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PUBLICLY AVAILABLE SPECIFICATION

PRE-STANDARD

colour inside

Tumble dryers for commercial use – Methods for measuring the performance

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Tumble dryers for commercial use – Methods for measuring the performance

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TUMBLE DRYERS FOR COMMERCIAL USE – METHODS FOR MEASURING THE PERFORMANCE

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IEC PAS 63124 has been processed by subcommittee 59D: Performance of household and similar electrical laundry appliances, of IEC technical committee 59: Performance of household and similar electrical appliances.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document
Draft PAS	**Report on voting**
59D/447/DPAS	59D/451/RVDPAS

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned may transform it into an International Standard.

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TUMBLE DRYERS FOR COMMERCIAL USE – METHODS FOR MEASURING THE PERFORMANCE

1 Scope

This PAS is applicable to **tumble dryers** for commercial use of the **automatic** and **non-automatic** type, incorporating an electric or steam heating device. It also includes **tumble dryers** which use gas as a heating source with a reference to appropriate EN gas standards.

The object is to state and define the principal performance characteristics of **tumble dryers** for commercial use of interest to users and to describe standard methods for measuring these characteristics.

NOTE It does not apply to **transfer tumble dryers** or dryers with automatic loading and unloading.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

EN 50570:2013, *Household and similar electrical appliances – Safety – Particular requirements for commercial electric tumble dryers*

CLC/TS 50640:2015, *Clothes washing machines for commercial use – Methods for measuring the performance*

EN 60456:2011, *Clothes washing machines for household use – Methods for measuring the performance* (IEC 60456:2010, modified)

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

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

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

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

3.1.4
automatic tumble dryer
tumble dryer 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.

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
transfer tumble dryer
tumble dryer with automatic loading and unloading via conveyers or by other means

Note 1 to entry: The loading and unloading conveyers are often located on opposite sides of the drying basket.

3.1.7
test load
textile load used for testing

3.1.8
pre-treatment
processing of a new **test load** prior to its first use to avoid rapid changes of characteristics during the tests

3.1.9
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 6.6.7.

3.1.10
test run
single performance assessment

3.1.11
test series
group of **test runs** on a **tumble dryer** which, collectively, are used to assess the performance of that **tumble dryer**

3.1.12
operation
performance of a function that occurs during the **tumble dryer** drying process such as heating up, drying, cooling, anti-creasing

3.1.13
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

3.1.14
end of the programme
moment in time when the **tumble dryer** indicates the **programme** is complete and the load is accessible to the user

3.1.15
programme time
period of time from the initiation of the **programme** (excluding any user programmed delay) until the **end of the programme**

3.1.16
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).

3.1.17
cycle time
period of time from the initiation of the **programme** (excluding any user programmed delay) until all activity ceases

Note 1 to entry: 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 2 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.

3.1.18
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

3.1.19
rated capacity
maximum mass in kilograms of dry textiles of a particular defined type, which the manufacturer declares can be treated in a specific **programme**

3.1.20
test load mass
actual mass of the **test load**

3.1.21
conditioned test load mass
mass of the **test load** when conditioned to correct humidity and temperature defined in 5.2.3.2

3.1.22
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)

Note 1 to entry: Target value toward which the **conditioned test load mass** will be adjusted.

[SOURCE: EN 61121:2013, 3.1.20, modified – The second part of the definition has been turned into the present Note 1 to entry.]

3.1.23
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

3.1.24
initial moisture content
moisture content of a **test load** prior to a test run

3.1.25
final moisture content
moisture content of a **test load** at the end of a test run

3.1.26
rated voltage
voltage assigned to the appliance by the manufacturer

3.2 List of symbols

The symbols are listed in Table 1.

Table 1 – List of symbols

Symbol	Unit	Definition
a	-	constant part of the regression line
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_C	kg/min	evaporation capacity
E_j	kWh	corrected **total energy** consumption for **test run** j
E_{mj}	kWh	measured **total energy** consumption for **test run** j
E_{ej}	kWh	measured **electric** energy consumption for **test run** j
E_{sj}	kWh	measured **steam** energy consumption for **test run** j
E_{gj}	kWh	measured **gas** energy consumption for **test run** j
E_s	kWh/kg	specific corrected energy consumption
F	m^3/min	volumetric flow rate
j	-	**test run** number
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
n	-	number of **test runs**
p	Pa	static pressure
S	-	standard deviation of measured results

Symbol	Unit	Definition
S_b	-	standard deviation of the measured **final moisture content** for all valid **test runs**
T	min	arithmetical average of the corrected **programme time** of all valid **test runs**
T_s	min/kg	specific corrected **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_f	g	mass of the **test load** after drying
W_{fj}	g	mass of the **test load** after drying for **test run** j
W_i	g	mass of the **test load** after wetting
W_w	g	mass of water collected
W_{wj}	g	mass of water collected during **test run** j
W_S	kg	mass of the small sheet in a **test load**
W_M	kg	mass of the medium sheet in a **test load**
W_L	kg	mass of the large sheet in a **test load**
W_T	kg	desired masst of the test load
x_i	-	i-th term of parameter x
$\overline{x_i}$	-	mean of all terms of parameter x
X_S		number of small sheets in a **test load**
X_M		number of medium sheets in a **test load**
X_L		number of large sheets in a **test load**
Y	-	performance parameter (energy consumption or **programme time**)
μ	%	average measured **final moisture content** for a **test load**
μ_{f0}	%	target **final moisture content**
μ_{fj}	%	measured **final moisture content** after **test run** j
μ_{ij}	%	measured **initial moisture content** for **test run** j
μ_{i0}	%	nominal **initial moisture content**

4 Requirements

4.1 General

This PAS does not specify minimum performance requirements for **tumble dryers**. This PAS does however set methods for the measurement of following performance parameters:

- electric energy consumption;
- steam energy consumption;
- gas energy consumption;
- water consumption;
- **programme** time;
- condensation efficiency;

- drying temperature of the textiles;
- volumetric flow rate of exhaust air.

Any claims of performance referring to this PAS for these parameters shall be measured in accordance with the requirements of this PAS. 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 up to a **rated capacity** of 10 kg. For capacities larger than 10 kg the supplier may declare the **rated capacity** at 1 kg intervals. 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 EN 50570:2013, 3.1.9.

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.

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 mm and shall be rounded up to the nearest higher millimetre.

- 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 to determine maximum possible height.
- 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.

5 Test conditions, materials, equipment and instrumentation

5.1 General

The tolerances specified for parameters within this PAS, 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

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

The supply frequency to each **tumble dryer** shall be maintained at the rated frequency ± 1 % throughout the test.

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

Voltage stabilizers should be designed such 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 water used as cooling fluid.

In all cases the water supply shall meet the requirements given in 5.2.2.2. Water used for normalizing **test loads** and wetting **test loads** shall meet the requirements of 5.2.2.2 and 5.2.2.3.

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 and, 5.2.2.4.

The performance of a dryer may differ when water of different quality is used to wet the **test load**.

5.2.2.2 Water temperature and pressure

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

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

The measured water temperature and pressure shall be reported.

5.2.2.3 Water hardness

Standard soft water with a total hardness of (0,5 ± 0,2) mmol/l shall be used for all procedures within this PAS. If available, naturally occurring water of the correct total hardness 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.

5.2.2.4 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 EN 60734.

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

If applicable the pH, alkalinity and conductivity of the water used shall be reported.

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 (23 ± 2) °C at the start of the drying test. The temperature shall not rise more than 4 K during the test run. The measured ambient temperature for tumble drying testing shall be reported. It shall be rounded to the nearest 0,5 °C. The maximum and minimum temperature during the test run shall be recorded. The measurement location shall be in the vicinity of the air intake.

The ambient relative humidity of the test room shall be maintained at (55 ± 10) % 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.

Care should be taken to ensure that the ambient temperature and relative humidity are not 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 6.6.5.2.

5.3 Test materials

5.3.1 General

This section sets out the specifications for test materials required for **tumble dryer** testing to this PAS, including **test loads** and detergent.

NOTE Suitable sources of test materials are given in A.6.

5.3.2 Test load

The **test load** shall consist of small, medium and large sheets as specified in A.2.

5.3.3 Detergent

The specification for the EN 60456 reference detergent A* base powder as defined in A.1. Detergent dosage is specified in 6.6.4.2.

5.4 Equipment

5.4.1 Equipment for normalization

The specification for a washing machine which is used for the **normalization** of **test loads** is defined in A.7.

5.4.2 Equipment for conditioning the test load

This PAS 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 standardized 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 6.6.5.2 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 6.6.5.3 for details. 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 Equipment for measurement

This PAS 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);
- steam energy (steam pressure, steam temperature, steam flow);
- gas energy (gas flow);
- temperature of water and air;
- water pressure;
- textile temperature during drying;
- relative humidity;
- 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 PAS shall comply with the specifications set out in Table 2.

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

Table 2 – Specification of instruments

Parameter	Unit	Resolution	Accuracy	Additional requirements
Mass				
Masses above 50kg	g	50 g	±100 g	-
Masses in the range between 10kg and 50 kg	g	10 g	±20 g	-
Masses in the range between 2 kg and 10 kg	g	1 g	±5 g	-
Masses in the range between 100 g and 2 000 g	g	0,5 g	±1 g	-
Masses in the range up to 100 g	g	0,05 g	±0,1 g	-
Temperature	°C	0,1 °C	±0,5 K	-
Ambient temperature	°C	-	-	See spec. in Annex J
Textile temperature	°C	0,1 °C	±0,5 K	-
Water temperature				
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	-
Energy	kWh	As specified in EN 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.
Electrical energy consumption	kWh		±1 %	
Steam energy consumption	kWh		±1 %	See Annex G.
Gas energy consumption		-		As a recommendation, see Annex H.
		-		
Hardness of water	mmol/l	As specified in EN 60734		
Conductivity of water	µS/cm	As specified in EN 60734		

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 Test specifications from manufacturers

Specifications that are given specifically for use by test laboratories shall be ignored.

6.3 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 PAS. Where there is more than one option for installation, the option chosen for testing shall be documented in the test report.

Steam heated **tumble dryers** shall be installed according to instructions in Annex G. **Gas** heated **tumble dryers** should be installed according to instructions in Annex H.

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 the **tumble dryer** shall be tested with a duct as specified in Annex B.

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.

6.4 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.

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

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.

6.5 Preparation of the tumble dryer for a test run

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

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 min while the drum door remains closed. Alternatively the **tumble dryer** shall be left for 15 h at ambient temperature between **test runs**.

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

6.6 Preparation of test loads

6.6.1 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 PAS. 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;
- 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**.

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

New **test load** items shall be treated before their first use by undergoing a **normalization** wash process five times, as defined in 6.6.4 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. **Test load** items that have undergone full **pre-treatment** following CLC/TS 50640:2014, 6.4.2 do not need to undergo a new **pre-treatment** when used for drying.

6.6.3 Requirements regarding the age of test load items

No individual **test load** items shall be used for more than 100 **test runs** (**Test runs** for washing performance according to CLC/TS 50640 and/or **test runs** for **tumble dryer** testing according to this PAS) excluding **pre-treatment** runs prior to initial use and the **normalization** runs (refer to 6.6.4).

Test loads intended for **tumble dryer** tests following this PAS shall not be used for any other purpose except for wash performance tests following the full procedures in CLC/TS 50640. Loads that have been used for any other purpose are not suitable for **tumble dryer** tests following this PAS.

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

6.6.4 Normalization of test load items

6.6.4.1 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 washing machine using a specified **programme** in order to bring the **test load** back into a standardized state.

6.6.4.2 Normalization procedure of test load items

Normalization of the **test load** items is achieved by processing them once in a washing machine using 15 g per kg of test load items of the reference detergent A* base powder. Carry this out using a washing machine and programme as described in A.7. On completion of the **programme**, the **test load** items shall then be dried in a **tumble dryer**.

6.6.5 Conditioning of test load items

6.6.5.1 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 **conditioning** method used shall be reported.

6.6.5.2 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 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 −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.

6.6.5.3 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.

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.

6.6.6 Test load composition

6.6.6.1 General

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 small, medium and large sheets in the **test load** for various required **test load masses** are selected so that they as much as possible correspond to the number of test load items as specified in CLC/TS 50640 for the same test load mass in a washing machine of the same load size. The number of test load items are specified in Table 3. Final adjustment of the **test load mass**, is made by adding or removing small sheets so that the total mass is as close as possible (±0,06 kg) to the required **nominal test load mass**.

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

Test load mass kg	Number of small sheets [a]	Number of medium sheets	Number of large sheets
	60 cm x 60 cm	90 cm x 120 cm	140 cm x 180 cm
2,0	6	4	0
2,5	4	6	0
3,0	9	6	0
3,5	8	8	0
4,0	12	8	0
4,5	11	10	0
5,0	15	10	0
5,5	14	12	0
6,0	12	12	1
6,5	11	14	1
7,0	15	14	1
7,5	14	16	1
8,0	12	16	2
8,5	10	18	2
9,0	8	18	3
9,5	7	20	3
10,0	12	20	3
15,0	11	20	10
20,0	11	20	17
25,0	11	20	24
30,0	10	20	31
40,0	9	20	45
50,0	9	20	59
60,0	8	20	73
70,0	14	20	86
80,0	13	20	100
90,0	12	20	114
100,0	12	20	128
150,0	8	20	198
200,0	11	20	267
250,0	14	20	336
300,0	10	20	406
For load sizes not shown in Table 3 see 6.6.6.2.			
[a] The actual number of small sheets may differ from the number indicated above (which is intended to be indicative).			
NOTE The number of small, medium and large sheets in this table will give a **test load** as similar as possible to the test load used for the same load mass in CLC/TS 50640.			

6.6.6.2 Calculation of the composition of test load items for load sizes above 10 kg and not shown in Table 3

Calculation of the test load composition is done according to the following formulae:

$$\text{Number of large sheets } (X_L) = \text{Integer}\left(\frac{W_T - 20 * W_M - 10 * W_S}{W_L}\right)$$

$$\text{Number of small sheets } (X_s) = \text{Integer}\,\frac{\left(W_T - 20 * M_M - X_L * W_L\right)}{W_S}$$

$$\text{Number of medium sheets}\left(X_M\right) = 20 \text{ for all test loads above 10 kg}$$

where:

W_T = the total test load mass (kg)

W_S = the mass of a small sheet

W_M = the mass of a medium sheet

W_L = the mass of a large sheet

X_S = number of small sheets

X_M = number of medium sheets

X_L = number of large sheets

Values according to specification of the test load given in A.2:

W_S = 0,110 kg (nominal mass)

W_M = 0,315 kg (nominal mass)

W_L = 0,720 kg (nominal mass)

The mass of the individual test load items as defined above is a nominal value. Therefore the number of small and large sheets for a certain load as defined in Table 3 may differ. If adjustments need to be done the number of **small sheet** shall not be selected lower than 10 and not above 20.

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.

6.6.7 Wetting

6.6.7.1 Temperature of the test load

Before wetting the temperature of the test load and the water used for wetting shall be within the limits of the ambient temperature specification according to 5.2.3.1

6.6.7.2 Wetting procedure

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. In order to get the wetting to be as homogeneously as possible the extraction speed of the washing machine shall be set so low that the final moisture not will be reached within 3 min. The load shall be spun for as long as necessary to reach **initial moisture content** in the range:

μ_{io} + 3 % to μ_{io} – 5 %

where

μ_{io} is the nominal initial moisture content.

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

$\frac{W_i - W_0}{W_0}$ 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 4. This initial wet mass is recorded as W_i.

Initial moisture contents other than specified in Table 4 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 4 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 4 – Specifications for initial moisture content in the test load

Nominal initial moisture content of the test load μ_{i0}	Allowable range for initial moisture content μ_{ij}
50 %	45 % to 53 %

7 Performance measurements – General requirements

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

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

- performance tests required (energy and water consumption, condensation efficiency, 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**.

The primary requirement of this PAS is for determination of performance at **rated capacity** for each relevant load type and set of test conditions. Any claim of performance to this PAS 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;
- steam energy consumption;
- gas energy consumption;
- water consumption;
- **programme** time;
- condensation efficiency;
- textile drying temperature;
- exhaust air volume.

8 Tests for performance

8.1 General

Clause 8 sets out the test procedure for the determination of performance for the **tumble dryer**.

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.

Table 5 – Specification for final moisture content of the test load after drying in a cotton dry programme

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
Drying **programme** 1	0 %	−3 % to +3 %	Less than +1,5 %

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** shall 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** as specified in Clause 6 shall be prepared for each **tumble dryer** being tested.

8.2.4 Test procedure

Immediately before each **test run**, the **test load** shall be wetted according to 6.6.7.

The **test load** shall be loaded into the **tumble drye**r within 5 min 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 2 min 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:

$\mu_{fj} = (W_{fj} - W_0) / W_0$ (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

If the **final moisture content** for a **test run** is within the range given in Table 5, then the **test run** shall be declared valid. Otherwise the **test run** shall be declared invalid.

If the dryer has stopped automatically during a **test run** because a 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

A **test series** of five tests shall be carried out on the **tumble dryer**. In circumstances where one of the five **test runs** is invalid, a sixth **test run** may be carried out on the **tumble dryer** using the same **programme** setting, and the same nominal **initial moisture content** as all the previous **test runs** in the **test series**. The invalid **test run** shall be eliminated completely from any subsequent evaluation.

If more than one **test run** is invalid in a **test series**, then the whole **test series** shall be declared invalid.

If the average **final moisture content** for a **test series** of five valid runs is below the upper limit of the allowable range given in Table 5, then the **test series** shall be declared valid and the results evaluated according to Clause 9. Otherwise the **test series** shall be invalid.

If a **test series** of 5 valid **test runs** is invalid, it shall not be made valid by substituting one of the **test runs** with a sixth **test run**.

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.

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 subclause 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.

The water added to the process in the form of steam shall not be added to the corrected water consumption as described in 9.5. The steam shall be reported as kilograms of steam according to Clause G.9.

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, steam energy, gas energy, water volume and temperature 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**.

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

8.4 Measurements to determine condensation efficiency

8.4.1 General

This subclause 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 9.7.

8.4.2 Procedure

The **tumble dryer** shall be conditioned no more than 36 h 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 4. It shall then be allowed to cool to ambient temperature as described in 6.5.

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 water collected is determined.

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

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

8.5 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 9.9.

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.

8.6 Performance measurement at maximum exhaust duct pressure

Performance measurement **test series** are normally performed with an exhaust duct pressure according to Table B.2. A performance test can also be made at the maximum exhaust duct pressure indicated by the manufacturer. In that case the damper in Figure B.2 shall be set so the pressure drop in the exhaust duct is equal to the maximum pressure declared by the manufacturer.

8.7 Measurement of the textile drying temperature

The textile drying temperature shall be measured by **temperature loggers** placed in the drum and following the load during the drying phase. The procedure and specification of the loggers are described in **Annex J**.

9 Assessment of performance

9.1 General

Clause 9 sets out the primary evaluation methods for the assessment of **tumble dryer** performance under this PAS. 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.

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 of the valid **test runs** of a **test series** is calculated as:

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

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 Total energy

The total measured energy E_{mj} is the sum of the measured electric energy and the measured steam energy measured according to Annex G and, if gas energy is measured, to follow the instructions in Annex H.

9.4 Corrected energy

If the final **moisture content** of a valid **test run** is within the target range given in Table 5 then the corrected energy consumption shall be evaluated as shown below using the measurements from valid **test runs** 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.

The corrected 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 energy (electrical and steam or gas)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 energy consumption E is calculated from the corrected 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 energy consumption of the **test run** j.

9.5 Corrected water consumption

The corrected water consumption shall be evaluated as shown below using the measurements from valid **test runs** determined in 8.3.

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.

9.6 Corrected programme time

If the **final moisture content** of a valid **test run** is within the target range given in Table 5 then the corrected **programme time** shall be evaluated as shown below using the measurements from valid test runs 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 energy consumption.

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**:

$$T = \frac{1}{n}\sum_{j=1}^{n} T_j$$

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.

9.7 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:

$$C_j = \frac{W_{wj}}{W_i - W_f} \times 100$$

where

W_{wj} is the mass of water collected during a **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.

The average condensation efficiency C is calculated from the condensation efficiencies of all valid **test runs** and expressed as a percentage:

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

where

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

j is the **test run** number;

C_j is the condensation efficiency of **test run** j.

9.8 Evaporation capacity

The evaporation capacity shall be evaluated as shown below using the measurement from valid **test runs** determined in 8.4:

$$E_c = \frac{1}{n}\sum_{j=1}^{n}\frac{W_{ij} - W_{fj}}{T_{mj}}$$

where

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

E_c is the **evaporation capacity**;

j is the **test run** number;

T_{mj} is the measured **programme time** of **test run** j;

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

W_{ij} is the mass of the **test load** used after wetting but before drying during **test run** j;

W_{fj} is the mass of the **test load** after drying during **test run** j.

9.9 Exhaust air volume

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

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 be presented in the format shown in Annex D.

Annex A
(normative)

Reference list

A.1 Reference detergent

See CLC/TS 50640:2015, Annex B.

A.2 Specification of test load

See CLC/TS 50640:2015, Annex C.

A.3 The bone dry method of conditioning

See CLC/TS 50640:2015, Annex F.

A.4 Uncertainty of measurement

See EN 60456:2011, Annex Q.

A.5 Environmental aspects of tumble dryer use

See EN 60456:2011, Annex R.

A.6 Source of materials and supplies

See CLC/TS 50640:2015, Annex N.

A.7 Washing machine for normalization

See CLC/TS 50640:2015, 6.4.4.2.

Annex B
(normative)

Exhaust ducts for tumble dryer testing

B.1 General

The pressure duct shall comply with a 15 m long duct with a diameter specified by the manufacturer. The duct can be of two different types; Type 1 and Type 2.

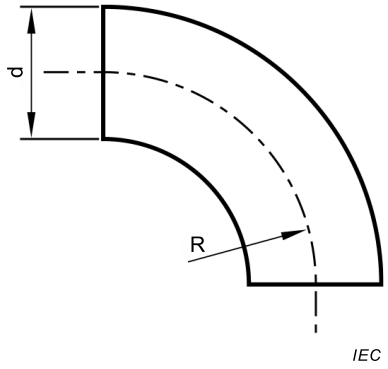
B.2 Specification of the exhaust duct type 1

B.2.1 Duct material

The duct shall consist of a steel pipe, called spiro-pipe. The diameter of the pipe shall be in accordance with the requirements given be the manufacturer for the **tumble dryer** under test.

B.2.2 The form of the duct

The duct can be in the form of a straight tube or bended. It is allowed to add maximum three 90° bends with a design according to Figure B.1. If one or more bends are added the total length of the exhaust duct shall be corrected. The correction shall be made according to Table B.1. A straight tube of the length of at least 200 cm shall be fitted between each bend.



Key

Allowed types of bends:

Type 1: R/d = 1

Type 2: R/d = 2

Figure B.1 – Exhaust duct bend

Table B.1 – Equivalent tube length of a 90° bend

Bend type	Equivalent tube length(m)
R/d = 1	16 × diameter(m)
R/d = 2	12 × diameter(m)
EXAMPLE Tube diameter 0,2 m. If two 90° bends with R/d = 1 are added they represent an equivalent tube length of 2 × 16 × 0,2 m = 6,4 m. Thus 8,6 m of straight tubes shall be added to achieve a corresponding all straight tube of 15 m.	

B.2.3 Instrumentation

The exhaust duct shall be equipped with exhaust pressure equipment and a flow meter. The pressure reading shall be made at a distance from the output of the **tumble dryer** of 0,5 m. No bend may exist between the output and the pressure measurement point. After the measurement point another straight tube with a length of at least 0,5 m shall be attached. The flow meter shall before and after the measurement point be attached to straight tubes with a length of 1 m or more.

B.3 Exhaust duct type 2

B.3.1 General

For laboratories where the space for ducts Type 1 is limited ducts according to Type 2 can be used.

B.3.2 Specification of exhaust duct Type 2

The duct shall be designed according to Figure B.2. The horizontal part of the duct shall be in accordance with the specification from the manufacturer while the vertical part can be in any dimension as long as the pressure drop between **tumble dryer** output and ambient is not larger than corresponding drop for an exhaust duct Type 1. The horizontal length of the duct before and after the pressure measurement point shall be 0,5 m.

B.3.3 Setting the correct exhaust duct pressure

The flow in the Type 2 exhaust duct restrictor shall be adjusted so the flow resistance in the duct is in line with the resistance of a Type 1 straight 15 m exhaust duct. This shall be done as follows: use the information given by the manufacturer regarding dimension of the exhaust duct and exhaust air flow. In Table B.2 select the column for the given diameter of the exhaust duct and chose the pressure drop corresponding to the air flow. (Use interpolation if necessary.)

Run the **tumble dryer without load** and **without heating** and adjust the air damper so the same pressure drop will occur as found in Table B.2. Measure the air flow and if the air flow now differs from the value obtained from the manufacturer read a new pressure drop in Table B.2 based on the measured air flow. Repeat the **operation** above until the pressure drop and the air flow is in accordance with the values in Table B.2.

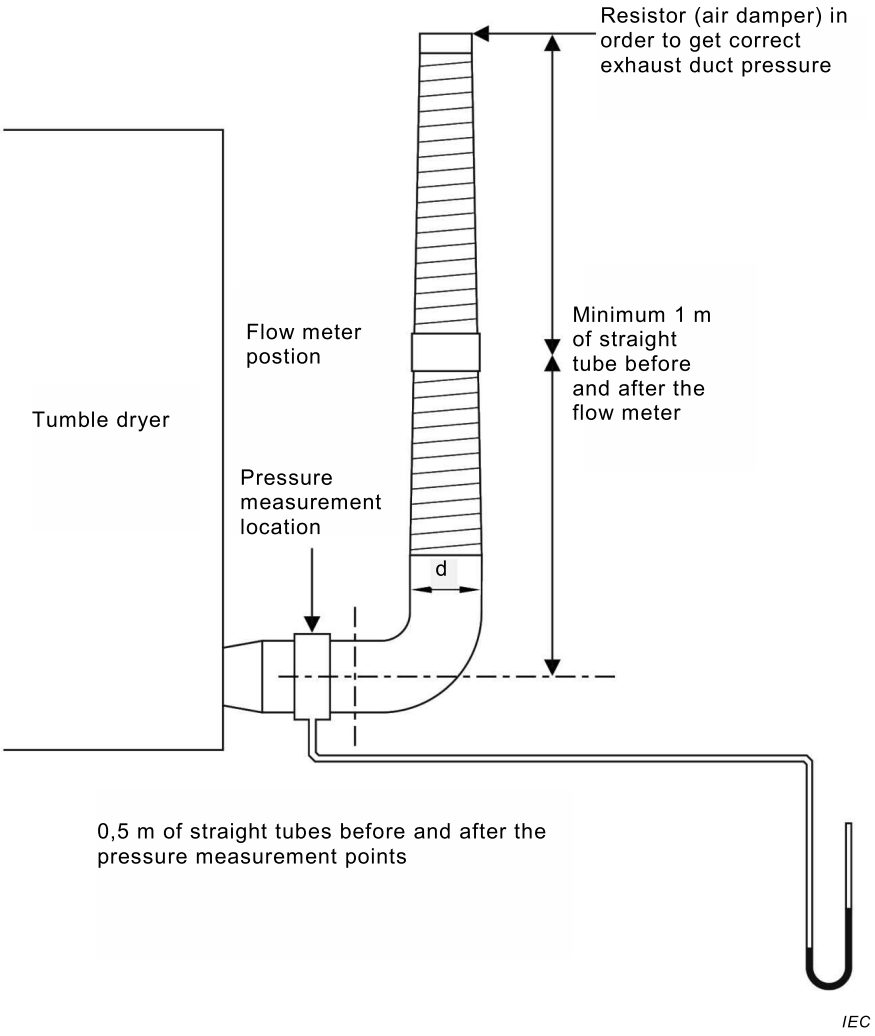


Figure B.2 – Exhaust duct Type 2

Table B.2 – Pressure drop values for different diameters and flows for a 15 m long duct

Pressure drop (Pa) for a circular duct for different duct diameters and air flows							
Cold air M^3/h flow	Exhaust duct diameter (mm)						
	100	125	150	200	250	315	400
150	69,28						
200	114,62	39,71					
220	135,42	46,92					
250	169,38	58,69	24,68				
260	181,41	62,85	26,44				
280	206,53	71,56	30,10				
300	233,03	80,74	33,96				
350	305,19	105,74	44,48				
360	320,62	111,09	46,73				
400	385,53	133,58	56,19	14,33			
420	419,90	145,49	61,19	15,60			
430	437,55	151,60	63,77	16,26			
450	473,78	164,16	69,05	17,61			
500	569,71	197,39	83,03	21,17			
550	673,12	233,22	98,10	25,01			
600	783,83	271,58	114,23	29,13			
620	830,12	287,62	120,98	30,85			
640	877,55	304,05	127,89	32,61			
650	901,68	312,41	131,41	33,51			
700	1 026,54	355,68	149,60	38,15	13,22		
750	1 158,28	401,32	168,80	43,04	14,91		
800	1 296,77	449,30	188,99	48,19	16,70		
850		499,59	210,14	53,59	18,57		
860		509,92	214,48	54,69	18,95		
900		552,15	232,24	59,22	20,52		
950		606,94	255,29	65,10	22,56		
1 000		663,95	279,27	71,21	24,67		
1 060		723,13	304,16	77,56	26,87		
1 100		784,46	329,96	84,14	29,15		
1 200		913,48	384,23	97,98	33,95		
1 300		1 050,83	442,00	112,71	39,05	13,03	
1 400		1 196,35	503,21	128,32	44,46	14,83	
1 500		1 349,87	567,78	144,78	50,16	16,74	
1 600			635,67	162,10	56,16	18,74	
1 700			706,82	180,24	62,45	20,83	
1 800			781,18	199,20	69,02	23,03	
1 900			858,70	218,97	75,87	25,31	
2 000			939,34	239,53	82,99	27,69	

Pressure drop (Pa) for a circular duct for different duct diameters and air flows							
Cold air M^3/h flow	**Exhaust duct diameter** (mm)						
	100	**125**	**150**	**200**	**250**	**315**	**400**
2 250			1 154,36	294,36	101,99	34,03	
2 500			1 388,09	353,96	122,64	40,91	13,15
2 750			1 640,04	418,21	144,90	48,34	15,54
3 000			1 909,78	487,00	168,73	56,29	18,10
3 250				560,22	194,10	64,76	20,82
3 500				637,80	220,98	73,72	23,70
3 750				719,64	249,34	83,18	26,74
4 000				805,69	279,15	93,13	29,94

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**.

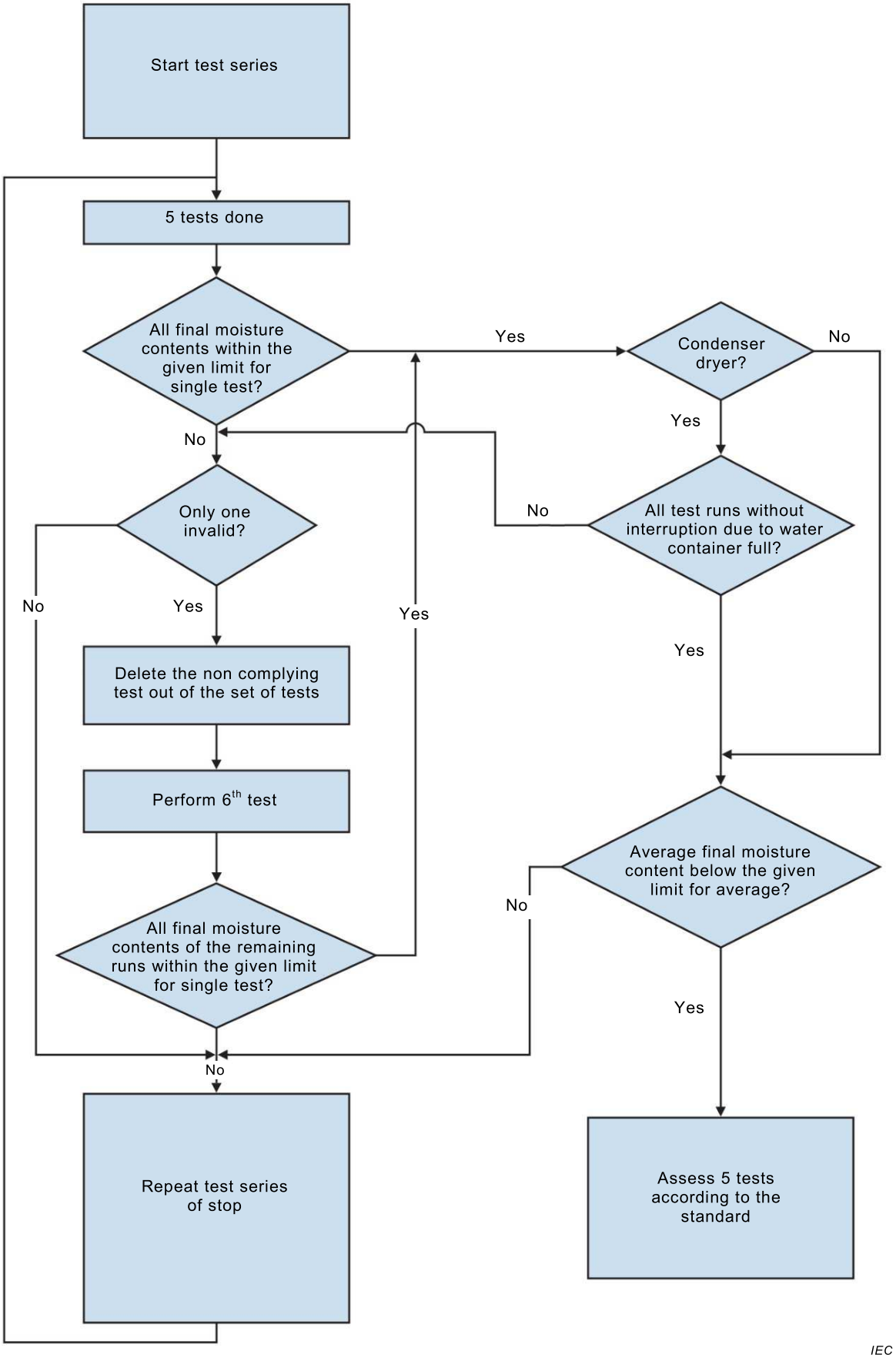

Start test series
5 tests done
All final moisture contents within the given limit for single test?
Yes
Condenser dryer?
No
Yes
No
Only one invalid?
No
All test runs without interruption due to water container full?
No
Yes
Yes
Yes
Delete the non complying test out of the set of tests
Perform 6th test
Average final moisture content below the given limit for average?
No
All final moisture contents of the remaining runs within the given limit for single test?
Yes
No
Repeat test series of stop
Assess 5 tests according to the standard
IEC

Figure C.1

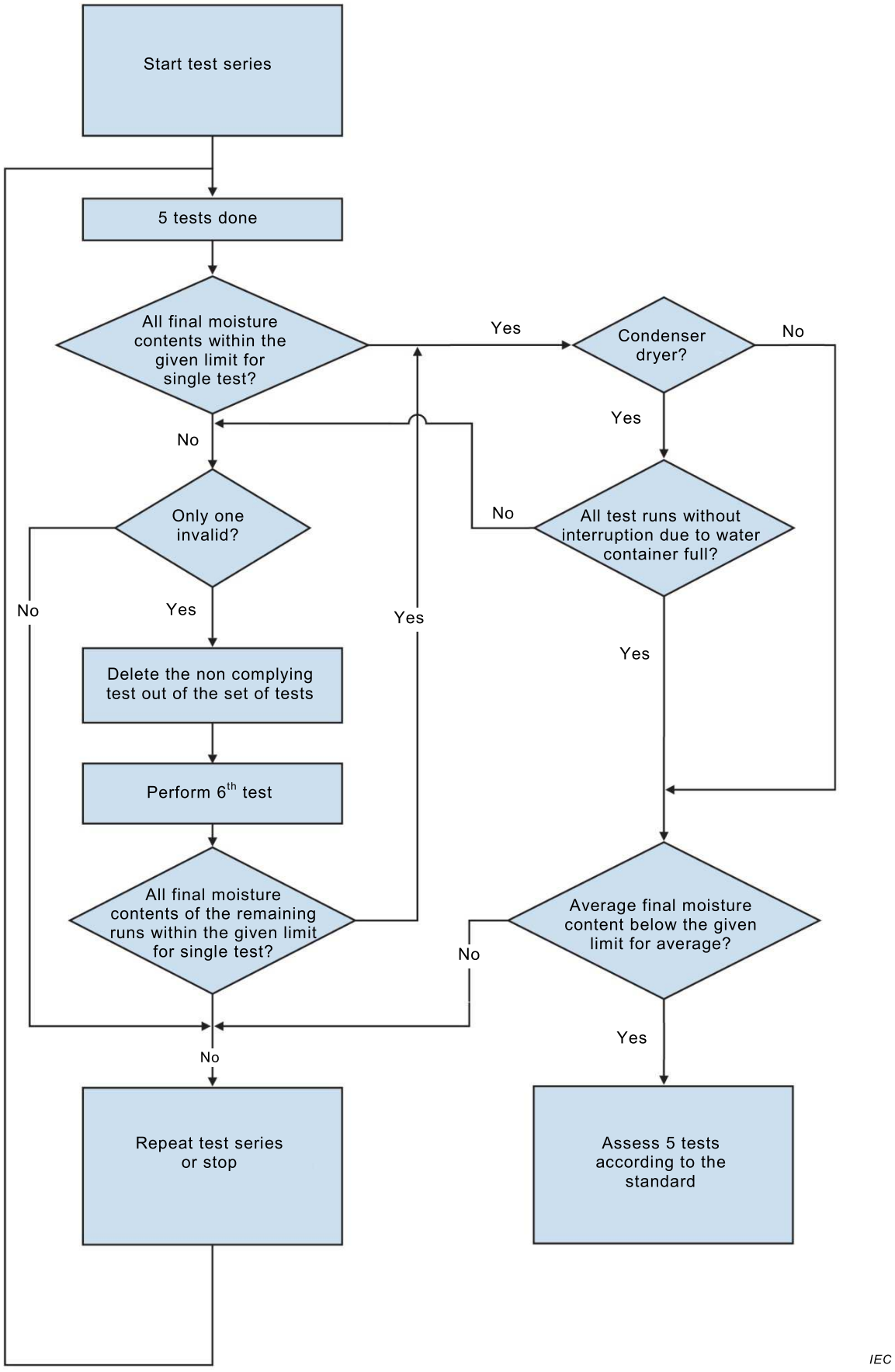

Start test series
5 tests done
All final moisture contents within the given limit for single test?
Yes
Condenser dryer?
No
Yes
No
Only one invalid?
No
All test runs without interruption due to water container full?
No
Yes
Yes
Yes
Delete the non complying test out of the set of tests
Perform 6th test
All final moisture contents of the remaining runs within the given limit for single test?
Average final moisture content below the given limit for average?
No
Yes
No
Repeat test series or stop
Assess 5 tests according to the standard
IEC

Figure C.2

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.3 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 CLC/TS 50594:2015**" (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):[a]	Drum volume (l): [a]
Rated capacity (kg) [a]	
Cotton/synthetics blend:	
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):
Heating alternative (electrical/steam/gas	
Cold water connection (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.	

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 electrical energy consumption	E_{ej}	kWh	m	0,01							
Measured steam energy consumption	E_{sj}	kWh	m	0,01							
Measured gas energy consumption	E_{gj}	kWh	m	0,01							
Measured energy consumption	E_{mj}	kWh	m	0,01							
Corrected energy consumption	E_j	kWh	m	0,01							
Specific corrected energy consumption	E_s	kWh/kg	calc	0,001							
Measured water consumption	L_{mj}	l	m	0,1							
Corrected water consumption	L_j	l	calc	0,1							

	Symbol	**Units**	**Noted** (n) **Measured** (m) **Calculated** (calc)	**Reported precision**[b]	**Run 1**	**Run 2**	**Run 3**	**Run 4**	**Run 5**	**Mean**	**S**
Specific corrected water consumption	L_s	i/kg	calc	0,1							
Measured programme time	T_{mj}	min	m	0,5							
Corrected programme time	T_j	min	calc	0,5							
Specific corrected programme time	T_s	min/kg	m	0,1							
Mass of water collected[a]	W_w	g	m	1							
Condensation efficiency[a]	C	%	calc	0,1							
Evaporation capacity	E_C	l/min	calc								
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 3 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)			
Water supply pressure (kPa)			
Supplied steam pressure (kPa)			
Supplied steam temperature (°C)			
Supplied gas type			
Supplied gas pressure (kPa)			
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 EN 60734			
Page number:	Number of pages in this report:		
[a] To be declared only when applicable.			

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 the volume of the clothes container

The volume of the clothes container shall be done in accordance with CLC/TS 50640:2015, Annex K.

E.3 Determination of the test load

The **test load mass** shall be calculated as follows:

Test load mass, in kg = V_c / 30,0

where:

V_c = the clothes container volume (V_c in litres)

Annex F
(normative)

Flexible initial moisture content method

F.1 General

This annex sets out an approach that forms the basis of a standard which characterizes 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.

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 3 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 %.

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

For non-automatic tumble dryers, the maximum programme time should be considered.

F.3 Evaluation

For each of the **test runs** energy consumption E_{mj}, time t_{mi}, 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**:

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

Corrected energy consumption:

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

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

$$b = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_{\mathrm{i}} - \overline{x})(y_{\mathrm{i}} - \overline{y})}{\frac{1}{n}\sum_{i=1}^{n}(x_{\mathrm{i}} - \overline{x})^2} = \frac{\sum_{i=1}^{n}(x_{\mathrm{i}} - \overline{x})(y_{\mathrm{i}} - \overline{y})}{\sum_{i=1}^{n}(x_{\mathrm{i}} - \overline{x})^2} = \frac{SS_{\mathrm{xy}}}{SS_{\mathrm{xx}}}$$

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

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

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
(normative)

Performance testing of steam heated tumble dryers

G.1 General

This annex specifies the instrumentation, installation, test procedure and calculation of energy consumption for steam heated tumble dryers.

G.2 Types of steam heating – Steam heated tumble dryers

All steam heated tumble dryers are indirect steam heated meaning that the steam energy is transferred to the drying air via a heat exchanger (steam battery). The energy of the condensate water can be recovered and shall be subtracted from the total steam energy.

G.3 Specification of steam properties

G.3.1 Type of steam

The steam shall be dry saturated steam. Required steam pressure is set by the tumble dryer manufacturer instructions. Maximum pressure for any test is limited to 1,4 MPa and with a corresponding temperature of 198 °C.

G.3.2 Steam generator

The steam generator shall be large enough to supply dry saturated steam to the dryer under test at the given steam pressure and flow specified by the manufacturer throughout the full test procedure. If dry saturated steam not can be guaranteed a super heater shall be added to the steam boiled so slightly superheated steam is produced.

The inlet water quality to the steam boiler shall be in accordance with EN 12953-10.

G.4 Equipment and instrumentation

G.4.1 Test equipment for measuring the characteristics of steam

G.4.1.1 Flow meter for measurement of steam velocity and mass flow

Flow meter intended for measurement of steam flow. The flow meter shall be able to tolerate the required pressure and temperature range of supplied steam.

G.4.1.2 Pressure sensor for measurement of the steam pressure

Pressure transducer intended for measurement of steam and with a pressure range from 0 to 1,4 MPa.

G.4.1.3 Temperature sensor for measurement of the steam and condensate temperature

Temperature sensor intended for incoming steam temperature measurement: temperature range from 0°C to 200°C.

Temperature sensor intended for condensate temperature measurement: temperature range from 0°C to 200°C.

G.4.1.4 Scale for measurement of the mass of the condensate

Scale to be used for mass measurement of the condensate.

G.4.1.5 Steam calculator

To calculate the steam energy transferred to the tumble dryer a steam calculator shall be used.

The calculator shall follow and support following standard: Formulation IAPWS IF 97 for calculation of the energy (IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam)

The calculator shall be able to correctly calculate the steam energy for dry saturated steam and for superheated steam. The calculator shall also preferably be equipped with a wet steam alarm.

G.4.2 Instruments

Parameter	Unit	Minimum resolution	Minimum accuracy
Steam flow	m/sec	± 0,1 %	± 1 %
Temperature	°C	± 0,1K	± 1 K
Pressure	kPa	± 0,05 % of set range	± 0,2 % of set range
Masses	g	See 5.6.2 Instruments	

G.4.2.1 Measurements

Parameter	Unit	Minimum accuracy	Additional requirements
Steam energy	kWh	± 2 %	The combined minimum accuracy refers to the steam calculation using the steam calculator, temperature and pressure sensor described above
Condensation water mass	g	±1 %	

NOTE It is probably not possible to find one set of equipment that covers the full required pressure and flow ranges for all kind of dryers under test.

If the maximum steam pressure is set lower than 1,4 MPa the requirements for the equipment regarding max pressure and temperature may be lowered as long as it is in line with the pressure and steam temperature delivered by the boiler.

G.5 Installation

G.5.1 General

It is very important that all instrumentation is installed according the manufacturers exact instructions. The installation can be made according two alternatives and the difference between the alternatives is the way the amount condensate is measured.

G.5.2 Installation of the measurement equipment for indirect steam heated tumbler dryers.(Alternative 1)

Figure G.1 shows a schematic installation of the measurement equipment for indirect steam heated tumble dryers.

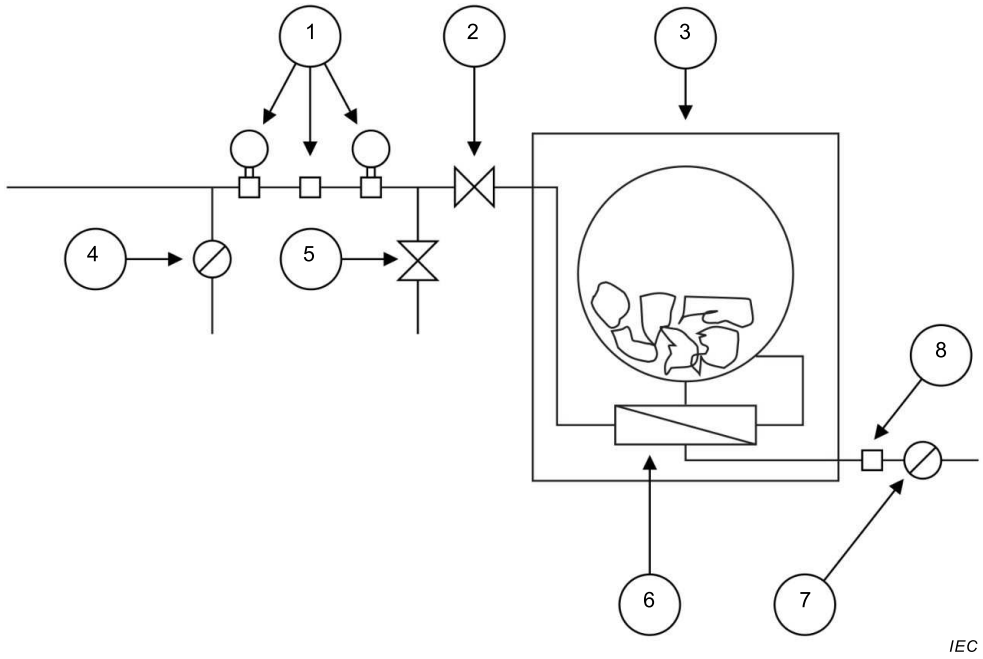
The steam flow entering the measurement instruments shall be as undisturbed as possible and therefore the steam measurement equipment (1) shall be placed together and with a straight part of the steam supply pipe prior and after the instruments according to the instrument suppliers instruction.

Also the tube diameter shall be according to the instructions and shall not change in diameter from where the straight supply steam tube starts and ends.

The steam trap (4) shall be placed so condensed water can be drained from the supply steam tube.

The shut off valve (2) and the steam measurement equipment (1) shall be placed as close as possible to the dryer under test. The steam supply pipe from the steam measurement equipment (1) to the dryer under test shall not be longer than 1,5 m.

After the steam battery (6) a temperature sensor (8) shall be installed and close to the sensor a steam trap (7) shall be placed.



Key

1 supply steam measurement equipment consisting of steam flow meter, temperature sensor and pressure transducer.

2 shut off valve

3 indirect steam heated tumble dryer

4 steam trap

5 drain valve

6 steam battery

7 steam trap

8 temperature sensor

Figure G.1 – Schematic installation of the measurement equipment for steam heated tumble dryers (Alternative 1)

G.5.3 Installation of the measurement equipment for indirect steam heated tumble dryers. (Alternative 2)

Figure G.2 shows an alternative schematic installation of the measurement equipment for indirect steam heated tumble dryers. This installation will give a possibility to compare the amount of steam supplied to the dryer with the amount of condensate water recovered in the tank.

The steam flow entering the measurement instruments shall be as undisturbed as possible and therefore the steam measurement equipment (1) shall be placed together and with a straight part of the steam supply pipe prior and after the instruments according to the instrument suppliers instruction.

Also the tube diameter shall be according to the instructions and shall not change in diameter from where the straight supply steam tube starts and ends.

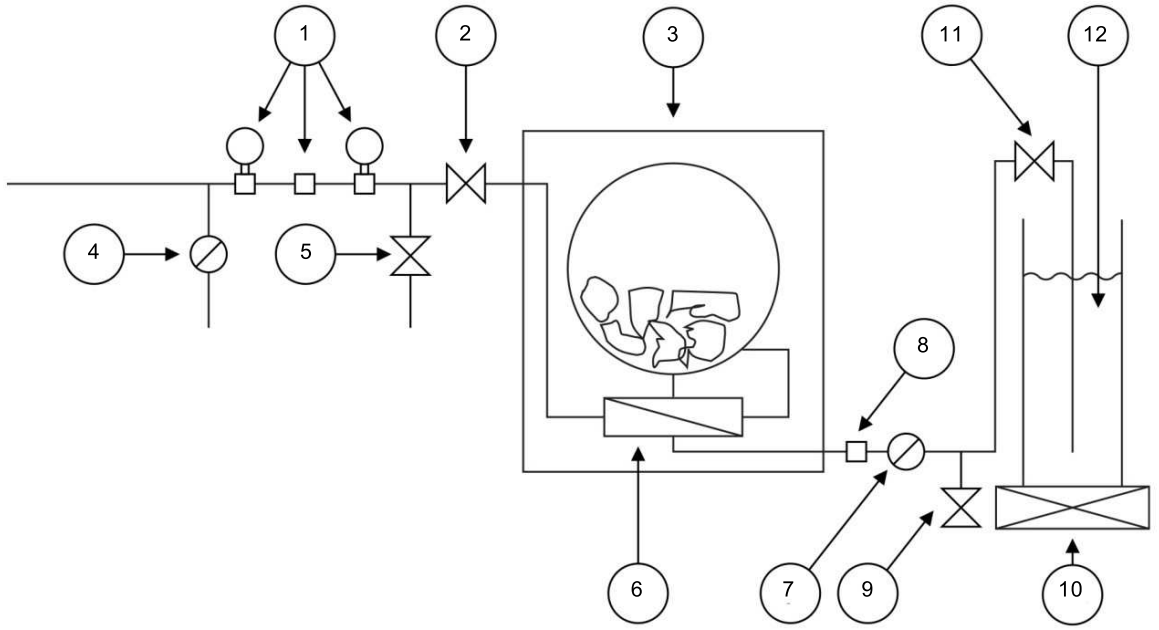
The steam trap (4) shall be placed so condensed water can be drained from the supply steam tube.

The shut off valve (2) and the steam measurement equipment (1) shall be placed as close as possible to the dryer under test. The steam supply pipe from the steam measurement equipment (1) to the dryer under test shall not be longer than 1,5 m.

After the steam battery (6) a temperature sensor (8) shall be installed and close to the sensor a steam trap (7) shall be placed.

The condensate is recovered in a water tank (12) placed on a scale (10).

The condensate water hose from the steam trap to the tank is equipped with a drain valve (9) and a shut off valve (11). The hose shall not have any physical connection with the tank in order not to disturb the mass measurement of the condensate water.



Key

1 supply steam measurement equipment consisting of steam flow meter, temperature sensor and pressure transducer.

2 shut off valve

3 indirect steam heated tumble dryer

4 steam trap

5 drain valve

6 steam battery

7 steam trap

8 temperature sensor

9 drain valve

10 scale

11 shut off valve

12 water tank

Figure G.2 – Schematic installation of the measurement equipment for steam heated tumble dryers (Alternative 2)

G.6 Preparation for testing

G.6.1 General

The ambient conditions shall follow the specifications given in 5.2. The tumble dryer shall be installed according to the manufacturer's instructions. The dimension of the steam hoses shall be in accordance with the installation instructions.

G.6.2 Indirect heated tumble dryer installed according to Alternative 1

The tumble dryer shall be prepared for testing according to Clause 6 with following additions:

Before the start of a test series the tumble dryer under test shall be run once with a full test load according to Table 4. After this initial run of the tumble dryer under test a test series shall start within 2 d of the initial run but not sooner than 1 d after the cleaning run. Any remaining

condensate within the test tumble dryer itself shall not be removed between the initial run and the start of a test series.

G.6.3 Indirect heated tumble dryer installed according to alternative 2

The tumble dryer shall be prepared for testing according to Clause 6 with following additions:

Before the start of a test series the tumble dryer under test shall be run once with a full test load according to Table 4. After this initial run of the tumble dryer under test a test series shall start within 2 d of the initial run but not sooner than 1 d after the cleaning run. After this initial run the drain valve (9) shall be opened in order to drain the condensate collected in the condensate hose. The amount of water (see G.7.3) in the tank (12) shall be reset to the start level. Any other remaining condensate within the test dryer itself may not be removed between the initial run and the start of a test series.

G.7 Tests for performance

G.7.1 General

This subclause contains information about the test procedure for performance measurements on steam heated tumble dryers and the additional requirements needed.

G.7.2 Performance testing of indirect steam heated tumble dryer installed according to alternative 1

All performance tests shall be according to Clause 7 and according to following additional requirements:

The tests shall be performed with the steam pressure and flow rate recommended by the manufacturer.

Before each test run the steam hoses outside the dryer under test shall be flushed with steam ensuring that the steam is as dry as possible when entering into the dryer under test. Close the shut off valve (2) and open the drain valve (5) and flush the steam until no condensate is visible in the valve outlet. The flushing shall occur immediate before the start of the test run. Close drain valve (5) and open the shut off valve (2) and start the test run.

The measured values from the steam measurement equipment (steam pressure, steam flow rate and steam temperature shall be recorded by the steam energy calculator and required output data shall be calculated and reported according to G.8.2.1.

The mass of steam (kg) calculated by the Steam energy calculator shall be recorded and reported according to G.8.2.3.

The average temperature of the condensate shall be recorded via the temperature sensor (8).

G.7.3 Performance testing of indirect heated tumble dryers installed according to Alternative 2

G.7.3.1 General

All performance tests shall be according to Clause 7 and according to following additional requirements:

The tests shall be performed with the steam pressure and flow rate recommended by the manufacturer.

The tank (12) shall be filled with water. The amount of water shall be approximately 4 times the expected amount of condensate and the vertical water distance between the steam outlet in the tank and the water surface shall be so high that all steam not yet condensed will condensate before breaking the water surface. The mass of the tank (12) with water shall be recorded.

Before each test run the steam hoses outside the dryer under test shall be flushed with steam ensuring that the steam is as dry as possible when entering into the dryer under test. Close the shut off valve (2) and open the drain valve (5) and flush the steam until no condensate is visible in the valve outlet. The flushing shall occur immediate before the start of the test run. Close drain valve (5) and open the shut off valve (2) and start the test run.

The measured values from the steam measurement equipment (steam pressure, steam flow rate and steam temperature shall be recorded by the steam energy calculator and required output data shall be calculated and reported according to G.8.3.1.

The average temperature of the condensate shall be recorded via the temperature sensor (9).

After each test run shut off valve (11) shall be closed and valve (9) shall be opened. The water in the condensate water hose shall be collected and poured into the tank (12) When the condensate water hose is empty the shut off valve (11) shall be opened again so any remaining water in the condensate water hose can flow into the tank (12).

The total mass of the tank (12) shall now be recorded.

G.7.3.2 Control of accuracy

The mass of the steam supplied to the **tumble dryer** as calculated by the steam energy calculator can be compared with the mass of the condensate calculated as the difference of the mass of the tank after and before the test run. If the mass values differ more than 10 % the run shall be regarded as not valid.

G.8 Assessment of performance

G.8.1 General

This subclause sets out the evaluation methods for the assessment of the energy performance of steam heated tumble dryers.

G.8.2 Evaluation of performance of indirect heated tumble dryer installed according to alternative 1

G.8.2.1 General

This subclause sets out the evaluation of supplied steam energy, energy recovered in the condensate and the total steam energy supplied to indirect heated tumbler dryers installed according to Alternative 1.

G.8.2.2 Evaluation of supplied steam energy

The steam energy supplied to an indirect heated tumbler dryer E_{ist} is the energy measured by the steam energy calculator.

G.8.2.3 Evaluation of the energy to be recovered through the condensate

The recovered energy of condensate water E_{cs} is calculated as:

$$E_{cs} = M_{dst} \times T_c / 860$$

T_c = T_{cs} if T_{cs} is < 100°C

T_c = 100°C if T_{cs} is ≥ 100°C

where

M_{dst} is the mass of steam supplied to the tumble dryer during a test run.

T_c is the condensate temperature

T_{cs} is the temperature recorded by the temperature sensor (8)

W_{cs} is the energy of the recovered condensate

1/860 is the energy equivalent

G.8.3 Evaluation of performance of indirect heated tumbler dryers installed according to alternative 2

G.8.3.1 General

This section sets out the evaluation of supplied steam energy, energy recovered in the condensate and the total steam energy supplied to indirect heated tumble dryer installed according to Alternative 2.

G.8.3.2 Evaluation of supplied steam energy

The steam energy supplied to an indirect heated tumble dryer E_{ist} is the energy measured by the steam energy calculator.

G.8.3.3 Evaluation of the energy to be recovered through the condensate

The recovered energy of condensate water is calculated as:

M_{cw} = M_{T1} – M_{T2}

T_c = T_{cs} if T_{cs} is < 100°C

T_c = 100°C if T_{cs} is ≥ 100°C

E_{cs} = M_{cw} x T_c /860

where

M_{cw} is the recovered amount of condensate water;

M_{T1} is the mass of the tank (12) at the end of the procedures described in G.7.3;

M_{T2} is the mass of the tank (12) at the start of the test run;

T_c is the condensate temperature;

T_{cs} is the temperature recorded by the temperature sensor (8);

W_{cs} is the energy of the recovered condensate;

1/860 is the energy equivalent.

G.8.4 Evaluation of total energy supplied to the tumbler dryer by steam

The total steam energy E_{st} for an indirect steam heated tumble dryer is equal to:

E_{st} = E_{ist} - E_{cs}

G.9 Data to be reported

The value of the total steam energy E_{st} and the mass of the supplied steam M_{dst} shall be reported in Table D.2.

Annex H
(informative)

Performance testing of gas heated tumble dryers

H.1 General

This annex gives references to CEN standards related to the safety and measurement of gas fired **tumble dryers**.

H.2 Installation, testing procedure and calculation of supplied gas energy

The dryer shall be installed according to reference given in a future standard, EN ZZZZZ.

NOTE At the time of introducing this PAS, the concerned document was not ready for publication, nor given an EN number.

All safety issues required shall be followed.

Specification for the gas energy measurement is given in Table 2.

The testing procedure shall follow the procedure given in Clauses 6, 7 and 8.

Formulae for calculating the supplied gas energy can be found in EN 1458-2.

Annex I
(informative)

Measurement of exhaust air volume

I.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 EN 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.

I.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 EN ISO 5167-1; and

t is the average **programme time**.

Annex J
(normative)

Measurement of the textile drying temperature

J.1 General

The textile drying temperature shall be measured by temperature loggers placed among the **test load** in the drying basket and following the load during the drying procedure.

J.2 Specification of the loggers

The specification of the temperature logger is given in Table J.1.

Table J.1 – Specification of temperature logger suitable for temperature measurement for both washing and drying

Temperature range	0 °C – 150 °C
Accuracy	≤ 0,5 °C over full range
Resolution	≤ 0,1°C
Response time TC (10 – 90 %)[a] water	≤ 2 min
Response time TC (10 – 90 %)[a] moving air(2 m/sec)	≤ 5 min
Sampling rate	≤ 10 s
Max mass	70 g
[a] TC (10 %–90 %) is the time it takes for the sensor to traverse between 10 % and 90 % of its final value. Response time can also be expressed as a TC 63 % value. The 63 % figure is the time for the sensor to reach 63 % of its final value. TC 10 %–90 % and the TC 63 % value are of approximately the same magnitude for a given sensor.	

J.3 Preparation of the loggers before measurement

The temperature logger shall be placed in a textile pocket made of the same fabric as the **test load**. The size of the pocket shall not be excessively larger than the logger. By doing this the logger will be protected from extensive shocks when hitting the basket walls and also any damage to the **test load** will be minimized. The pocket shall be closed by clips or by any other means.

In order to make the logger follow the motion pattern of the **test load** as close as possible the pocket shall be attached to one of the medium-sized test sheets.

J.4 Number of loggers

Following number of temperature loggers shall be placed in the **tumble dryer** depending on the size of the dryer.

The number of temperature loggers to be placed in the dryer is dependent on the size of the dryer as described in Table J.2.

Table J.2 – Number of temperature loggers to be used during a textile drying temperature measurement

Size of drying basket	Number of temperature loggers to use
< 200 l	2
200 l – 1 000 l	3
> 1 000 l	4

J.5 Measuring the temperature

The loggers shall be placed in the middle of the load before the drying sequence is started. If more than one logger is used they shall be placed evenly within the drum. The loggers shall follow the drying textiles throughout the drying process until the **end of the programme**. Directly after the **programme** end the loggers shall be removed and the logged data loaded to a computer.

J.6 Presenting the result

The temperature data obtained by the logger shall preferably be presented as a curve showing the temperature during the whole drying process. The result can be presented as individual temperature profiles for each logger or as a mean value of the loggers for each time point.

If max drying temperature shall be reported max drying temperature shall be defined as the highest temperature measured during the drying cycle by any logger.

Bibliography

[1] EN 1458-2, *Domestic direct gas-fired tumble dryers of types B22D and B23D, of nominal heat input not exceeding 6 kW – Part 2: Rational use of energy*

[2] EN 60704-1:2010, *Household and similar electrical appliances – Test code for the determination of airborne noise – Part 1: General requirements (IEC 60704-1:2010)*

[3] EN ISO 5167-1, *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 5167-1)*

[4] IEC Guide 109:2003, *Environmental aspects – Inclusion in electrotechnical product standards*

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