurement as specified above.

The time between the **end of** the **programme** and start of **left on mode** power and energy consumption measurements shall be less than or equal to 5 min.

After starting power and energy consumption measurements in **post programme phase LU,** the **load** shall be removed within 5 min. At the completion of unloading, the door shall remain fully open.

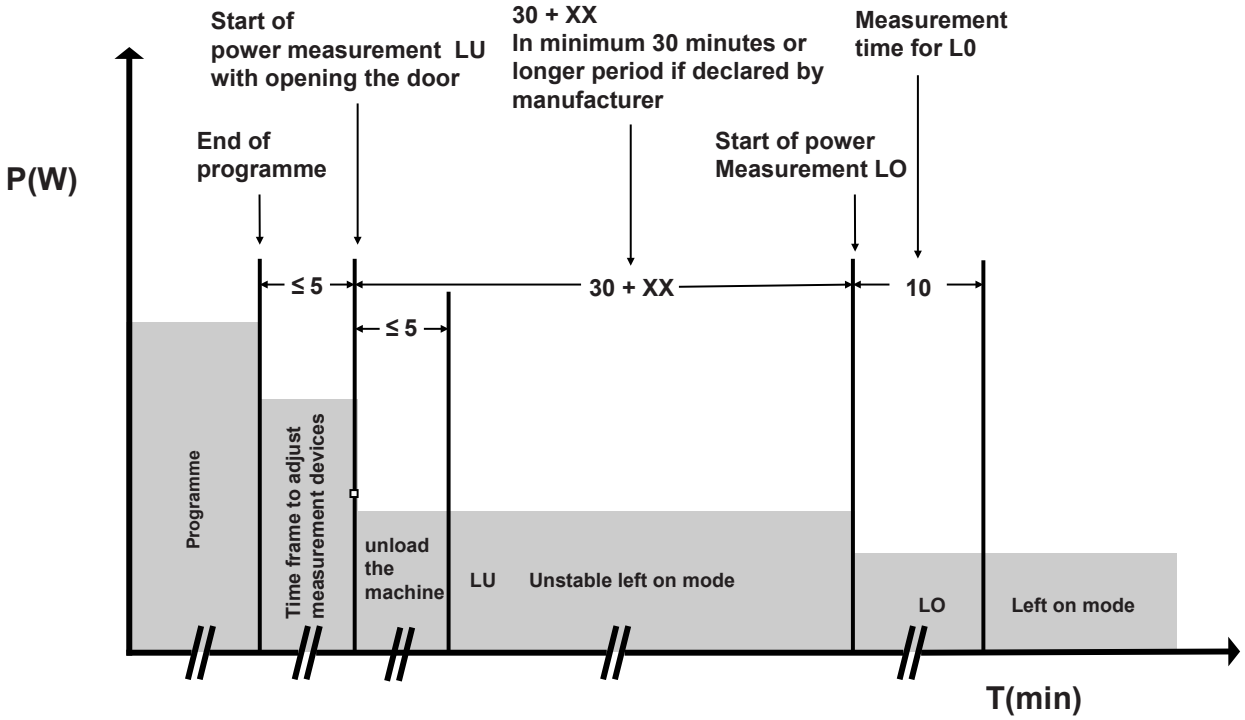

Figure ZA.1 – Phases of left-on mode power and energy consumption measurement

The measurement of energy consumption shall be done according to EN 50564:2011, 5.3.2, paragraph 7.

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;

– no user intervention on the machine besides unloading.

ZA.4.6 Measurement of power and energy consumption in off mode

The measurements to determine **off mode** power and energy consumption shall be run for the **tumble dryer** in accordance with this annex once for **treatment full**. At the completion of the **programme** the **tumble dryer** shall be unloaded. For determination of this mode, the **tumble dryer** shall then be switched off in accordance with the manufacturers' instructions. Where there is no power switch, the **tumble dryer** shall be left to revert to a steady state power consumption of its own accord.

NOTE Refer to EN 50564 for the definition of power switch.

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;

– no user intervention on the machine besides unloading.

At the completion of unloading, the door remains open.

Power and energy consumption measurements in **off mode** shall be determined for a period of not less than 10 min.

For **tumble dryers** that are equipped with a power switch, the measurement shall start immediately after switch off the **tumble dryer**.

For **tumble dryers** that are not equipped with a power switch, the measurement shall start 10 min after the end of the post programme phase LU.

Power measurements for this mode shall be made in accordance with the requirements of EN 50564, except the requirement defining air speed (EN 50564:2011, 4.2).

Data for the required parameters power and energy consumption shall be recorded at regular intervals of 1 s or less throughout the test using a data logger or computer.

ZA.5 Assessment of performance

ZA.5.1 General

ZA.5 sets out the additional requirements for the assessment of performance as defined in Clause 9 for the determination of the following parameters for a cotton load related to the combined test sequence for the **tumble dryer**:

– evaluation of data (see ZA.5.2);

– evaluation of condensation efficiency (see ZA.5.3);

– evaluation of water consumption (see ZA 5.4);

– evaluation of **programme** time (see ZA.5.5);

– evaluation of energy consumption of the **programme** (see ZA.5.6);

– evaluation of power and energy consumption in left-on mode (see ZA.5.7);

– evaluation of power and energy consumption in off mode (see ZA.5.8);

– calculation of the Energy Efficiency Index (EEI) (see ZA.5.9).

In case of an invalid **test run,** the **test run** result for the **tumble dryer** shall not be used for any evaluation of that **tumble dryer** within the **test series**.

ZA.5.2 Evaluation of data

Test data from 7 **test runs** shall be evaluated. It is required that the results from these 7 **test runs** are then averaged to yield a single test result. ZA.5.2 describes how the average value shall be calculated for each performance parameter.

In addition to the evaluations described in the following sub-clauses, a statistical analysis shall be carried out. This sub-clause describes the procedure for the statistical analysis.

The confidence interval is described by the RMS-error which is defined by the residuals of the two test conditions and the number of **test runs** per **treatment**. For both **treatments** the average values, the standard deviations and the residuals are calculated out of the **test runs**. For the **test series** the value and the two sided confidence interval are calculated out of the **treatment** values. The pooled standard deviation is required to calculate the RMS error.

a) The formulae in Clause 5 use the following abbreviations:

dry means **treatment full**;
dry1/2 means **treatment half**.

b) The average value per **treatment** $\bar{x}$ is calculated as follows:

$$\bar{x} = \frac{\sum_{j=1}^{n} x_j}{n}$$

where

x_j is the value for each measured **test run**;
n is the number of **test runs** per **treatment**.

c) The standard deviation per **treatment** s_x is calculated as follows:

$$s_x = \sqrt{\frac{1}{n-1}\sum_{j=1}^{n}\left(x_j - \bar{x}\right)^2}$$

where

$\bar{x}$ is the average value per **treatment;**
x_j is the value for each **test run;**
n is the number of **test runs** per **treatment**.

d) The sum of squared residuals per **treatment** r_x is calculated as follows:

$$r_x = \sum_{j=1}^{n}(x_j - \bar{x})^2$$

where

$\bar{x}$ is the average value per **treatment;**
x_j is the value for each **test run** of the **treatment;**
n is the number of **test runs** per **treatment.**

e) The average value per **test series** V is calculated as follows:

$$V = (3 \times \bar{x}_{dry} + 4 \times \bar{x}_{dry1/2})/7$$

where

$\bar{x}_{dry,dry1/2}$ is the average value per **treatment.**

f) The root mean square error per **test series** RMS is calculated as follows:

$$RMS = \sqrt{\frac{1}{5}(3 \cdot r_{dry} + 4 \cdot r_{\text{dry1/2}})}$$

where

$r_{dry,dry1/2}$ is the sum of squared residuals per **treatment;**
5 is the degree of freedom (number of runs minus number of **treatments**).

g) The pooled standard deviation per **test series** Std_V is calculated as follows:

$$Std_V = RMS \cdot \sqrt{(4/7)^2/4 + (3/7)^2/3} = 0{,}378 \cdot RMS$$

where

RMS is the root mean square error per **test series;**
3 is the number of **test runs** in **treatment full**;
4 is the number of **test runs** in **treatment half**;
7 is the total number of **test runs** in a **test series**.

h) The two sided confidence interval per **test series** CI is calculated as follows:

$$CI = V \pm Std_V \cdot t_{5,0.05}$$

where

V is the average value per **test series**;
Std_V is the pooled standard deviation per **test series**;
$t_{5,0.05}$ is the “Student T” factor for 5 degrees of freedom for a confidence level of 95 %, is 2,570 6.

ZA.5.3 Evaluation of condensation efficiency

a) The overall condensation efficiency shall be calculated by the non weighted average of the condensation efficiency of all 7 **test runs** in **treatment full** and in **treatment half**.

b) All **test runs** shall be used for evaluation of the condensation efficiency unless condition in 8.4.2 is fulfilled.

c) The average value for the condensation efficiency values $\overline{C_{dry}}$ for the **treatment full** is calculated as follows:

$$\overline{C_{dry}} = \frac{\sum_{j=1}^{n} C_j}{n}$$

where

C_j is the condensation efficiency value per **treatment full** in each **test run**, as calculated in 9.6;
n is the number of **test runs** per **treatment full** (n = 3);
j is the **test run.**

d) The average value for the condensation efficiency value $\overline{C_{dry1/2}}$ for the **treatment half** is calculated as follows:

$$\overline{C_{dry1/2}} = \frac{\sum_{j=1}^{n} C_j}{n}$$

where

C_j is the condensation efficiency value per **treatment half** in each **test run**, as calculated in 9.6;
n is the number of **test runs** per **treatment half** (n = 4);
j is the **test run.**

e) The average value for the Condensation Efficiency C_t for the combined **test series** is calculated as follows and rounded to one decimal place:

$$C_t = \left(3 \times \overline{C_{dry}} + 4 \times \overline{C_{dry1/2}}\right)/7$$

where

$\overline{C_{dry}}$ is the Condensation Efficiency for **treatment full;**
$\overline{C_{dry1/2}}$ is the Condensation Efficiency for **treatment half.**

ZA.5.4 Evaluation of water consumption

a) The total **water consumption** of the **programme** for each single **test run** is determined according to 8.3 and corrected according to 9.4.

b) The average value for the total water consumption $\overline{L_{dry}}$ for the **treatment full** is expressed in litres and calculated as follows:

$$\overline{L_{dry}} = \frac{\sum_{j=1}^{n} L_j}{n}$$

where

L_j is the total water consumption for **test run** j with **treatment full** in litre, as calculated in 9.4;
n is the number of **test runs** per **treatment full** (n = 3).

c) The average value for the total water consumption $\overline{L_{dry1/2}}$ for the **treatment half** is expressed in litres and calculated as follows:

$$\overline{L_{dry1/2}} = \frac{\sum_{j=1}^{n} L_j}{n}$$

where

L_j is the total water consumption for **test run** j with **treatment half** in litre, as calculated in 9.4;
n is the number of **test runs** per **treatment half** (n = 4).

d) The average value for the total water consumption L_t for the combined **test series** is expressed in litres, calculated as follows and rounded to the nearest whole litre:

$$L_t = \left(3x\overline{L_{dry}} + 4x\overline{L_{dry1/2}}\right)/7$$

where

$\overline{L_{dry}}$ is the average water consumption for **treatment full** in l;
$\overline{L_{dry1/2}}$ is the average water consumption for **treatment half** in l.

ZA.5.5 Evaluation of programme time

a) The total **programme time** for each single **test run** is determined according to 8.3 and corrected according to 9.5.

b) The average value for the **programme time** $\overline{t_{dry}}$ for the **treatment full** is expressed in minutes and calculated as follows:

$$\overline{t_{dry}} = \frac{\sum_{j=1}^{n} t_j}{n}$$

where

t_j is the **programme time** for **test run** j with **treatment full** in min, as calculated in 9.5;
n is the number of **test runs** per **treatment full** (n = 3).

c) The average value for the **programme time** $\overline{t_{dry1/2}}$ for the **treatment half** is expressed in minutes and calculated as follows:

$$\overline{t_{dry1/2}} = \frac{\sum_{j=1}^{n} t_j}{n}$$

where

t_j is the **programme time** for **test run** j with **treatment half** in min, as calculated in 9.5;
n is the number of **test runs** per **treatment half** (n = 4).

d) The average value for the **programme time** t_t for the combined **test series** is expressed in minutes, calculated as follows and rounded to nearest whole minute:

$$t_t = \left(3x\overline{t_{dry}} + 4x\overline{t_{dry1/2}}\right)/7$$

where

$\overline{t_{dry}}$ is the average **programme time** for **treatment full** in min;
$\overline{t_{dry1/2}}$ is the average **programme time** for **treatment half** in min.

ZA.5.6 Evaluation of energy consumption of the programme

a) The total energy consumption of the **programme** for each single **test run** is determined according to 8.3 and corrected according to 9.3.

b) The average value for the total energy consumption $\overline{E_{dry}}$ for the **treatment full** is expressed in kWh and calculated as follows:

$$\overline{E_{dry}} = \frac{\sum_{j=1}^{n} E_j}{n}$$

where

E_j is the total energy consumption for **test run** j with **treatment full** in kWh, as calculated in 9.3;
n is the number of **test runs** per **treatment full** (n = 3).

c) The average value for the total energy consumption $\overline{E_{dry1/2}}$ for the **treatment half** is expressed in kWh and calculated as follows:

$$\overline{E_{dry1/2}} = \frac{\sum_{j=1}^{n} E_j}{n}$$

where

E_j is the total energy consumption for **test run** j with **treatment half** in kWh, as calculated in 9.3;
n is the number of **test runs** per **treatment half** (n = 4).

d) The average value for the total energy consumption E_t for the combined **test series** is expressed in kWh, calculated as follows and rounded to two decimal places:

$$E_t = \left(3 \times \overline{E_{dry}} + 4 \times \overline{E_{dry1/2}}\right) / 7$$

where

$\overline{E_{dry}}$ is the average energy consumption for **treatment full** in kWh;
$\overline{E_{dry1/2}}$ is the average energy consumption for **treatment half** in kWh.

ZA.5.7 Evaluation of power and energy consumption measurements in left-on mode

a) The values for the power P_{LU} and P_{LO} for the 2 **post programme phases** (LU and LO) for the **treatment full** shall be expressed in W and shall be calculated as follows:

$$P_{LU} = \frac{E_{LU}}{t_{mLU}} \times 60$$

$$P_{LO} = \frac{E_{LO}}{t_{mLO}} \times 60$$

where

P_{LU} is the power during **post programme phase LU** per **treatment full** in W;
P_{LO} is the power during **post programme phase LO** per **treatment full** in W;
E_{LU} is the energy consumption during **post programme phase LU** per **treatment full** in Wh;
E_{LO} is the energy consumption during **post programme phase LO** per **treatment full** in Wh;
t_{mLU} is the time for **post programme phase LU** in min (according ZA.4.5.2);
t_{mLO} is the time for **post programme phase LO** in min (set to 10 min).

b) When the **tumble dryer** is equipped with a power management system to automatically revert the appliance to 'off-mode' after the **end of the programme** the value for the **left on mode duration** t_{LU} is derived from the record for the **post programme phase LU** as follows:

When the value of P_{LU} for one minute becomes less than or equal to P_O +0,1W, the time at the beginning of this minute minus the time at opening the door is noted as t_{LU} .

ZA.5.8 Evaluation of power and energy consumption measurements in off mode

a) The value for the power in **off mode** P_O for the **treatment full** is expressed in W and calculated as follows:

$$P_O = \frac{E_O}{t_{mO}} \times 60$$

where

E_O is the accumulated energy consumption in **off mode** per **treatment full** in Wh;

t_{mO} is the measurement time for **off mode** power per **treatment full** in min (set to 10 min).

ZA.5.9 Calculation of the Energy Efficiency Index (EEI)

For the calculation of the Energy Efficiency Index (EEI) of a **tumble dryer**, the Annual Energy Consumption AE_C of a **tumble dryer** is compared to its Standard Annual Energy Consumption SAE_C.

a) The Annual Energy Consumption AE_C is calculated in kWh/year as follows and rounded to two decimal places:

The annual energy consumption is calculated as the sum of the energy consumption for 160 **cycles** per year plus the energy consumption in **Off mode** plus the energy consumption in stable **left on mode** LO plus the energy consumption in **unstable left on mode** LU.

$$AE_C = E_t \times 160 + \left\{ \frac{P_O + P_{LO}}{1.000} \times \left[\frac{525600 - (t_t + t_{mLU}) \times 160}{2 \times 60} \right] \right\} + \left[\frac{P_{LU}}{1.000} \times \frac{t_{mLU} \times 160}{60} \right]$$

where

E_t is the average total energy consumption of the active mode as calculated in ZA.5.6 d) in kWh;

P_{LU} is the power during **post programme phase LU** as calculated in ZA.5.7 in W;

P_{LO} is the power during **post programme phase LO** as calculated in ZA.5.8 in W;

t_{mLU} is the duration of **post programme phase LU** as defined in ZA.4.5.2 in minutes;

P_o is the average power in off-mode as calculated in ZA.5.8 in W;

t_t is the **programme time** as calculated in ZA.5.5 d) in minutes;

160 is the total number of standard drying **cycles** per year.

b) The weighted per **cycle** energy consumption E_c including the low power mode energy consumption expressed in kWh/cycle is calculated as follows and rounded to two decimal places

$$E_C = AE_C / 160$$

where

AE_C is the Annual Energy Consumption of the **tumble dryer**;
160 is the total number of standard drying cycles per year.

c) The Standard Annual Energy Consumption (SAE_C) for **air vented tumble dryers** is calculated in kWh/year as follows and rounded to two decimal places:

$$SAE_C = 140 \times c^{0.8} - 30 \times \frac{t_t}{60}$$

where

c is the **rated capacity** as declared by the manufacturer for the cotton dry **programme** at **full load**;
t_t is the average value for the **programme time.**

d) For **condenser tumble dryers** the Standard Annual Energy Consumption (SAE_C) is calculated in kWh/year as follows and rounded to two decimal places:

$$SAE_C = 140 \times c^{0.8}$$

where

c is the **rated capacity** as declared by the manufacturer for the **cotton dry programme** at **full load.**

e) The Energy Efficiency Index (EEI) is calculated as follows and rounded to one decimal place:

$$EEI = \frac{AE_C}{SAE_C} \times 100$$

where

AE_C is the Annual Energy Consumption of the **tumble dryer**;
SAE_C is the Standard Annual Energy Consumption of the **tumble dryer**.

ZA.6 Data to be reported

ZA.6.1 General

ZA.6 presents the data to be reported for the **tumble dryer**.

The layout of Tables ZA.2 to ZA.5 is only a recommendation.

Title: "**Test Report to EN 61121**" (state date of issue and reference the amendments that have been introduced)

ZA.6.2 Data for tumble dryer

Table ZA.2 – Data for tumble dryer

Laboratory name and address:	
Laboratory test report id:	Laboratory sample id:
Brand:	Model name:
Model number:	Serial number:
Source of appliance:	Country of manufacture:
Purchase date of appliance:	
Appliance dimensions declared (cm)	Appliance dimensions measured (cm)
Height:	Height:
Width:	Width:
Depth:	Depth:
Drum volume (l):[a]	Drum volume (l):[a]
Rated capacity (kg)[a]	
Cotton:	Synthetics/blends:
Design	
Axis (vertical / horizontal):	Loading (top / front):
Air vented (yes / no):	Condenser (yes / no):
Automatic (sensor-controlled) (yes / no):	Timer controlled (yes / no):
Cold water connections[a] (yes / no):	
Rated voltage (V):	Rated frequency (Hz):
Additional information (for example, include here if applicable, reasons why the test had to be stopped before completion and state if the nominal test load mass is not equal to the rated capacity):	
Page number:	Number of pages in this report:
[a] As applicable	

ZA.6.3 Data, parameters and results for the test series

Table ZA.3, Table ZA.4 and Table ZA.5 shall be reported for a **test** used to determine the performance of a **tumble dryer** when applying the combined test procedure using a cotton **test load**.

Table ZA.3 – Data, parameters and results for the tumble dryer

Laboratory name and address:								
Laboratory test report id:						Laboratory sample id:		
Programme setting								
Global Parameters	symbol	unit	noted (n) measured (m) calculated (calc)	accuracy	treatment half part A	treatment half part B	treatment full	test series
Runs	n			1	2	2	3	7
Confidence level	CL	%		1				

Treatment	symbol	unit	noted (n) measured (m) calculated (calc)	reported accuracy	half part A		half part B		full part A + part B		
Test runs					1	2	3	4	5	6	7
Date of test run		yyyy.mm.dd	n								
Conditioned test load mass	W_0	g	calc	1							
Mass of test load after wetting	W_i	g	n	1							
Nominal initial moisture content	μ_{io}	%	n	0.1							
Initial moisture content	μ_{ij}	%	calc	0.1							
Final load mass	W_f	g	m	1							
Nominal final moisture content	μ_{fo}	%	n	0.1							
Final moisture content	μ_{fj}	%	calc	0.1							
Measured energy consumption	E_{mj}	kWh	m	0.01							
Corrected energy consumption	E_j	kWh	calc	0.01							
Specific energy consumption	E_s	kWh/kg	calc	0.001							
Measured programme time	t_{mj}	min	m	1							
Corrected programme time	t_j	min	calc	1							
Specific programme time	t_s	min/kg	m	0.1							
Measured water consumption	L_{mj}	l	m	1							
Corrected water consumption [a]	L_j	l	calc	0.1							
Specific water consumption [a]	L_s	l/kg	calc	0.1							
Initial mass of the condenser reservoir [a]		g	m	1							
Final mass of the condenser reservoir		g	m	1							
Mass of water collected [a]	W_w	g	m	1							
Condensation efficiency	C	%	calc	0.1							
Ambient temperature		°C	m	0.1							
Ambient humidity		%	m	1							
Page number:						Number of pages in this report:					
[a] shall only be declared when applicable											

Table ZA.4 – Data, parameters and results for the low power mode measurements

Laboratory name and address:							
Laboratory test reference:			Laboratory sample reference:				
Programme setting							
Global Parameters	symbol	unit	noted (n) measured (m) calculated (calc)	accuracy	treatment half	treatment full	test series
Runs	n			1	1	1	2
Confidence level	CL	%		1			

Treatment	symbol	unit	noted (n) measured (m) calculated (calc)	accuracy	half	full
Test runs					1	1
Date of test run		yyyy.mm.dd	n			
Programme time	t_t	min	m	1		
Measurement time for post programme phase LU	t_{mLU}	min	m	1		
Acumulated energy consumption (left-on mode unstable)	W_{LU}	Wh	m	0.01		
Accumulated energy consumption (left-on mode stable)	W_{LO}	Wh	m	0.01		
Accumulated energy consumption (off mode)	W_O	Wh	m	0.01		
Power (left-on mode unstable)	P_{LU}	W	calc	0.01		
Power (left-on mode stable)	P_{LO}	W	calc	0.01		
Power (off mode)	P_O	W	calc	0.01		
Left on mode duration	t_L	min	m	1		
Page number:			Number of pages in this report:			
* shall only be declared when applicable						

Table ZA.5 – Performance results of the tumble dryer

Laboratory name and address:					
Laboratory test report id:		Laboratory sample id:			
Programme setting					
Reason for extra test run (if applicable)					
	symbol	unit	reported accuracy	average	standard deviation
Average of the final moisture of all test runs	μ	%	0.1		
Average of the corrected energy consumption of all test runs	E_t	kWh	0.01		
Average of the corrected energy consumption of all test runs at treatment full	E_{full}	kWh	0.01		
Average of the corrected energy consumption of all test runs at treatment half	E_{half}	kWh	0.01		
Average of the programme time of all test runs	t_t	min	0.1		
Average of the programme time of all test runs at treatment full	t_{full}	min	0.1		
Average of the programme time of all test runs at treatment half	t_{half}	min	0.1		
Average of the corrected water consumption of all test runs	L_t	l	0.1		
Average of the corrected water consumption of all test runs at treatment full	L_{full}	l	0.1		
Average of the corrected water consumption of all test runs at treatment half	L_{half}	l	0.1		
Average of the condensation efficiency of all test runs	C_t	%	0.1		
Average of the condensation efficiency at **treatment full**	C_{full}	%	0.1		
Average of the condensation efficiency at **treatment half**	C_{half}	%	0.1		
Power (left-on mode unstable)	P_{LU}	W	0.01		
Power (left-on mode stable)	P_{LO}	W	0.01		
Power (off mode)	P_O	W	0.01		
Annual energy consumption	AE_C	kWh	0.01		
Energy consumption per cycle	AE_C/cycle	kWh	0.01		
Standard annual energy consumption	SAE_C	kWh	0.01		
Energy Efficiency Index	EEI	-	0.1		

NOTE For single **treatments**, the standard deviation follows ZA.5.2 c). For the average values of a whole **test series**, the standard deviation follows ZA.5.2 g).

ZA.6.4 Additional information to be reported

The number of items included in part A and part B of the **test load** shall be reported.

Test Conditions and materials used for the **test series** shall be reported for the **tumble dryer** according to Table D.3.

The age distribution of the **test load** shall be reported according to Table D.4.

Annex ZB
(normative)

Tolerances and control procedures

All values declared by the manufacturer shall not deviate by more than the specified tolerance from the values measured and reported in Tables ZA.3, ZA.4 and ZA.5.

The applicable tolerances are specified in the relevant annexes of the COMMISSION DELEGATED REGULATION (EU) No 392/2012 implementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of household **tumble dryers** and of the COMMISSION REGULATION (EU) No 932/2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for household **tumble dryers**.The verification of declared values consists of two steps:

Step 1:

One test series shall be carried out on a single sample of a tumble dryer model. All parameters specified in the above regulations shall be measured in accordance with this European Standard. The measured values of all these parameters shall be compared to the declared values and the specified limit values, taking into account the tolerances specified in the above regulations for step 1.

If all the measured values for all the specified parameters fall within the specified tolerances, no further action shall be required.

If one or more measured values fall outside the specified tolerances then the procedure described in step 2 shall be carried out.

Step 2:

One test series shall be carried out on three further samples of the tumble dryer model tested in stage 1. All parameters specified in the above regulations shall be measured in accordance with this European Standard. The average measured values for the three samples shall be calculated as the arithmetic mean of the measured value for each sample. These averages shall be rounded according to EN ISO 80000-1:201X, B.3, Rule B.

The average of the measured values of all the specified parameters for the three samples shall be compared to the declared values and the specified limit values, taking into account the tolerances specified in the above regulations for step 2.

For comparison with the measurement the calculated limits for verification including the tolerances allowed shall be rounded according to EN ISO 80000-1:201X, B.3, Rule B to one more decimal place than the given precision in this standard

A schematic representation of the procedure is set out in Figure ZB.1.

NOTE Acoustical noise values are measured according to EN 60704-1 and EN 60704-2-6 and verified separately according EN 60704-3.

Regulation (comparison to limit)
Declaration (comparison to declared data)

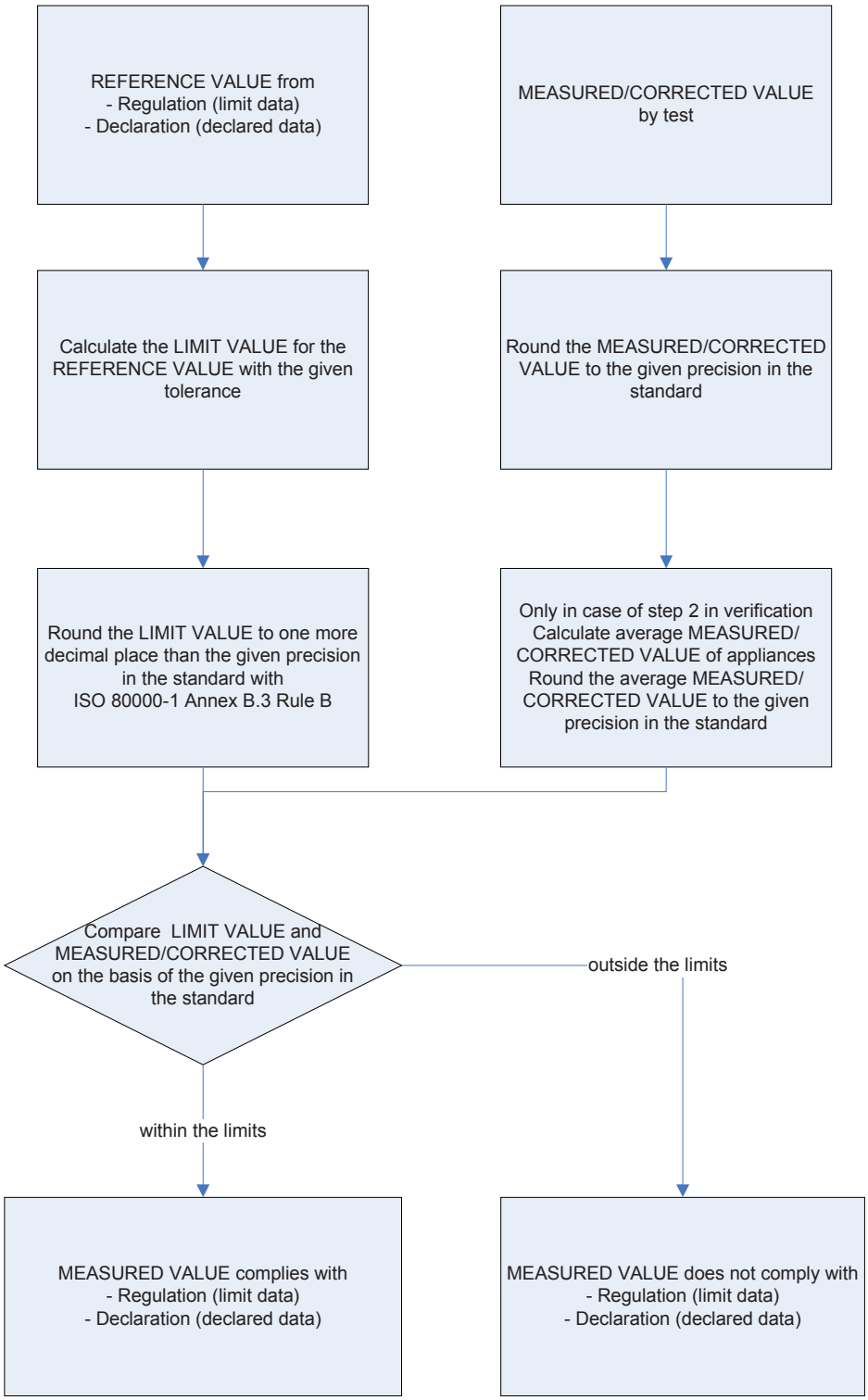

Figure ZB.1 – Control procedure for each value to be verified

Annex ZC
(normative)

Normative references to international publications with their corresponding European publications

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

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60335-2-11 (mod)	2008	Household and similar electrical appliances - Safety - Part 2-11: Particular requirements for tumble dryers	EN 60335-2-11	2010
IEC 60456 (mod) + corr. September	2010 2011	Clothes washing machines for household use - Methods for measuring the performance	EN 60456 + AC	2011 2011
IEC 60704-1	-	Household and similar electrical appliances – Test code for the determination of airborne noise - Part 1: General requirements	EN 60704-1	-
IEC 60704-2-6	-	Household and similar electrical appliances – Test code for the determination of airborne acoustical noise - Part 2-6: Particular requirements for tumble dryers	EN 60704-2-6	-
IEC 60704-3	-	Household and similar electrical appliances – Test code for the determination of airborne acoustical noise – Part 3: Procedure for determining and verifying declared noise emission values	EN 60704-3	-
IEC 60734	2012	Household electrical appliances - Performance - Water for testing	EN 60734	2012
IEC 62053-21	2003	Electricity metering equipment (a.c.) - Particular requirements - Part 21: Static meters for active energy (classes 1 and 2)	EN 62053-21	2003
IEC 62301 (mod)	2011	Electrical and electronic Household and office equipment - Measurement of low power consumption	EN 50564	2011
ISO 5167-1	2003	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 1: General principles and requirements	EN ISO 5167-1	2003

Publication	Year	Title	EN/HD	Year
ISO 80000-1 + corr. 1	2009 2011	Quantities and units - Part 1: General	EN ISO 80000-1	- [1)]

1) To be published.

Annex ZZ
(informative)

Coverage of Requirements of Commission Regulation (EU) No 932/2012 and Commission Delegated Regulation (EU) No 392/2012

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers only the following requirements out of those given in Commission Regulation (EU) No 932/2012 of 3rd October 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for household **tumble driers** and Commission Delegated Regulation (EU) No 392/2012 of 1st March 2012 supplementing Directive 2010/30/EU with regard to energy labeling of household **tumble driers**:

– ensuring that the prospective harmonized standard(s) provides, where appropriate, revised and/or new definitions for at least the appliances and parameters included in the Commission Regulation (EU) No 932/2012 and in the Commission Delegated Regulation (EU) No 392/2012, including low power modes (**off-mode** and **left-on-mode**) where the product is not fulfilling its main function and different from those covered by the Commission Regulation (EC) No 1275/2008 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for standby and off-mode electric power consumption of electrical and electronic household and office equipment;

– ensuring that the prospective harmonized standard(s) provides procedures and methods to measure at least the energy consumption, condensation efficiency, **programme time** for household **tumble driers** as included in the Commission Regulation (EU) No 932/2012 and in the Commission Delegated Regulation (EU) No 392/2012;

– ensuring that the prospective harmonized standard(s) specifies procedures and methods for measuring the airborne acoustical noise emissions;

– ensuring that the prospective harmonized standard(s) specifies procedures and methods for measuring the power consumption and duration of the identified product specific low power modes where the product is not fulfilling its main function and different from those covered by the Commission Regulation (EC) No 1275/2008 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for standby and **off-mode** electric power consumption of electrical and electronic household and office equipment;

– ensuring that the prospective harmonized standard(s) takes into account improved test conditions and test materials to better reflect the user behavior and the state of the art at European and international level.

- a test procedure for a combined test sequence of full and **partial load** is introduced;
- a test procedure for measuring power consumption in low power modes is introduced;
- a formula to calculate the energy consumption of tumble dyers including low power modes is added; the formula allows the measurement of low power modes consumption to be completed within a reasonable time by introducing two new terms: ‘stable left on mode’ and ‘**unstable left on mode’**. The formula also allows products with and without power management systems to be tested using the same procedure. The procedure includes features designed to prevent circumvention. The weighted annual energy consumption (AEc) calculated by this formula gives a result which is equal to or marginally higher than the value that would be obtained using the formula given in the Commissions Regulation (EU) 932/2012 and in the Commission Delegated Regulation (EU) No 392/2012. This minor difference is considered to be an acceptable alternative which avoids the need to measure low power modes for an indefinite period of time as required by the regulation;
- control procedures for checking measured values in comparison to values declared by the manufacturer under consideration of permitted tolerances are updated;

– ensuring that the prospective harmonized standard(s) identifies and controls the sources of variability, in particular for market surveillance purposes;

– defining a template for a test report indicating the information to be declared by the manufacturers to fulfill at least the ecodesign and labeling requirements set out by Commission Regulation (EU) No 932/2012 and in the Commission Delegated Regulation (EU) No 392/2012.

Uncertainty figures will be published as an amendment to this standard as soon as they become available.

Compliance with this standard provides means of conformity with the specified requirements of the Commission Regulations concerned.

WARNING: Other requirements or other EU Directives or Commission Regulations may be applicable to the products falling within the scope of this standard.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

TUMBLE DRYERS FOR HOUSEHOLD USE – METHODS FOR MEASURING THE PERFORMANCE

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61121 has been prepared by subcommittee 59D: Home laundry appliances, of IEC technical committee 59: Performance of household and similar electrical appliances.

This fourth edition cancels and replaces the third edition published in 2002 and Amendment 1 (2005). This edition constitutes a technical revision.

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

a) General:

- more terms have been defined and some previous definitions have been streamlined, in addition to the correction of some symbols and equations;
- where possible, definitions and terms have been used in common with IEC 60456:2010;
- the content has been organised into a more logical and simple structure, and repetitive sections have been removed.

b) Conditions of measurement:

- the wording of various sections has been revised to reduce ambiguity;
- limits have been defined for water characteristics for automatic tumble dryers that are sensitive to conductivity as well as methods to adjust these characteristics where necessary.

c) Reproducibility and repeatability of test results:

- revision of the specification for the cotton **test load** to include suitable test materials which are currently available on the market;
- more careful definition of the process and conditions for **pre-treatment, conditioning** and **normalization**.

d) Test methods:

- accuracy of measurement has been defined for all instruments;
- limits and interpretations of the allowable **final moisture content** for each type of dryer are now defined;
- practical advice regarding the test procedure has been given with the aim of reducing ambiguity.

Words in **bold** in the text are defined in Clause 3.

This bilingual version (2013-07) corresponds to the monolingual English version, published in 2012-02.

The text of this standard is based on the following documents:

FDIS	Report on voting
59D/393/FDIS	59D/395/RVD

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

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

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

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This fourth edition has been developed in light of experience with use of the third edition of IEC 61121. The structure has been revised to ensure that this remains harmonised with the IEC 60456:2010 for clothes washers.

TUMBLE DRYERS FOR HOUSEHOLD USE – METHODS FOR MEASURING THE PERFORMANCE

1 Scope

This International Standard is applicable to household electric **tumble dryers** of the **automatic** and **non-automatic** type, with or without a cold water supply and incorporating a heating device. This excludes **tumble dryers** which use gas or other fuels as a heating source.

The object is to state and define the principal performance characteristics of household electric **tumble dryer**s of interest to users and to describe standard methods for measuring these characteristics.

NOTE This International Standard applies also to **tumble dryers** for communal use in blocks of flats or in launderettes. It does not apply to **tumble dryers** for commercial laundries.

[C] NOTE Z1 The methods of measuring the performance of tumble dryers which use gas as a heating source are covered by EN 1458-2. [C]

2 Normative references

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

IEC 60335-2-11:2008, *Household and similar electrical appliances – Safety – Part 2-11: Particular requirements for tumble dryers*

IEC 60456:2010, *Clothes washing machines for household use – Methods for measuring the performance*

IEC 60734:-[1], *Household electrical appliances – Performance – Water for testing*

IEC 62053-21:2003, *Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)*

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

ISO 5167-1:2003, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full – Part 1: General principles and requirements*

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

[C] EN 60704-1, *Household and similar electrical appliances – Test code for the determination of airborne noise – Part 1: General requirements (IEC 60704-1)*

EN 60704-2-6, *Household and similar electrical appliances – Test code for the determination of airborne acoustical noise – Part 2-6: Particular requirements for tumble dryers (IEC 60704-2-6)* [C]

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1 To be published.

〈C〉 EN 60704-3, *Household and similar electrical appliances – Test code for the determination of airborne acoustical noise – Part 3: Procedure for determining and verifying declared noise emission values (IEC 60704-3)* 〈C〉

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply:

3.1.1
tumble dryer
appliance in which textiles are dried by tumbling in a rotating drum, through which air is passed

3.1.2
air vented tumble dryer
tumble dryer that draws in fresh air which is passed over the textiles and where the resulting moist air is exhausted into the room or vented outside

3.1.3
condenser tumble dryer
tumble dryer which includes a device for removing moisture from the air used for the drying process

〈C〉 **3.1.4**
automatic tumble dryer
tumble dryer which has at least one programme which switches off the drying process when a certain moisture content of the load is reached

Note 1 to entry: This may include systems that use conductivity or temperature sensing. 〈C〉

3.1.5
non-automatic tumble dryer
tumble dryer which does not switch off the drying process when a certain **moisture content** of the load is reached, usually controlled by a timer, but may also be controlled manually

3.1.6
test load
textile load used for testing

3.1.7
pre-treatment
processing of a new **test load** prior to its first use to avoid rapid changes of characteristics during the tests

3.1.8
conditioning
bringing the **test load** into thermodynamic equilibrium with the defined ambient air conditions of temperature and humidity

Note 1 to entry: The process of **conditioning** is not the same as "wetting" which is described in 6.5.7.

3.1.9
test run
single performance assessment

3.1.10
test series
group of **test runs** on a **tumble dryer** which, collectively, are used to assess the performance of that **tumble dryer**

3.1.11
operation
each performance of a function that occurs during the **tumble dryer** drying process such as heating up, drying, cooling, anti-creasing

3.1.12
programme
series of **operations** which are pre-defined within the **tumble dryer** and which are declared by the manufacturer as suitable for drying certain types of textiles

3.1.13
end of the programme
moment in time when the **tumble dryer** indicates the **programme** is complete and the load is accessible to the user

Note 1 to entry: Where there is no such indicator and the door is locked during **operation**, the **programme** is deemed to be complete when the load is accessible to the user. Where there is no indicator and the door is not locked during **operation**, the **programme** is deemed to be complete when the power consumption of the appliance drops to a steady state condition and it is not performing any function. For **non-automatic tumble dryers**, the **programme** is deemed to be complete when it is stopped by the operator.

Note 2 to entry: 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 **tumble dryers** there may be a short delay from an **end of the programme** indicator until the load is accessible by the user.

3.1.14
programme time
period of time from the initiation of the **programme** (excluding any user programmed delay) until the **end of the programme**

3.1.15
cycle
complete drying process, as defined by the selected **programme**, consisting of a series of **operations** including any **operations** that occur after the **end of the programme**

Note 1 to entry: Examples of **operations** that may occur after the completion of the **programme** are monitoring and anti- creasing **operations** (where applicable).

3.1.16
cycle time
period of 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 1 to entry: **Cycle time** includes any activity that may occur for a limited period after the **end of the programme**. Any cyclic event that occurs indefinitely is considered to be steady state.

3.1.17
normalization
processing of a **test load** after a pre-determined number of **cycles** to bring the **test load** to a normal state prior to testing

3.1.18
rated capacity
maximum mass in kg of dry textiles of a particular defined type, which the manufacturer declares can be treated in a specific **programme**

3.1.19
test load mass
actual mass of the **test load**

3.1.20
nominal test load mass
mass of dry textiles of a particular type for which the performance of the **tumble dryer** will be tested (**rated capacity** or part load). Target value toward which the conditioned **test load mass** will be adjusted

3.1.21
moisture content
ratio of the difference between **test load mass** and the conditioned **test load mass** to the conditioned **test load mass** expressed in percent

3.1.22
initial moisture content
moisture content of a **test load** prior to a test run

3.1.23
final moisture content
moisture content of a **test load** at the end of a test run

3.1.24
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.

Note 1 to entry: Where the **tumble dryer** has no controls or switches that can bring it to the **off mode** condition, it is left to revert to a steady state power consumption by its own accord.

3.1.25
left on mode
the 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 1 to entry: In some products this mode may be an equivalent power to **off mode**.

3.1.26
rated voltage
voltage assigned to the appliance by the manufacturer

〚C〛 **3.1.Z1**
full load
rated capacity for cotton textiles

3.1.Z2
partial load
half of the **rated capacity** for cotton textiles

NOTE See Annex ZA for additional requirements.

3.1.Z3
treatment
combination of **test load** and **programme** to be used for a **test run** within a combined **test series** as defined in Annex ZA 〚C〛

〈C〉 **3.1.Z4**
treatment full
test run using **cotton dry programme** with **full load**

3.1.Z5
treatment half
test run using **cotton dry programme** with **partial load**

3.1.Z6
unstable left on mode
condition persisting after completion of the **programme** and unloading of the machine and where the power consumption may change without any intervention by the end-user

3.1.Z7
post programme phases
phases after the **end of programme** defined to be used for the measurement of **left on mode**

3.1.Z8
post programme phase LU
phase after the **end of programme** defined to be used for the measurement of the unstable left on mode

3.1.Z9
post programme phase LO
phase after the **end of programme** defined to be used for the measurement of the left on mode

3.1.Z10
left on mode duration
time to revert automatically the machine to ‘off-mode’ after the **end of the programme** if the **tumble dryer** is equipped with a power management system

3.1.Z11
power management system
system within the **test tumble dryer** which reverts it automatically to **off mode**

3.1.Z12
frequency of cleaning
number of cycles after which the heat exchanger or filters shall be cleaned 〈C〉

3.2 List of symbols

〖C〗 The symbols are listed in Table 1 and Table Z1. 〖C〗

Table 1 – List of symbols

Symbol	Unit	Definition
a	-	constant part of the regression line
$\overline{A}$	-	weighted average age of the **test load** expressed as the number of **test runs**
A_k	-	age of item after **conditioning**
b	-	slope part of the regression line
C	%	arithmetical average of the condensation efficiency of all valid **test runs**
C_j	%	condensation efficiency for **test run j**
d	kg/l	density of water
E	kWh	arithmetical average of the corrected energy consumption of all valid **test runs**
E_j	kWh	corrected electric energy consumption for **test run** j
E_{mj}	kWh	measured electric energy consumption for **test run** j
E_s	kWh/kg	specific energy consumption
F	m^3/min	volumetric flow rate
j	-	**test run** number
k	-	**test load** item number
K	-	constant = 1,9 * 10^{-3} Pa h^2/m^6
L	l	arithmetical average of the corrected water consumption of all valid **test runs**
L_j	l	corrected water consumption for **test run** j
L_{mj}	l	measured water consumption for **test run** j
L_s	l/kg	specific water consumption
m_c	g	Conditioned mass of textile sample (Figure H.1)
n	-	number of **test runs**
N	-	number of items in the **test load**
p	Pa	static pressure
P_{off}	W	**off mode** power
P_{on}	W	**left on mode** power
S	-	standard deviation of measured results
S_b	-	standard deviation of the measured **final moisture content** for all valid **test runs**
S_w	-	arithmetical average of the evenness of drying of all valid **test runs**
s_{wj}	-	evenness of drying for a single **test run**
t	min	arithmetical average of the **programme time** of all valid **test runs**
t_s	min/kg	specific **programme time**
t_j	min	corrected **programme time** for **test run** j
t_{mj}	min	measured **programme time** for **test run** j
V_c	l	clothes container volume
V	m^3	exhaust air volume
W	g	**rated capacity** for the type of load tested
W_0	g	mass of the conditioned **test load**
W_{0k}	g	mass of conditioned **test load** item k

Symbol	Unit	Definition
W_f	g	mass of the **test load** after drying
W_{fj}	g	mass of test load after drying for **test run** j
W_{fk}	g	mass of **test load** item k after drying
W_i	g	mass of the **test load** after wetting
W_{wj}	g	mass of water collected in the condenser reservoir during **test run** j
x_i	-	*i*-th term of parameter x
$\bar{x}_i$	-	mean of all terms of parameter x
Y	-	performance parameter (energy consumption or **programme time**)
y_b	-	number of table tennis balls
μ_f	%	arithmetical average of the measured **final moisture content** of all valid **test runs**
μ_{fjav}	%	arithmetical average **final moisture content** of all the individual items in the **test load**
μ_{f0}	%	target **final moisture content**
μ_{fj}	%	measured **final moisture content** after **test run** j
μ_{fjk}	%	measured **final moisture content** of the **test load** item *k* for each valid **test run** j
μ_{ij}	%	measured **initial moisture content** for **test run** j
μ_{i0}	%	nominal **initial moisture content**

〈C〉 Table Z1 – Symbols relating to Annex ZA

Symbol	Units	Definition
[ ]		rounding up/down to full integer values (no decimal places) as described in EN ISO 80000-1
⌊ ⌋		always rounding up to full integer values (no decimal places)
⌈ ⌉		always rounding down to full integer values (no decimal places)
AE_C	kg	Annual Energy Consumption
c		**Rated capacity** to calculate the Standard Annual Energy Consumption of **tumble dryer**
CI		Two sided confidence interval per **test series**
EEI		Energy Efficiency Index of a **tumble dryer**
$\overline{E_{dry}}$	kWh	Average energy consumption for **treatment full**
$E_{dry1/2}$	kWh	Average energy consumption for **treatment half**
E_t	kWh	Average total energy consumption for the combined **test series**
$E_{LU,}$	Wh	Energy consumption during **post programme phase LU** per **treatment full**
$E_{LO,}$	Wh	Energy consumption during **post programme phase LO** per **treatment full**
$E_{O,}$	Wh	Energy consumption in off mode per **treatment full**

〈C〉

Symbol	Units	Definition
$\overline{C_{dry}}$	%	Condensation Efficiency Index for the **treatment full**
$\overline{C_{dry1/2}}$	%	Condensation Efficiency Index for the **treatment half**
C_t	%	Condensation Efficiency Index for the combined **test series**
$\overline{L_{dry}}$	l	Average value for the total water consumption for the **treatment full**
$\overline{L_{dry1/2}}$	l	Average water consumption for **treatment half**
L_t	l	Average value for the total water consumption for the combined **test series**
$W_{n,part}$	g	Nominal partial **test load mass**
n_{SH}		Number of sheets at rated **test load mass**
n_{PC}		Number of pillowcases at rated **test load mass**
n_T		Number of towels at rated **test load mass**
$n_{A,SH}$		Number of sheets in part A
$n_{A,PC}$		Number of pillowcases in part A
$n_{A,T}$		Number of towels in part A
$n_{B,SH}$		Number of sheets in part B
$n_{B,PC}$		Number of pillowcases in part B
$n_{B,T}$		Number of towels in part B
n		Number of **test runs** per **treatment**
p		**Treatment** type
part		**Partial load** identifier (part = A,B)
P_O	W	Off mode power for **treatment full**
P_{LU}	W	Power during **post programme phase LU**
P_{LO}	W	Power during **post programme phase LO**
r_{dry}		Residual per **treatment full**
$r_{dry1/2}$		Residual per **treatment half**
RMS		Root mean square error per **test series**
SAE_C		Standard Annual Energy Consumption
Std_p		Pooled standard deviation per **test series**

〈C〉

Symbol	Units	Definition
s_x		Standard deviation per **treatment**
t_{mLU}	min	Time for **post programme phase LU**
t_{mLO}	min	Time for **post programme phase LO**
$\overline{t_{dry}}$	min	Average programme time for **treatment full**
$\overline{t_{dry1/2}}$	min	Average programme time for **treatment half**
t_{LU}	min	Left on duration
t_t	min	Average value for the programme time for the combined **test series**
t_{mO}	min	Measurement time for off mode power in **treatment full**
$t_{5,0.05}$		"Student T" factor for 5 degrees of freedom for a confidence level of 95 %
V		Value per **test series**
X		Post **programme** phase (X = U, O)
x		Average value per **treatment**
X_j		Value for each **test run**
$\overline{x_{dry,dry1/2}}$		Average value per **treatment**

〈C〉

4 Requirements

4.1 General

〈C〉 This European Standard does not specify minimum performance requirements for **tumble dryers**. However, **tumble dryers** have to be able to achieve valid **test runs** and valid **test series** with **final moisture content** values that are in the allowable ranges as set out on Table 6. This European Standard does however set methods for the measurement of following performance parameters: 〈C〉

- Electric energy consumption;
- Water consumption;
- **Programme time**;
- Condensation efficiency;
- Evenness of drying;
- Volumetric flow rate of exhaust air;
- **Off mode** power and **left on mode** power.

Any claims of performance referring to this International Standard for these parameters shall be measured in accordance with the requirements of this standard. Any claims of performance referring to this document at other than **rated capacity** shall be qualified with load type and capacity used for the test (refer to Clause 7 for details).

4.2 Rated capacity

The manufacturer or supplier shall declare the **rated capacity** at 0,5 kg intervals for each relevant textile type. Relevant textile types are cotton and synthetic/blends.

The **rated capacity** for any textile type shall not exceed the maximum mass of dry laundry, in kilograms, to be used in the appliance in accordance with 3.1.9 of IEC 60335-2-11:2008.

If the **rated capacity** is not declared by the manufacturer, the **rated capacity** shall be deduced from the clothes container volume (see 4.3) as described in Annex E.

Where the manufacturer gives a range of values for the **rated capacity** for a particular textile type, the maximum value shall be used.

NOTE For different textiles the **rated capacity** of an appliance may be different.

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 cm and shall be rounded to the nearest whole cm.

- Height = vertical dimension measured from the lower edge (on the floor) to the upper edge of the top, 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.
- Max height = maximum vertical dimension measured from the lower edge (on the floor) to a horizontal plane at the maximum height of the **tumble dryer** with the door/lid open. If adjustable levelling feet are provided, they shall be moved up and down to determine minimum and maximum possible heights.
- Width = horizontal dimension, between the sides, as measured between two parallel vertical planes against the sides of the **tumble dryer**, including all projections.
- Depth = horizontal dimension as measured from a vertical rear plane against the **tumble dryer** and the most prominent part of the front, knobs and handles not being taken into account, with the door/lid closed, including all projections.
- Max depth = horizontal dimension as measured from a vertical rear plane against the **tumble dryer** and the most prominent part of the front knobs and handles not being taken into account, with the door/lid open (generally when at right angles to the machine front), including all projections.
- Clothes container volume = the volume of the container in which textiles are placed, where required, shall be determined in accordance with Annex E.

NOTE Dimension max height is generally only applicable to top access **tumble dryers** while dimension max depth is generally only applicable to front access **tumble dryers**.

5 Test conditions, materials, equipment and instrumentation

5.1 General

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

5.2 Ambient conditions

5.2.1 Electricity supply

〖C〗 The supply voltage shall be maintained throughout the test at 230 V ± 1 % or at 400 V ± 1 % as defined by the manufacturer's installation guide. If more than one option for installation is available and no clear indication for testing is given, the supply voltage shall be 230 V ± 1 %. The supply voltage measured during the tests shall be recorded.

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

The supply frequency shall be maintained at 50 Hz ± 1 %. 〖C〗

The measured voltage and frequency of the power supply used during testing shall be reported.

Voltage stabilisers shall ensure that the normal **operation** of the **tumble dryer** does not cause undue distortion of the voltage waveform.

5.2.2 Water supply

5.2.2.1 General

This section describes the specifications for water to be used for preparing **test loads**, wetting **test loads** and for use in water cooled condensers.

In all cases the water supply shall meet the requirements given in 5.2.2.2 and 5.2.2.3.

Water used for normalising **test loads** and wetting **test loads** shall meet the requirements of 5.2.2.2, 5.2.2.3 and 5.2.2.4.

Water used for wetting **test loads** for testing conductivity controlled **automatic tumble dryers** shall meet the requirements of 5.2.2.2, 5.2.2.3, 5.2.2.4 and 5.2.2.5.

NOTE The performance of a dryer may differ according to the quality of the water used to wet the **test load**.

5.2.2.2 Water temperature

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

5.2.2.3 Water pressure

The pressure of the water supply during water intake at each appliance water inlet shall be maintained at (240 ± 50) kPa. The measured water pressure shall be reported.

5.2.2.4 Water hardness

〖C〗 Hard water with a total hardness of (2,5 ± 0,2) mmol/l according to EN 60734 shall be used. If available, naturally occurring water of the correct total hardness and, if applicable, the correct pH, alkalinity and conductivity may be used. Alternatively, water of the correct total hardness shall be prepared according to EN 60734.

The total hardness of the water used shall be reported.

The pH, alkalinity and conductivity of the water used to wet the load shall be reported. 〖C〗

5.2.2.5 Water alkalinity and conductivity

When testing conductivity controlled **automatic tumble dryers**, the characteristics of the water used for wetting the **test load** can have a large influence on the test results. The water characteristics are defined in terms of hardness, alkalinity and conductivity.

For the purpose of testing **automatic tumble dryers** the water for wetting the **test load** shall have the characteristics of water prepared according to Method B of IEC 60734.

If water characteristics need to be adjusted, Method B or Method C3 of IEC 60734 shall be followed.

The alkalinity and conductivity of the water used shall be reported.

NOTE Method B of IEC 60734 describes how to prepare artificial water based on demineralised water. Method C3 of IEC 60734 describes how to produce water with the same characteristics as with Method B but based on natural water.

5.2.3 Ambient temperature and humidity

5.2.3.1 Ambient temperature and relative humidity for tumble dryer testing

The ambient temperature of the test room shall be maintained at (23 ± 2) °C throughout the **tumble dryer** test. The ambient temperature shall be measured in the vicinity of the **tumble dryer** being tested. The maximum and minimum measured temperatures shall be reported and rounded to the nearest 0,5 °C.

The ambient relative humidity of the test room shall be maintained at (55 ± 5) % throughout the **tumble dryer** test. The ambient relative humidity shall be measured in the vicinity of the **tumble dryer** being tested. The maximum and minimum measured ambient relative humidity for **tumble dryer** testing shall be reported rounded to the nearest whole percentage.

The ambient temperature and relative humidity shall not be influenced by the appliance itself or other appliances in the laboratory.

5.2.3.2 Ambient temperature and ambient relative humidity for conditioning of test load items

Where an ambient controlled room or chamber is used for **conditioning** the **test 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 test 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 Requirements for **conditioning** the **test load** are specified in 6.5.5.2.

5.3 Test materials

5.3.1 General

This section sets out the specifications for test materials required for **tumble dryer** testing to this International Standard, including:

- **Test loads** (load items);
- Detergent.

NOTE Suitable sources of test materials are given in A.8.

5.3.2 Test loads

5.3.2.1 Cotton test load

Where a cotton load is specified for testing, the cotton **test load** shall consist of sheets, pillowcases and towels as specified in A.2.

5.3.2.2 Synthetics/blends test load

Where a synthetics/blends load is specified for testing, the synthetics/blends **test load** shall consist of men's shirts and pillowcases as defined in A.2.

5.3.3 Detergents

The specification for the IEC 60456:2010 reference detergent A* base powder is defined in A.1. Detergent dosage is specified in 6.5.4.2 and 6.5.4.3.

5.4 Equipment

5.4.1 Equipment for normalization

The specification for the reference washing machine which is used for the **normalization** of **test loads** is defined in A.9.

NOTE Other clothes washing machines can be used provided that they have the same washing and rinsing performance according to IEC 60456:2010 or better in the relevant **programme**. They may be used up to their **rated capacity**.

5.4.2 Equipment for conditioning the test load

This International Standard requires **test 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 **test load** items are:

- Leaving the **test 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 with the ambient conditions. Refer to 6.5.5.2 for details.
- Treating the **test load** items in a clothes dryer of specified performance to ensure that the **test load** items are in a "bone dry" state. Refer to 6.5.5.3 for details. Annex A.3 sets out the method and the specifications for a **tumble dryer** which is used for this method.

5.4.3 Equipment for wetting the test load prior to a test

Any washing machine may be used to wet the load prior to a test, provided it has the following features:

- a **rated capacity** which is equal to or greater than the load being wetted;
- at least one rinse **operation** with a duration of at least five minutes;
- the rinse shall consist of a volume of water in litres at least three times the mass of the **test load** in kilograms;
- a spin drying **operation** capable of achieving the desired **initial moisture content**.

5.4.4 Other equipment

This International Standard requires the measurement of a range of parameters during testing of a **tumble dryer**. These parameters include the following:

- mass;
- electrical parameters (voltage, energy, power and frequency);

- temperature of water and air;
- relative humidity;
- water pressure;
- total water hardness;
- conductivity of water (conductivity sensing dryers only);
- alkalinity of water (conductivity sensing dryers only);
- time.

The specifications of instruments used to take the measurements for some of these parameters are explicitly defined in 5.5.

NOTE Several different instruments for the measurement of mass are likely to be required for tasks such as mass of load items and the whole **test load** and mass of detergent.

5.5 Instrumentation and accuracy

Instruments used for this International Standard shall comply with the specifications set out in Table 2.

Devices using viscosity to measure water volume shall be calibrated at the nominal temperature ± 5 °C, and the nominal flow rate.

Table 2 – Specification of instruments

Parameter	Unit	Resolution	Accuracy	Additional requirements
Masses above 3 000 g	g	1 g	± 5 g	-
Masses in the range between 100 g and 3 000 g	g	0,5 g	± 1 g	-
Masses in the range up to 100 g	g	0,05 g	± 0,1 g	-
Ambient temperature	°C	0,1 °C	± 0,5 K	-
Water temperature	°C	0,1 °C	± 0,5 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 %	-
Water pressure	kPa	10 kPa	± 5 %	-
Time	s	5 s	± 10 s	-
Electrical energy consumption	kWh	- As specified in IEC 62053-21 (class 1, instrument definition)	± 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
Hardness of water	mmol/l	As specified in IEC 60734		
Conductivity of water	μS/cm	As specified in IEC 60734		
Off mode and **left on mode** power	W	Measurement instrumentation for off mode and left on mode power are described in IEC 62301:2011		

6 Preparation for testing

6.1 General

This section sets out the requirements for the preparation of a **tumble dryer.** It also specifies the requirements for the preparation of **test loads**.

6.2 Installation of the tumble dryer

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

Where the **tumble dryer** is intended for use without a duct (i.e. the **tumble dryer** is intended to be vented into the room), the **tumble dryer** shall be tested as supplied without a duct.

Where the **tumble dryer** is intended for use with a duct and the duct is supplied with the **tumble dryer** (i.e. not as a separate accessory), the **tumble dryer** shall be tested with this duct, placed in a configuration consisting of three right angle bends as in Figure B.2.

Where the **tumble dryer** is intended for use with a duct and the duct is supplied with the **tumble dryer** (i.e. not as a separate accessory), but the supplied duct is too short to be placed in a configuration consisting of three right angle bends as in Figure B.2, it shall be tested with a duct as specified in B.3.

Where the **tumble dryer** is intended for use with a duct and the duct is not supplied with the **tumble dryer**, the **tumble dryer** shall be tested with a duct as specified in B.3.

Where a manufacturer gives the option to use the **tumble dryer** both with and without a duct, the **tumble dryer** shall be tested with a duct.

The test report shall clearly state which duct configuration, if any, is used in each test.

Where a water inlet is supplied, it shall be connected to an appropriate laboratory water supply system for testing (refer to 5.2.2).

If the manufacturer gives the option to use a **condenser tumble dryer** both with and without condensation box, the dryer shall be tested in accordance with the manufacturer's instructions. If no instructions are provided, then the dryer shall be tested with the condensation box.

6.3 Preparation of the tumble dryer for a test series

Before a **test series** is commenced the **tumble dryer** shall be checked to confirm that it has no operating defects that may affect the **operation** of the unit.

〖C〗 Before each **test series** the filters, heat exchangers and ducts intended to be serviced by the consumer shall be cleaned according to the manufacturer's instructions. 〖C〗

6.4 Preparation of the tumble dryer for a test run

〖C〗 Before each **test run** the filters, heat exchangers and ducts intended to be serviced by the consumer shall be cleaned according to the manufacturer's instructions. 〖C〗

[C] The manufacturer's specification for the **frequency of cleaning** of the heat exchanger and related filters shall be followed. If no specification is given regarding frequency, or the specified frequency is greater than six cycles then the heat exchanger and its related filters shall not be cleaned between test runs within a test series. In this context, the manufacturer's specification for cleaning the heat exchanger and its related filters means the specification that is directed towards the user. Specifications that are given specifically for use by test laboratories shall be ignored. 〈C]

The **tumble dryer** shall be at laboratory ambient temperature (refer to 5.2.3.1) at the beginning of each **test run**. This requirement has been met if the temperature of the hottest internal surface of the **tumble dryer** drum remains within 2 °C of the ambient air temperature for a period of 15 minutes whilst the drum door remains closed. Alternatively the **tumble dryer** shall be left for 18 hours at ambient temperature between **test runs**.

NOTE The latter is the preferred method when testing **tumble dryer**s with a high thermal mass (such as heat pump dryers).

6.5 Preparation of test loads

6.5.1 General

This section sets out requirements for the preparation of the **test loads** used in the **tumble dryer** which is to be tested in accordance with this International Standard. Refer to Clause 7 regarding the selection of the required **test load mass** and requirements for tests at **rated capacity**. This section sets out:

- **Pre-treatment** of new **test load** items prior to use in testing;
- Average age requirements for **test load** items used in a **test series**;
- **Normalization** of the **test load** items;
- **Conditioning** of **test load** items to determine the **test load mass** at a known remaining **moisture content**;
- **Test load** composition;
- Wetting of the **test load**.

6.5.2 Pre-treatment of new test load items prior to use

New cotton and synthetics/blend **test load** items shall be treated before their first use by undergoing a **normalization** wash process five times, as defined in 6.5.4 but without intermediate drying. 15 g of the reference detergent A* base powder per kg of **test load** is added to the first five washes. After the final **pre-treatment** wash, the **test load** shall be dried.

6.5.3 Requirements regarding the age of test load items

6.5.3.1 General

No individual cotton or synthetic/blend **test load** item shall be used for more than 80 **test runs** excluding **pre-treatment** runs prior to initial use and the **normalization** runs (refer to 6.5.4).

Test loads intended for **tumble dryer** tests following this standard shall not be used for any other purpose. Loads that have been used for any other purpose are not suitable for **tumble dryer** tests following this standard.

NOTE It may be advisable to use the same test load for a test series.

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

6.5.3.2 Average age requirements for cotton test load items

To minimise the influence of changes in the characteristics of the textiles with increasing age, the cotton **test 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 **test load** between 30 and 50 **test runs**, using the nominal mass for each item given in A.2. An example of how this can be achieved is provided in A.2. The weighted average age of the **test load** shall be calculated according to A.4. The weighted average age shall be reported.

〚C〛 The weighted average age limitations for the **test load** apply only for **full load** and not for **partial load**. 〚C〛

6.5.3.3 Average age requirements for synthetics/blends test load items

To minimise the influence of changes in the characteristics of the textiles with increasing age, half of the synthetics/blends **test load** shall consist of items used up to 40 **test runs** and the other half more than 40 **test runs**. The synthetics/blends **test load** shall consist of shirts and pillowcases that are well distributed in age to give a weighted average age of the **test load** between 20 and 60 **test runs** using the nominal mass for each item given in A.2. The weighted average age of the **test load** shall be calculated according to A.2.

6.5.4 Normalization of test load items

6.5.4.1 General

After they have been used for a minimum of 10 **test runs** and a maximum of 12 **test runs**, all **test load** items shall undergo **normalization**. **Normalization** is the process of washing the **test load** in a reference washing machine (or suitable alternative as described in 5.4.1) using a specified **programme** in order to bring the **test load** back into a standardized state.

6.5.4.2 Normalization of cotton test load items

Normalization of cotton **test load** items is achieved by processing them once in a reference washing machine using 15 g / kg of the reference detergent A* base powder and using the 60 °C cotton reference **programme** described in A.10. On completion of the **programme**, the **test load** items shall then be dried in a **tumble dryer**.

For **normalization** purposes, up to 6,5 kg can be washed in a reference washing machine. Where the **test load** to be normalized is more than 6,5 kg, the **test 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.

6.5.4.3 Normalization of synthetics/blend test load items

Normalization of synthetics/blend **test load** items by processing them once in a reference washing machine using 15 g / kg of the reference detergent A* base powder and using the 60 °C synthetics/blends textile reference **programme** described in A.10. On completion of the **programme** the **test load** items shall then be dried in a **tumble dryer**.

For **normalization** purposes up to 4 kg can be washed in a reference washing machine. Where the **test load** to be normalized is more than 4 kg, the **test 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.

6.5.5 Conditioning of test load items

6.5.5.1 General

Conditioning is the process of bringing the **test load** to a known **moisture content** after **normalization** 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.

6.5.5.2 Conditioning of test load items in an ambient controlled room/chamber

In this method, the **test load** textiles are dried in a **tumble dryer** to a **final moisture content** of each single item of about -3 % in the case of cotton textiles or about -1 % in the case of synthetics/blend textiles and they are then stretched or flattened by hand. They are then allowed to reach an equilibrium **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 textiles 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.
- Textiles 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.

NOTE The **final moisture content** is defined at -3 % and -1 % in order to ensure that all items of the load are conditioned coming from a more dry state.

The mass of the complete test load in its conditioned state shall be recorded. If the test load is to be used for evenness measurements then the mass of each and every test load item in its conditioned state shall be recorded.

6.5.5.3 Conditioning of test load items using the bone dry method

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

If the load is to be used for evenness of drying measurements, the bone dry mass and the conditioned mass of each item in the load shall be determined individually.

The specification for the **tumble dryer** used and the method to prepare the **test load** to the bone dry condition prior to a **test series** and the calculation of conditioned mass is specified in A.3.

6.5.6 Test load composition

6.5.6.1 Cotton test load composition

The **test load mass** is adjusted so that it corresponds to the required **test load mass** for the specified **programme** of the **tumble dryer** to be tested. The numbers of sheets, pillowcases and towels in the cotton **test load** for various required **test load masses** are specified in Table 3. Final adjustment of the **test load mass**, is made by adding or removing towels so that the total mass is as close as possible (± 60 g) to the required **nominal test load mass**.

Table 3 – Number of items in the cotton test load for various test load masses

Required test load mass kg [a]	Number of sheets	Number of pillowcases	Number of towels [b]
1	0	2	5
1,5	0	3	7
2	0	4	9
2,5	0	5	12
3	2	4	5
3,5	2	4	10
4	2	4	14
4,5	2	6	15
5	2	6	19
5,5	2	8	19
6	2	8	24
6,5	2	10	24
7	2	12	24
7,5	3	12	22
8	3	12	27
8,5	3	14	27
9	4	14	25
9,5	4	14	29
10	4	16	30
10,5	5	15	30
11	5	15	34
11,5	5	16	37
12	6	17	32
12,5	6	17	37
13	6	18	39
13,5	6	19	42
14	6	19	46
14,5	7	20	42
15	7	21	44

a For test load masses to the whole or half kg rating which are greater than those specified in the table, 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 pillowcase). The balance of the required nominal test load mass is made up of towels as required. The mass of all test load items can be expected to decline slightly with increasing age.

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

Care is required to ensure that no **test load** items are lost or gained between **test runs**, so a system of accounting for all **test load** items should be used.

〖C〗 Table 3 applies to define the **full load** for a **test series**. Refer to ZA.2 regarding the splitting of the **full load** for the tests with **partial load** and for the number of sheets, pillowcases and towels to be used for part A and part B of the **partial loads**. 〖C〗

6.5.6.2 Synthetics/blends test load composition

The **test load mass** is adjusted so that it corresponds to the required **test load mass** for the specified **programme** of the **tumble dryer** to be tested. The numbers of pillowcases and shirts in the synthetics/blends **test load** for various required **test load mass**es are specified in Table 4. The synthetic/blends **test load** is set up first with an equal number of shirts and pillowcases. Final adjustment of the **test load mass** is made by adding or subtracting one shirt or one pillowcase, whichever brings the **test load mass** to be closest to the required **nominal test load mass**.

Table 4 – Number of items in the synthetic/blends test load for various test load masses

Required test load mass kg	Number of shirts	Number of pillowcases
1	3	3
1,5	4	4
2	5	6
2,5	7	6
3	8	8
3,5	9	9
4	11	11
4,5	12	12
5	14	13
NOTE The actual number of items above is only indicative. The mass of all **test load** items can be expected to decline slightly with increasing age.		

Care is required to ensure that no **test load** items are lost or gained between **test runs**, so a system of accounting for all **test load** items should be used.

6.5.7 Wetting

The **initial moisture content** is established by wetting and spinning the load.

The load shall be homogeneously wetted. This shall be carried out in a washing machine according to the specification given in 5.4.3. The load shall be spun for as long as necessary to reach **initial moisture content** in the range:

$$\mu_{io} + 1\ \%\ \text{to}\ \mu_{io} - 3\ \%$$

where μ_{io} is the nominal **initial moisture content**.

The **moisture content** of the wet **test load** μ_{ij} is calculated as

$$\frac{W_i - W_0}{W_0}\ \text{expressed as a percentage,}$$

where

W_i is the mass of the **test load** after wetting; and

W_0 is the mass of the conditioned **test load**.

Water is then added evenly by means of a fine spray as necessary, so that the **initial moisture content** of the **test load** when starting the test lies within the allowable range specified in Table 5. This initial wet mass is recorded as W_i.

Initial moisture contents other than specified in Table 5 may be used if clearly stated with the results. Annex F shows how the results of tests using two different **initial moisture contents** may be used to calculate the drying time and energy consumption that relate to other **initial moisture contents**.

NOTE 1 The preferred method is the one given in Annex F. The values given in Table 5 are only recommended where a single result is required for a single market and load.

NOTE 2 Results measured directly have priority over results calculated using the method shown in Annex F, for the purposes of resolving disputes.

Table 5 – Specifications for initial moisture content in the test load

Textile	Nominal initial moisture content μ_{i0}		Allowable range for initial moisture content μ_{ij}	
	A	B	A	B
Cotton	70 %	60 %	69 % to 71 %	59 % to 61 %
Synthetics/blend	50 %	40 %	49 % to 51 %	39 % to 41 %

7 Performance measurements – General requirements

This clause sets out the overall strategy for carrying out performance tests using this International Standard.

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

- Load type (i.e. cotton or synthetics/blends);
- Performance tests required (energy and water consumption, condensation efficiency, evenness of drying, etc);
- **Programme** to be tested on the **tumble dryer**;
- **Initial moisture content** of the **test load**;
- Target **final moisture content** of the **test load**;
- **Test load mass** (**rated capacity** or part load).

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

When two or more of the following performance parameters are required for a single **tumble dryer**, they shall be measured as far as possible using a single common **test series** as set out in Clause 8:

- Electric energy consumption;
- Water consumption;
- **Programme time**;
- Condensation efficiency;
- Evenness of drying;
- Exhaust air volume.

[C] For the combined test series according to Annex ZA, the following parameters shall be selected:

- The load type shall be cotton.
- The **initial moisture content** shall be according to column B in Table 5.

For the combined test series according to Annex ZA, the following parameters shall be measured for the **tumble dryer** using a common single **test series** consisting of 7 runs and using two load sizes (**full load** and **partial load**) as set out in Annex ZA:

– condensation efficiency;

– **programme time;**

– energy consumption;

– energy consumption in low power modes.

The evaluation of these parameters for the **tumble dryer** is specified in Annex ZA.

Programmes to be tested on the **tumble dryer** for the combined test series according to Annex ZA:

A 'dry cotton' **programme** for achieving a **final moisture content** according Table 6 shall be used in accordance with the manufacturers' instruction. For **automatic dryers,** exactly the same **programme** setting for the 'dry cotton' **programme** shall be used for the tests with **full load** and for the tests with **partial load**. For **non-automatic dryers,** the same settings except the drying duration shall be used for the tests with **full load** and for the tests with **partial load**. [C]

8 Tests for performance

8.1 General

This clause sets out the test procedure for the determination of performance with a cotton load or a synthetic/blend load.

[C] For the combined **test series** according to Annex ZA, additional requirements for the test procedure of the **tumble dryer** are included in Annex ZA. [C]

8.2 Test procedure for performance tests

8.2.1 Test conditions, materials and preparation for testing

For each **test run the tumble dryer** shall be prepared according to Clause 6.

8.2.2 Programme

The **programme** selected on the **tumble dryer** and any associated settings shall initially be in accordance with the manufacturer's instructions. In the absence of any instructions from the manufacturer, or if the recommended **programmes** do not achieve valid results (see 8.2.5) then a suitable **programme** is established by trial and error before a full **test series** is carried out.

[C] For **automatic tumble dryers** and for **non-automatic tumble dryers**, those **programme** settings are selected which aim to achieve final moisture values that are close as possible to the nominal **final moisture content** given in Table 6, but no greater than the values given in Table 6. [C]

[C] For **automatic tumble dryers**, the same programme setting shall be used for tests with both full loads and partial loads. For **non-automatic tumble dryers**, the time settings shall be evaluated separately for **full load** and **partial load**. [C]

Table 6 – Specification for final moisture content of the test load after drying

Programme or user requirements	Target final moisture content value μ_{f0}	Range for final moisture content for a test run μ_{fj}	Allowable range for average final moisture content μ of a test series
Dry cotton	0 %	–3 % to +3 %	Less than +1,5 %
Iron dry cotton	+12 %	+8 % to +16 %	Less than +14 %
Synthetic/blends textile	+2 %	–1 % to +5 %	Less than +3,5 %

The selected **programme** shall be used for all **test runs** in a **test series**. If it is decided part way through a **test series** that the **programme** must be changed in order to achieve the required target **final moisture content** value then the **test series** shall be aborted and another **test series** started using the alternate **programme**.

The **programme** selected on the **tumble dryer** (with any associated settings) shall be reported.

8.2.3 Test load

Prior to a **test run**, a separate conditioned **test load** of the required type and mass as specified in Clause 6 shall be prepared for each **tumble dryer** being tested.

[C] NOTE For a **test series**, several different **test loads** of the capacity under test may be used in accordance with ZA.2. [C]

8.2.4 Test procedure

Immediately before each **test run**, the **test load** shall be wetted according to 6.5.7.

The **test load** shall be loaded into the **tumble drye**r within 5 minutes of having been wetted and the selected **programme** shall be started without delay.

No control on the **tumble dryer** (for example the timer control) shall be adjusted by the operator while the **programme** is running.

At the **end of the programme**, the **test load** shall be removed within 5 minutes and immediately weighed. The final **test load mass** for **test run** *j* is recorded as W_{fj}.

When the **programme** has terminated and the **tumble dryer** has stopped, this means that the **test run** has finished. The **test load** shall not be subjected to any further drying as part of the same **test run**.

The **final moisture content** for **test run** *j* is calculated as:

$$\mu_{fj} = (W_{fj} - W_0) / W_0 \text{ (expressed as a percentage)}$$

where W_0 is the mass of the conditioned **test load.**

The **final moisture content** shall be reported.

8.2.5 Validity of a test run

[C] For the combined test series according to Annex ZA, the **test run** shall be declared valid, if the measured value of the **final moisture content** of that **test run** is below the upper limit given in Table 6. [C]

If the dryer has stopped automatically during a **test run** because the condensate container is full of water, the fact shall be reported and the **test run** shall be declared invalid.

Any adverse warning indicators (e.g. warnings or faults) shall be recorded and considered when assessing **test run** validity. However, if the run is not invalid for any of the reasons given above, it shall be declared valid.

8.2.6 Validity of a test series

[C] For the combined test series according to Annex ZA, a complete **test series** consists of three valid tests in **treatment full** and four valid tests in **treatment half**.

If one of the in total seven tests of the series is declared invalid, this single test may be repeated using the same **programme** settings as used for the previous tests and the same nominal initial moisture content as all the previous tests runs in the test series. The invalid test run shall be eliminated completely from any subsequent evaluation.

If more than one single test of the series is invalid, the whole **test series** shall be declared invalid.

If the average **final moisture content** for a **test series** of seven valid **test runs** is below the limit in Table 6, then the **test series** shall be declared valid and the results are evaluated according to Clause 9. Otherwise, the **test series** shall be invalid.

If a **test series** of 7 valid **test runs** is invalid, it shall not be made valid by substituting one of the **test runs** with an eighth **test run**. [C]

Data from an invalid **test series** shall not be used for evaluation according to Clause 9.

If a **tumble dryer** cannot complete a valid **test series** using the **programme** recommended by the manufacturer to dry a particular load type then this fact shall be reported. A new **test series** shall then be carried out using the **programme** with the next lower **final moisture content**. If no such **programme** is available then the **test series** shall be stopped.

If a **tumble dryer** cannot complete a valid **test series** with a particular load type using any of its **programmes** then this fact shall be reported.

A schematic representation of a **test series** is set out in Annex C.

8.3 Measurements to determine water and energy consumption and programme time

8.3.1 General

This clause contains specific requirements for the measurement of energy consumption, **programme time** and water consumption. The purpose is to obtain reproducible data for the calculation of environmental impacts and cost of **operation** based on energy and water consumption.

Evaluation of the measurements performed in this clause is set out in 9.2, 9.3, 9.4 and 9.5.

Determination of power consumption in **off mode** and **left on mode** is specified in A.5.

8.3.2 Procedure

The **test load** shall be subjected to the performance test procedure specified in 8.2. During these tests, instrumentation for the measurement of electrical energy and water volume shall record the required parameters (refer to Clause 5). 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 until after the **end of the programme**.

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

〖C〗 Evaluation shall be made on all valid **test runs** of a valid **test series** for the selected **programme**. 〖C〗

8.4 Measurements to determine condensation efficiency

8.4.1 General

This clause contains specific requirements for the measurement of condensation efficiency of **condenser tumble dryers**. Evaluation of the measurements performed in this clause is set out in 9.6.

〖C〗 Evaluation shall be made on all valid **test runs** of a valid **test series** for the selected **programme**. 〖C〗

8.4.2 Procedure

The **tumble dryer** shall be conditioned no more than 36 hours before the first **test run** by drying a **rated capacity** load that has been wetted to no less than the minimum relevant value given in Table 5. It shall then be allowed to cool to ambient temperature as described in 6.4.

The **tumble dryer** door shall remain closed during the period before starting the test.

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

The mass of the **test load** is measured immediately before and after the **test run**. The mass of moisture condensed during the **test run** and collected in the container is determined.

If more than 36 hours elapses between one **test run** and the next then the **tumble dryer** shall be conditioned as described above prior to the next **test run**.

〖C〗 Measurements shall be made on all valid **test runs** of a valid **test series** for the selected **programme**. 〖C〗

8.5 Measurements to determine evenness of drying

8.5.1 General

This clause contains specific requirements for the measurement of evenness of drying. Evaluation of the measurements performed in this clause is set out in 9.7. Limitations to this method and procedures for overcoming them are given in Annex G.

8.5.2 Procedure

Before testing, each individual piece of the **test load** is marked. The individual weight of each piece is measured and recorded after **conditioning** as described in 6.5.5 and after each **test run**.

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

Measurements shall be made on all five valid **test runs** of a valid **test series** for the selected **programme**.

8.6 Measurements to determine exhaust air volume

This clause contains specific requirements for the measurement of exhaust air volume. Evaluation of the measurements performed in this clause is set out in 9.8.

This measurement is applicable for externally **vented tumble dryers** only.

Under certain climatic conditions an **air vented tumble dryer** which is externally vented may consume additional thermal energy where the indoor temperature is lower or higher than the outdoor air temperature. In this case it is assumed that the exhaust air is vented outside and replaced through the intake of outdoor air into the building.

A possible measurement procedure is specified in Annex H.

9 Assessment of performance

9.1 General

This clause sets out the primary evaluation methods for the assessment of **tumble dryer** performance under this International Standard. These methods are applicable to both load types described in Clause 5.

This clause includes the evaluation of all the performance parameters listed in Clause 7.

Rounding shall only be applied to reported values in Annex D. If numbers have to be rounded they shall be rounded to the nearest number according to ISO 80000-1:2009 (B.3, Rule B). If the rounding takes place to the right of the comma, the omitted places shall not be filled with zeros.

〖C〗 For the combined **test series** according to Annex ZA, additional requirements for evaluation for the **tumble dryers** are included in Annex ZA. 〈C〗

9.2 Final moisture content of the load

The **final moisture content** of the load shall be evaluated as shown in 8.2.4.

The average **final moisture content** μ_f of the valid **test runs** of a **test series** is calculated as:

$$\mu_f = \frac{1}{n}\sum_{j=1}^{n}\mu_{fj}$$

where

n is the number of **test runs**;

j is the **test run** number;

μ_{fj} is the measured **final moisture content** after **test run** j.

The standard deviation of the measured **final moisture content** S_b, which is a measure of the variability between **test runs** in one **test series** on a selected **programme** or timer setting, is calculated for a **test series**:

$$S_b = \sqrt{\frac{1}{n-1}\sum_{j=1}^{n}(\mu_{fj} - \mu)^2}$$

where

n is the number of **test runs**;

j is the **test run** number;

μ_{fj} is the measured **final moisture content** after **test run** j;

μ is the average measured **final moisture content** for the **test series**.

9.3 Corrected electrical energy consumption

〈C〉 If the **final moisture content** of a valid **test run** is within the target range given in Table 6, then the corrected electrical energy consumption shall be evaluated as shown below using the measurements determined in 8.3.

Otherwise, no correction shall be made on the energy consumption and the measured energy consumption shall be declared as the corrected energy consumption. 〈C〉

The corrected electrical energy consumption E_j is calculated for each **test run** j in a **test series**:

$$E_j = E_{mj} \, x \, \frac{(\mu_{i0} - \mu_{f0}) \, x \, W}{(W_i - W_f)}$$

where

E_{mj} is the measured electric energy for **test run** j;

μ_{i0} is the nominal **initial moisture content**;

μ_{f0} is the target **final moisture content**

W is the **rated capacity** of the **tumble dryer** for the type of load tested;

W_i is the mass of the **test load** after wetting;

W_f is the mass of the **test load** after drying.

The average corrected electric energy consumption E is calculated from the corrected electric energy consumption of all valid **test runs**:

$$E = \frac{1}{n} \sum_{j=1}^{n} E_j$$

where

n is the number of **test runs**;

j is the **test run** number;

E_j is the corrected electrical energy consumption of the **test run** j.

〈C〉 Additional steps of evaluation for the **tumble dryer** are specified in Annex ZA. 〈C〉

9.4 Corrected water consumption

〈C〉 If the **final moisture content** of a valid **test run** is within the target range given in Table 6, then the corrected water consumption shall be evaluated as shown below using the measurements determined in 8.3.

Otherwise, no correction shall be made on the water consumption and the measured water consumption shall be declared as the corrected water consumption. 〈C〉

The corrected water consumption L_j is calculated for each **test run** j in a **test series**

$$L_j = L_{mj} \, x \, \frac{(\mu_{i0} - \mu_{f0}) \, x \, W}{(W_i - W_f)}$$

where

L_{mj} is the measured water consumption for **test run** j;

μ_{i0} is the nominal **initial moisture content**;

μ_{f0} is the target **final moisture content**;

W is the **rated capacity** of the **tumble dryer** for the type of load tested;

W_i is the mass of the **test load** after wetting;

W_f is the mass of the **test load** after drying.

The average corrected water consumption L is calculated from the corrected water consumption of all valid **test runs**:

$$L = \frac{1}{n} \sum_{j=1}^{n} L_j$$

where

n is the number of **test runs**;

j is the **test run** number;

L_j is the corrected water consumption of **test run** j.

〖C〗 Additional steps of evaluation for the **tumble dryer** are specified in Annex ZA. 〖C〗

9.5 Corrected programme time

〖C〗 If the **final moisture content** of a valid **test run** is within the target range given in Table 6, then the corrected **programme time** shall be evaluated as shown below using the measurements determined in 8.3.

Otherwise, no correction shall be made on the **programme time** and the measured **programme time** shall be declared as the corrected **programme time**. 〖C〗

The corrected **programme time** t_j is calculated for each **test run** j in a **test series**:

$$t_j = t_{mj} \, x \, \frac{(\mu_{i0} - \mu_{f0}) \, x \, W}{(W_i - W_f)}$$

where

t_{mj} is the measured **programme time** for **test run** j;

μ_{i0} is the nominal **initial moisture content**;

μ_{f0} is the target **final moisture content**;

W is the **rated capacity** of the **tumble dryer** for the type of load tested;

W_i is the mass of the **test load** after wetting;

W_f is the mass of the **test load** after drying.

The average corrected **programme time** t is calculated from the corrected **programme times** of all valid **test runs**:

$$t = \frac{1}{n}\sum_{j=1}^{n} t_{\mathrm{j}}$$

where

n is the number of **test runs**;

j is the **test run** number;

t_{j} is the corrected **programme time** of **test run** j.

〖C〉 Additional steps of evaluation for the **tumble dryer** are specified in Annex ZA. 〈C〗

9.6 Condensation efficiency

The **condensation efficiency** shall be evaluated as shown below using the measurements from valid **test runs** determined in 8.4.

Condensation efficiency C_j is calculated for all valid **test runs** and expressed as a percentage:

$$C_{\mathrm{j}} = \frac{W_{\mathrm{wj}}}{W_{\mathrm{i}} - W_{\mathrm{f}}} \times 100$$

where

W_{wj} is the mass of water collected in the condenser reservoir during **test run** j;

W_{i} is the mass of the **test load** used after wetting but before drying;

W_{f} is the mass of the **test load** after drying.

〖C〉 The average condensation efficiency C shall be calculated from the condensation efficiencies of all valid **test runs** expressed as a percentage: 〈C〗

$$C = \frac{1}{n}\sum_{j=1}^{n} C_{\mathrm{j}}$$

where

n is the number of **test runs**;

j is the **test run** number;

C_{j} is the condensation efficiency of **test run** j.

〖C〉 Additional steps of evaluation for the **tumble dryer** are specified in Annex ZA. 〈C〗

9.7 Evenness of drying

The evenness of drying shall be evaluated as shown below using the measurements from valid **test runs** determined in 8.5.

For each valid **test run** j, the **final moisture content** μ_{fjk} is calculated for each individual item k in the **test load**, expressed as a percentage:

$$\mu_{fjk} = (W_{fk} / W_{0k}) - 1$$

where

W_{fk} is the final mass of item k;

W_{0k} is the mass of the conditioned **test load** item k.

For each valid **test run** j the average **final moisture content** of all the individual items in the **test load** μ_{fjav} is calculated:

$$\mu_{fjav} = \frac{1}{N} \sum_{k=1}^{N} \mu_{fjk}$$

where

k is the item number;

N is the total number of load items in the **test load**;

μ_{fjk} is the measured **final moisture content** of **test load** item k for each valid **test run** j.

For each valid **test run**, the standard deviation of the **final moisture content** of the items s_{wj} is calculated as the standard deviation of the **final moisture content** of each **test load** item.

$$s_{wj} = \sqrt{\frac{1}{N} \sum_{k=1}^{N} (\mu_{fjk} - \mu_{fjav})^2}$$

where

k is the item number;

N is the total number of load items in the **test load**;

μ_{fjav} is the arithmetical average **final moisture content** of all the individual items in the **test load** (%);

μ_{fjk} is the measured **final moisture content** of **test load** item k for each valid **test run** j.

$$\mu_{fjav} = \frac{1}{N} \sum_{k=1}^{N} \mu_{fjk}$$

The average evenness of drying S_w is calculated from the evenness of drying results of at least five valid **test runs**,

$$S_w = \frac{1}{n} \sum_{j=1}^{n} s_{wj}$$

where

n is the number of **test runs**;

j is the run number;

s_{wj} is the evenness of drying result for **test run** j.

9.8 Exhaust air volume

The exhaust air volume shall be evaluated as shown in Annex H.

10 Data to be reported

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

〈C〉 For a test series according to Annex ZA data to be reported for the **tumble dryer** are specified in Annex ZA. 〈C〉

Annex A
(normative)

Reference list

A.1 Reference detergent

〈C〉 See EN 60456:2011, Annex B. 〈C〉

A.2 Specification of test load

〈C〉 See EN 60456:2011, Annex C. 〈C〉

A.3 The bone dry method of conditioning

〈C〉 See EN 60456:2011, Annex G. 〈C〉

A.4 Calculation of weighted average age of the cotton test load

〈C〉 See EN 60456:2011, Annex I, but replace the term ‘washing **operation**’ with the term ‘drying **operation**’ and replace the term ‘base load’ with the term ‘**test load**’.

NOTE Annex I applies only for **full load** and not for **partial load**. 〈C〉

A.5 Measurements of energy consumption in low power modes

〈C〉 See EN 60456:2011, Annex L.

The above paragraph is informative. 〈C〉

A.6 Uncertainty of measurement

〈C〉 See EN 60456:2011, Annex Q. 〈C〉

A.7 Environmental aspects of tumble dryer use determined in IEC 61121

〈C〉 See EN 60456:2011, Annex R. 〈C〉

A.8 Source of materials and supplies

〈C〉 See EN 60456:2011, Annex U. 〈C〉

A.9 Reference washing machine

〈C〉 See EN 60456:2011, Annex D. 〈C〉

A.10 Reference programme

〈C〉 See EN 60456:2011, Annex E. 〈C〉

Annex B
(normative)

Nominal and standard exhaust duct for tumble dryer testing

B.1 Nominal exhaust duct for tumble dryer testing

The pressure / volumetric air flow curve for the nominal exhaust duct shall comply, with an accuracy of ±5 %, to the following formula:

$$p = K \times F^2$$

where

p is the static pressure, measured at the point where the duct is connected to the **tumble dryer**;

F is the volumetric air flow;

K $1{,}9 \times 10^{-3}$ Pa h^2/m^6.

For example at a volumetric airflow of 200 m^3/h the pressure is 76 Pa.

Figure B.1 shows the theoretical pressure/volumetric airflow curve for the duct.

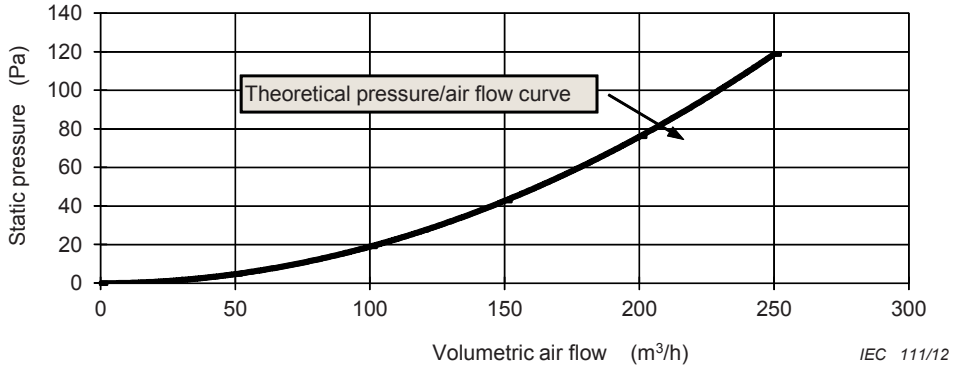

Figure B.1 – Pressure/volumetric air flow curve

This can be achieved by using a standard IEC exhaust duct as defined in the following section.

B.2 Standard IEC exhaust duct for tumble dryer testing

The standard IEC exhaust duct shall be formed according to Figure B.2. It consists of two straight pipe pieces and three bends. The pipe is of steel, so-called "spiro-pipe". Where the **tumble dryer** is placed on a balance, it may be more practical to replace the standard exhaust with the standard exhaust simulator which consists of a bend and a flexible pipe made of a plastic strip tube according to Figure B.3.

In this case, a standard exhaust shall be installed first. Then the **tumble dryer** is operated and the pressure in the duct at the **tumble dryer** outlet measured according to Figure B.2. The flexible pipe is then formed so as to give the same pressure as in Figure B.1. When this pressure is obtained, the flexible pipe shall be fixed.

Dimensions in millimetres

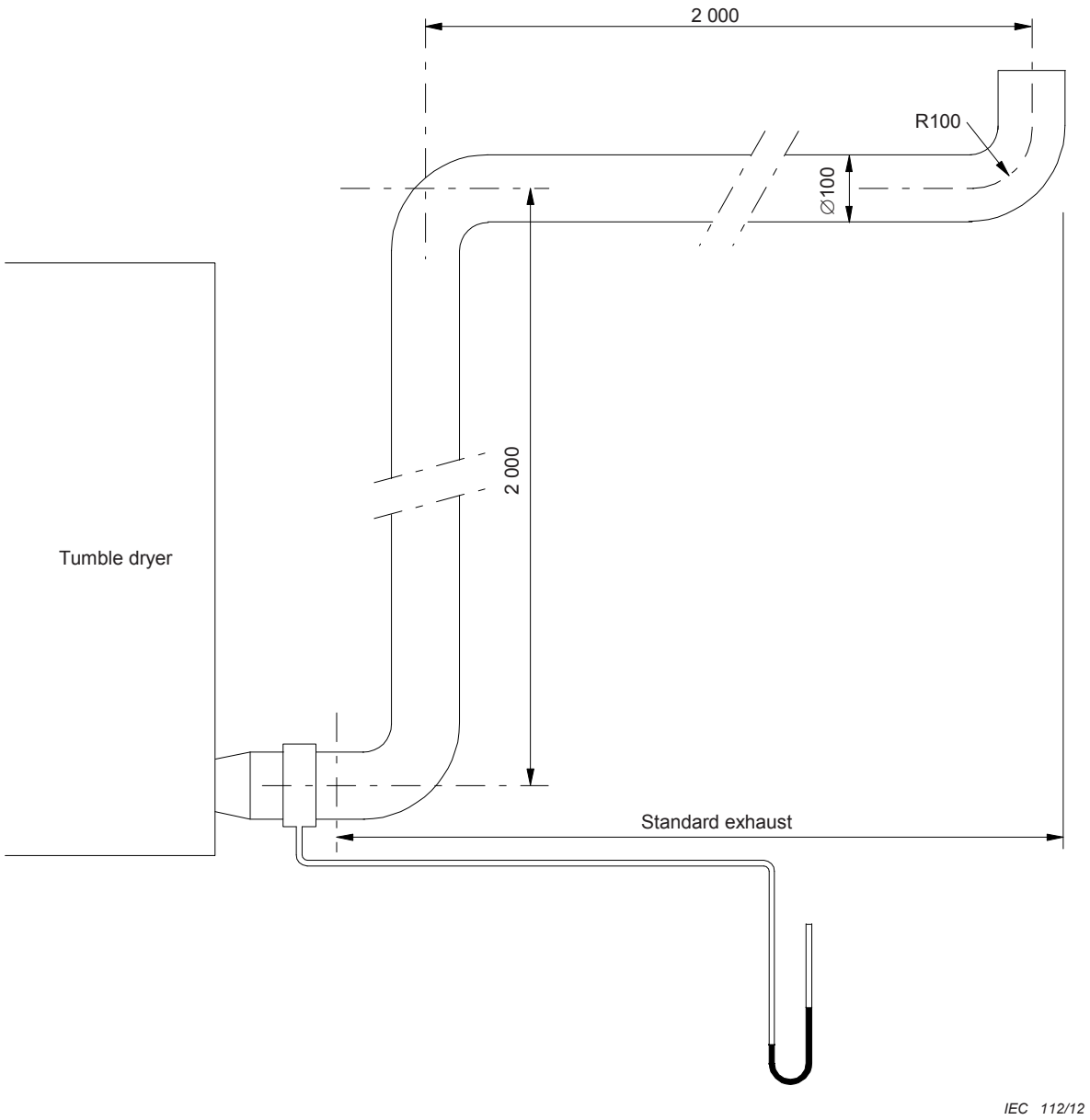

Figure B.2 – Standard exhaust duct

Dimensions in millimetres

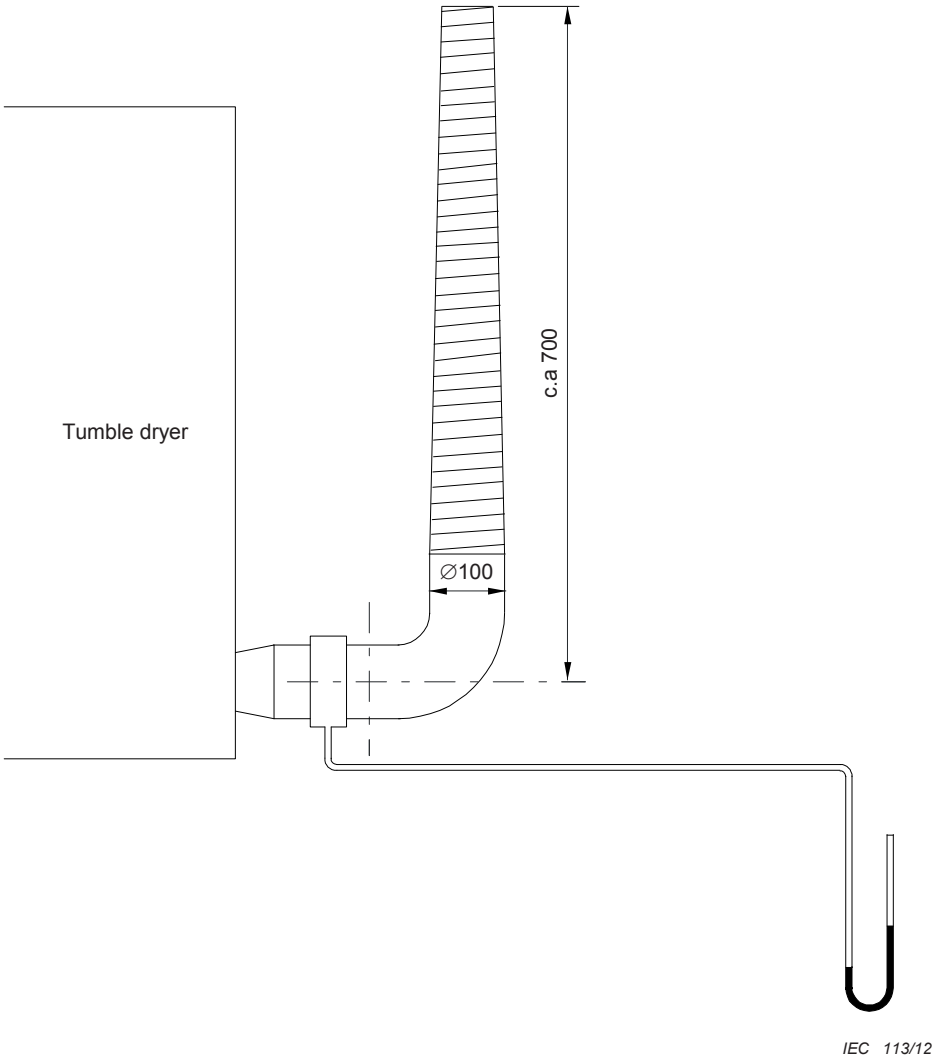

Figure B.3 – Standard exhaust simulator

Annex C
(informative)

Flow diagrams

Figure C.1 shows the decision chart illustrating the requirements for a valid **test series** for **automatic tumble dryers**. Figure C.2 shows the decision chart illustrating the requirements for a valid **test series** for **non automatic tumble dryers**.

〈C〉 For a **test series** according to Annex ZA, Figure C.Z1 shows the decision chart illustrating the requirements for a valid test series for both **automatic tumble dryers** and **non automatic tumble dryers**. 〈C〉

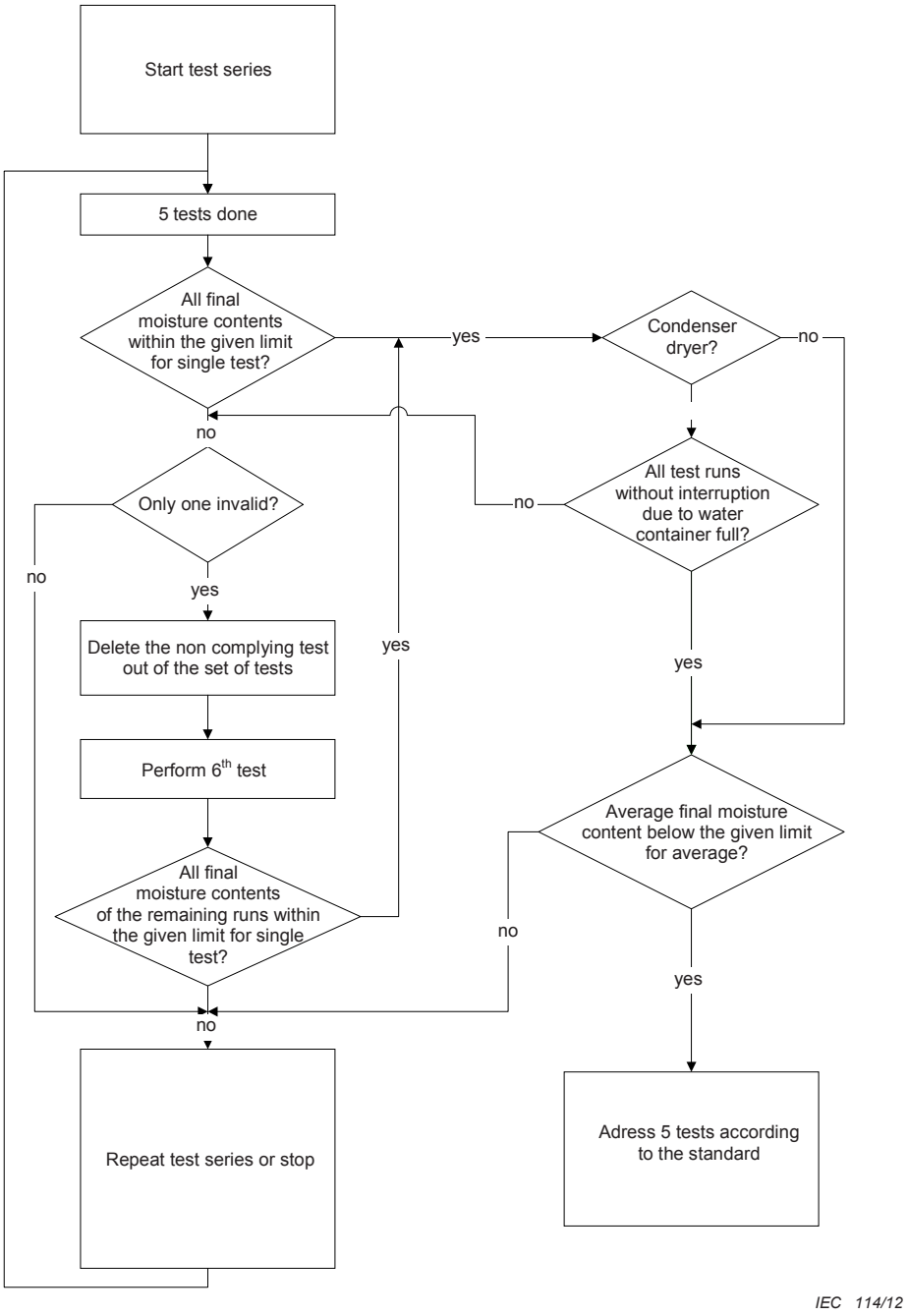

Figure C.1 – Decision chart illustrating the requirements for a valid test series for automatic tumble dryers

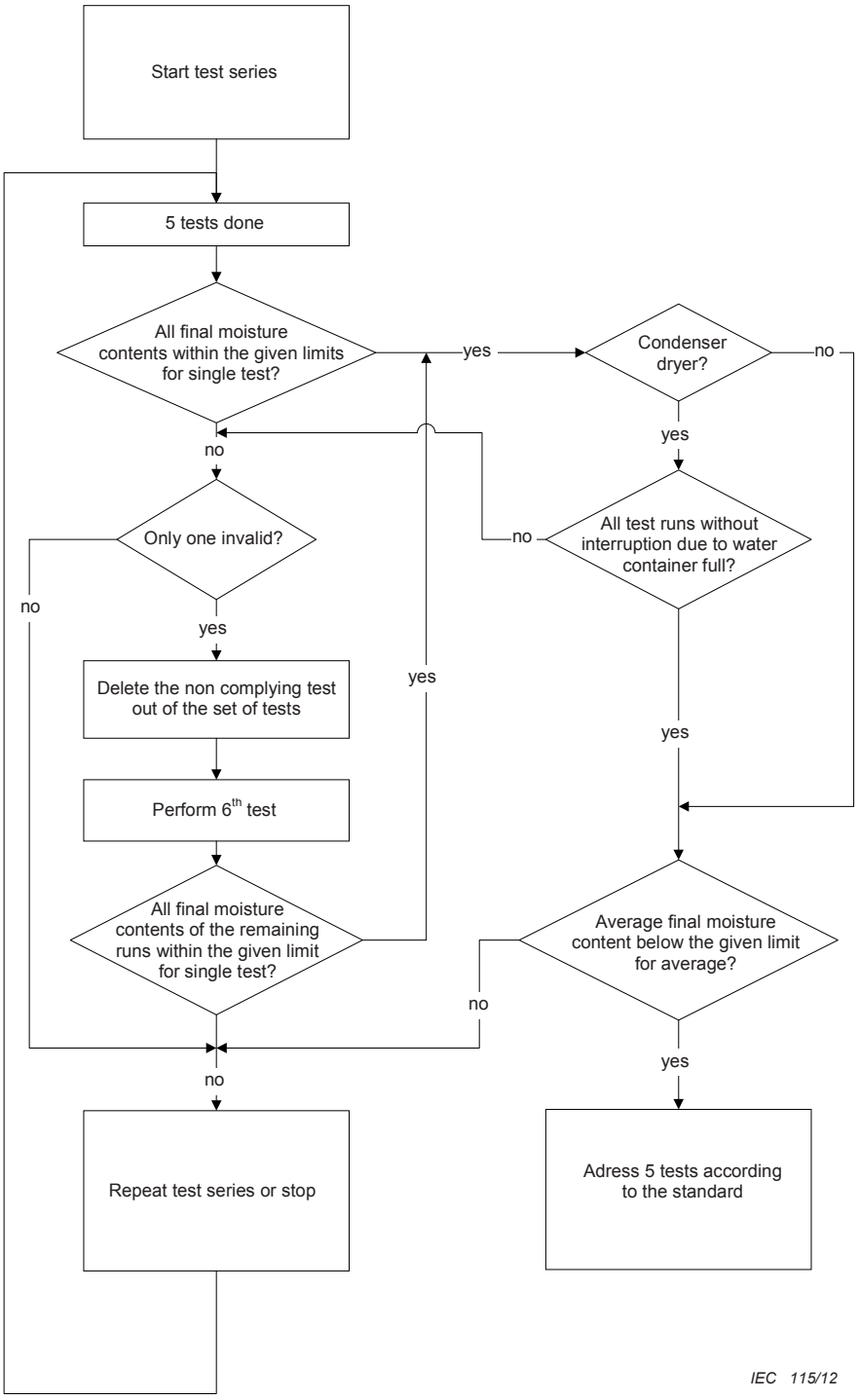

Figure C.2 – Decision chart illustrating the requirements for a valid test series for non-automatic tumble dryers

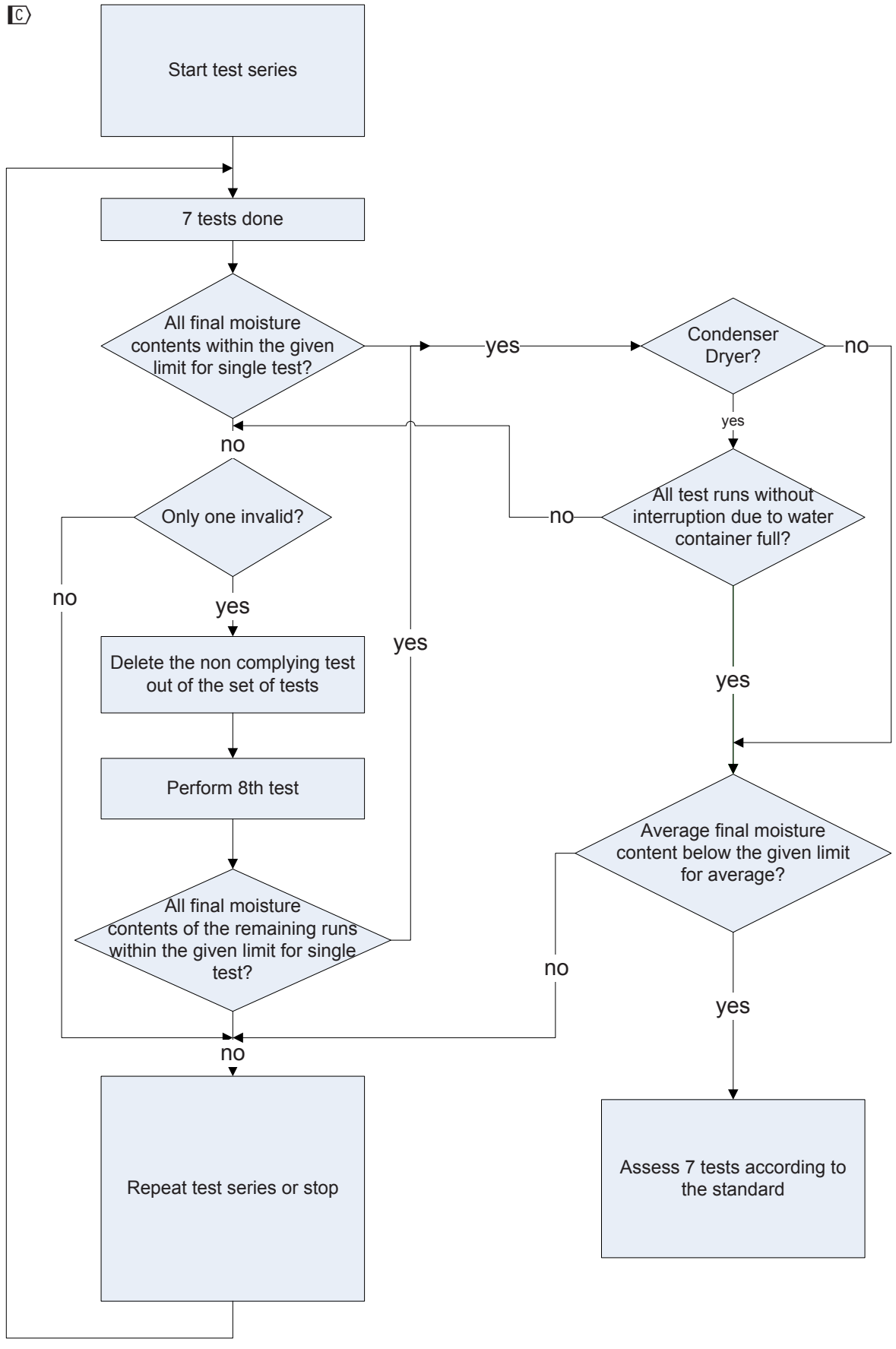

Figure C.Z1 – Decision chart illustrating the requirements for a valid test series for test series according to Annex ZA

Annex D
(normative)

Test report – data to be reported

This annex presents the data to be reported.

The layout of the following Tables D.1 to D.4 is recommended. Only the tables and parameters that are relevant for the **test series** need to be included.

Table D.1 – Identification data

Title: "**Test Report to IEC 61121**" (state edition and year used)

Laboratory name and address:	
Laboratory test report id;	Laboratory sample id;
Brand:	Model name:
Model number:	Serial number:
Source of appliance:	Country of manufacture:
Appliance dimensions declared (cm)	**Appliance dimensions measured** (cm)
Height:	Height:
Max height:	Max height:
Width:	Width:
Depth:	Depth:
Max depth:	Max depth:
Drum volume (l):*	Drum volume (l):*
Rated capacity (kg)*	
Cotton:	Synthetics/blends:
Design of dryer	
Axis (vertical / horizontal):	Dryer loading (top / front):
Air vented (yes / no):	Condenser (yes / no):
Automatic (sensor-controlled) (yes / no):	Timer controlled (yes / no):
Cold water connections* (yes / no):	
Rated voltage (V):	Rated frequency (Hz):
Additional information (for example, include here if applicable, reasons why the test had to be stopped before completion and state if the nominal test load mass is not equal to the rated capacity):	
Page number:	Number of pages in this report:
* as applicable	

Table D.2 – Test measurements

Laboratory name and address:											
Laboratory test reference:					Laboratory sample reference:						
Programme setting;											
	Symbol	Units	Noted (n) Measured (m) Calculated (calc)	Reported precision [b]	Run 1	Run 2	Run 3	Run 4	Run 5	Mean	S
Date of test		yy/mm/dd	n	-							
Conditioned **test load mass**	W_0	g	m	1							
Mass of **test load** after wetting	W_i	g	m	1							
Nominal **initial moisture content**	μ_{io}	%	n	0,1							
Initial moisture content	μ_{ij}	%	calc	0,1							
Final test load mass	W_f	g	m	1							
Target **final moisture content**	μ_{f0}	%	n	0,1							
Final moisture content	μ_{fj}	%	calc	0,1							
Measured energy consumption	E_{mj}	kWh	m	0,01							
Corrected energy consumption	E_j	kWh	calc	0,01							
Specific corrected energy consumption	E_s	kWh/kg	calc	0,001							
Measured water consumption[a]	L_{mj}	l	m	1							
Corrected water consumption[a]	L_j	l	calc	0,1							
Specific corrected water consumption[a]	L_s	l/kg	calc	0,1							
Measured **programme time**	t_{mj}	min	m	1							
Corrected **programme time**	t_j	min	calc	1							
Specific corrected **programme time**	t_s	min/kg	m	0,1							

Laboratory name and address:											
Laboratory test reference:					Laboratory sample reference:						
Programme setting;											
	Symbol	Units	Noted (n) Measured (m) Calculated (calc)	Reported precision [b]	Run 1	Run 2	Run 3	Run 4	Run 5	Mean	S
Initial mass of the condenser[a] reservoir		g	m	1							
Final mass of the condenser[a] reservoir		g	m	1							
Mass of water collected[a]	W_w	g	m	1							
Condensation efficiency[a]	C	%	calc	0,1							
Evenness of drying[a]	s_{wj}	-	calc	0,1							
Exhaust air volume[a]	V	m^3	calc	1							
Ambient temperature		°C	m	0,1							
Ambient humidity		%	m	1							
Page number:					Number of pages in this report:						

[a] To be declared only when applicable.

[b] The figures for reported precision specify the rounding and reporting of values. As an example, a reported precision of 0,001 means that the result shall be reported rounded to three decimal places.

Table D.3 – Test conditions and materials

Laboratory name and address:			
Laboratory test reference:	Laboratory sample references:		
Conditions during the drying test	**Average**	**Max**	**Min**
Air temperature around the **tumble dryer** (°C)			
Test room humidity (%)			
Electricity supply voltage (V)			
Electricity supply frequency (Hz)			
Water supply temperature (°C)[a]			
Water supply pressure (kPa)[a]			
Conditions during the wetting of the load	**Average**	**Max**	**Min**
Water supply temperature (°C)			
Water supply hardness (mmol/l)			
Water supply conductivity (μS/cm)[a]			
Water supply alkalinity (mmol/l)[a]			
Washing machine used (model and **rated capacity**)			
Conditions during the **conditioning** of the load			
Ambient temperature (°C)[a]			
Humidity (%)[a]			
Tumble dryer used for bone drying[a] (model and rated capacity)			
Bone dry conversion factor used[a]			
Conditions during the normalizing of the load			
Water supply temperature (°C)			
Water supply hardness (mmol/l)			
Water supply alkalinity (mmol/l)[a]			
Water supply conductivity (μS/cm)[a]			
Method used to prepare the water according to IEC 60734			
Page number:	Number of pages in this report:		
[a] to be declared only when applicable.			

Table D.4 – Weighted average age – Cotton load

Laboratory name and address:					
Laboratory test reference:			Laboratory sample reference:		
Test load reference:			Test run(s) for which this **test load** was used:		
	Number of items in given range of age at the start of the test run(s)				Weighted average age per type
	0 to 19	20 to 39	40 to 59	60 to 80	
Towels					
Pillowcases					
Sheets					
Weighted overall average age					
Page number:			Number of pages in this report:		

〖C〗 NOTE The statements concerning weighted average age in A.4 and Table D.4 apply to full loads but not to partial loads. 〈C〗

Annex E
(normative)

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

E.1 General

This annex sets out the method for the determination of **test load mass** when **rated capacity** is not declared.

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

The objective is to determine the entire mass of dry **test load** that can be placed in the **tumble dryer** during a drying **operation**.

Procedure:

a) Place the tumble dryer in such a position that the uppermost edge of the clothes container opening is levelled horizontally, keeping the transport-lock system (where fitted) locked to avoid errors in volume measurement by lowering of the system.

b) Fill the clothes container with the table tennis balls of 40 mm diameter (specification as in ITTF Technical Leaflet T3) with occasional stirring to get the closest packing of the table tennis balls and to avoid the appearance of void spaces.

c) Add as many table tennis balls as possible without preventing the door closing (it must be possible to close the door without compressing the balls).

d) Count the number (y) of table tennis balls in the clothes container.

NOTE This can be simplified by preparing e.g. a rectangular flat tray where always the same number of balls fit in.

e) Repeat the steps b) to d) three times, calculate the average of the numbers of table tennis balls (y=(y_1+y_2+y_3)/3) and use this number for calculation of test load mass.

f) The clothes container volume (V_c in litre) is calculated as follows:

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

NOTE This equation was derived empirically by comparison with the method given in Annex N of IEC 60456:2010 using water in horizontal axis systems (washer and dryer) with capacities in the range of 35 to 120 litres.

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

Test load mass, in kg = V_c / 24,0

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 International Standard.

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

Annex F
(normative)

Flexible initial moisture content method

F.1 General

In previous editions of this standard, the primary focus was measurement of energy consumption of dryers at **rated capacity**. The energy was determined at one or two **initial moisture contents** as defined in the standard. While this information is useful to determine the comparative energy of products under a specific set of conditions, it does not provide relevant information on the energy performance of a dryer under different conditions that could be expected during normal use.

For individual consumers, the **initial moisture content** of the load to be processed by the dryer is a function of the spin performance of the washing machine used and the load capacity that the consumer wants to treat. This can vary widely from user to user and even from load to load.

This annex sets out a new approach that forms the basis of a globally applicable clothes dryer standard which characterises the energy consumption of a dryer over a wide range of **initial moisture contents**. Using this approach, the energy consumption of a dryer can be accurately determined for any specified **initial moisture content** (within a defined range) without the need for additional testing. As the energy consumption of most dryers is highly linear with respect to **initial moisture content**, this approach has been found to be accurate for most dryer types.

In a global context, the average spin performance of clothes washers varies by country and region and these variations have been a primary driver for the lack of global harmonisation of clothes dryer test procedures. The approach in this annex sets out a single set of tests that can produce relevant average energy data for any particular country or region without the need for additional regional specific testing. This single global test method can therefore be used as the basis for local energy labelling **programmes** in all regions. The approach in this annex also allows the basis for energy labelling calculations to be re-based over time as the spin performance of new clothes washers (or the stock of installed clothes washers) improves without the need for further retesting of products.

The spin performance of all clothes washer models on the market is different and the previous test method was unable to take account of these differences in terms of the expected energy impact on dryer usage. The approach set out in this annex can provide highly relevant consumer-based information by providing comparative energy data for individual dryers when used in conjunction with a particular washer (with a known spinning performance). This data is also highly useful for modelling of energy consumption during actual use in applications such as **programme** impact evaluation.

This method allows the performance parameters energy consumption and **programme time** for a specific **initial moisture content** to be calculated from energy consumption and drying times measured for two other **initial moisture contents**. If the linear relationship is known, energy consumption and **programme time** can be calculated by linear interpolation for any **initial moisture content** between 45 % and 90 %.

A linear relationship is described as:

$$Y = b \times x + a$$

where

Y is the performance parameter (energy consumption or **programme time**);

b is the slope (as calculated in F.3);

x represents the **initial moisture content** μ;

a is the constant part of the regression line (as calculated in F.3).

This method is only valid if the drying process reaches the **final moisture content** stated in Table 6 on every **test run**.

F.2 Procedure

Two **test series** shall be performed on a single **tumble dryer** as described in Clause 8 but with **initial moisture contents** between 45 % and 90 %. The minimum difference between the mean **initial moisture contents** of the two **test series** shall not be less than 30 %. The **initial moisture content** of every test run in each **test series** shall be maintained within a tolerance of ± 5 %.

NOTE 1 For **condenser tumble dryers**, it is recommended that the external water drain is used.

NOTE 2 For **non automatic tumble dryer**s, the maximum **programme time** should be considered.

F.3 Evaluation

For each of the **test runs** energy consumption E_{mj}, time t_{mj}, and **final moisture content** μ_{fj} shall be recorded. Energy consumption and **programme time** shall be corrected regarding the measured **final moisture content** and conditioned mass as follows:

Corrected **programme time**:

$$t_i = t_{\mathrm{mi}} \frac{(\mu_{\mathrm{i}} - \mu_{\mathrm{f}0})\ W}{(\mu_{\mathrm{i}} - \mu_{\mathrm{f}\,j})\ W_0}$$

Corrected energy consumption:

$$E_i = E_{\mathrm{mj}} \frac{(\mu_{\mathrm{i}} - \mu_{\mathrm{f}0})\ W}{(\mu_{\mathrm{i}} - \mu_{\mathrm{f}\,j})\ W_0}$$

'*a*' and '*b*' are calculated as follows:

$$b = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2} = \frac{SS_{xy}}{SS_{xx}}$$

Where x_{i} represents the **moisture content** and y_{i} is the corresponding corrected energy consumption or **programme time**, $\bar{x}$ is the arithmetic mean of the **initial moisture content** and, $\bar{y}$ the arithmetic mean of the corrected measurands.

$$a = \bar{y} - b\bar{x}$$

For any required **initial moisture content** *x* the corresponding energy consumption and **programme time** is then calculated by

$$Y = b \times x + a$$

where *a* and *b* are the values as calculated above.

Annex G
(informative)

Assessment of evenness of drying

When assessing the evenness of drying in the cotton iron dry test **programme** of different **tumble dryers** or different **programmes** in one dryer, it is very important to ensure that the **final moisture content** is in a smaller range than is defined for energy testing.

The evenness of drying depends in most appliances on the **final moisture content**. The drier the load, the better the evenness of drying value. Because independent tests have shown that the relationship between evenness of drying and **final moisture content** is different for different **tumble dryers**, it is not possible to define a single correction formula for correcting the evenness of drying according to the **final moisture content**. Over- and under-compensation would appear.

To ensure evenness of drying is measured and can be compared in a reproducible way, it is necessary to reduce the tolerance of the **final moisture content** of 12 % from ± 4 % to ± 2 %. With this measure, comparable results are ensured.

If the **final moisture content** of a **test run** exceeds the range of ± 2 % this should be noted with the test results.

Annex H
(informative)

Measurement of exhaust air volume

H.1 Procedure

The volumetric flow rate of exhaust air shall be measured while the **tumble dryer** is operating without a load and with the heater switched off. The **tumble dryer** shall be attached to the standard exhaust described in Annex B and the measurement shall be made using the equipment described in ISO 5167-1.

The pressure at the outlet of the standard exhaust and in the vicinity of the dryer relative to the environment shall be maintained at 0 Pa at the operating flow rate. The air temperature, humidity and pressure shall be maintained at 23 °C, 55 % RH and $1{,}013 \times 10^5$ Pa respectively.

NOTE A formal procedure for this test is under development.

H.2 Exhaust air volume

Exhaust air volume V is calculated from the volumetric flow rate and the duration of the **test run** and expressed in cubic metres:

$$V = F \times t$$

where

F is the volumetric flow rate measured according to ISO 5167-1; and

t is the average **programme time**.

H.3 Examples for measurement setup

Figure H.1 presents the suction chamber setup.

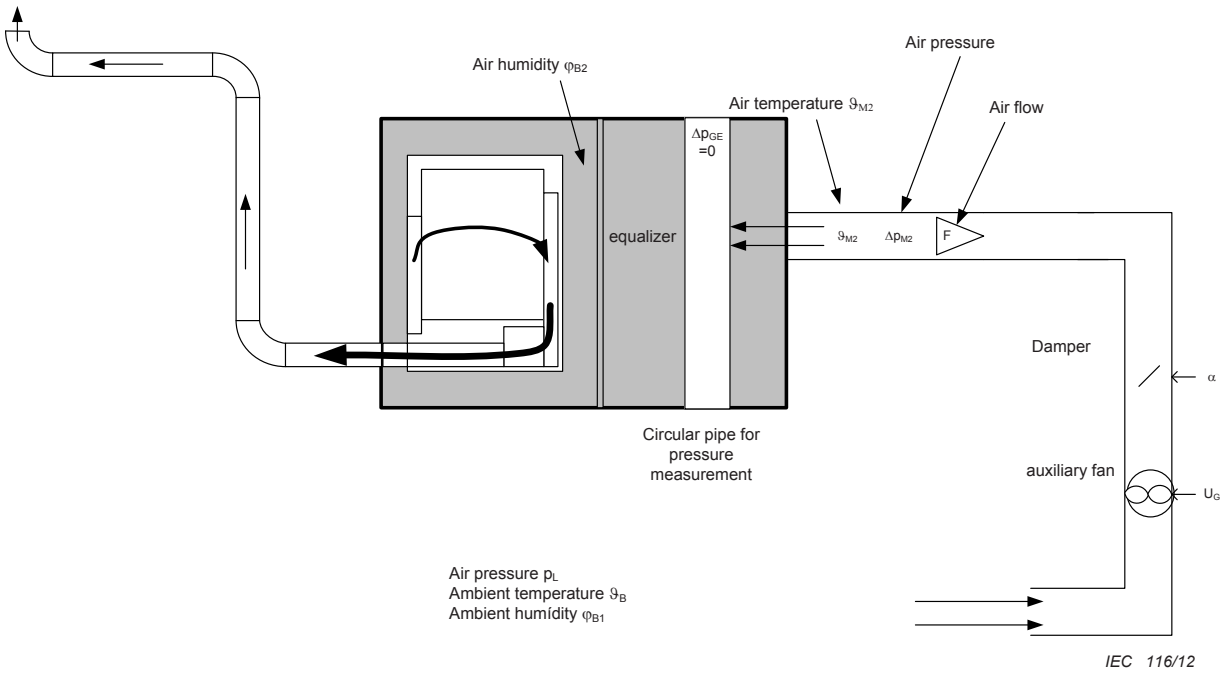

Figure H.1 – Suction chamber setup

Bibliography

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