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**Surface cleaning appliances –
Part 2: Dry vacuum cleaners for household or similar use – Methods for
measuring the performance**

**Appareils de nettoyage des sols –
Partie 2: Aspirateurs à sec à usage domestique ou analogue – Méthodes de
mesure de l'aptitude à la fonction**



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SURFACE CLEANING APPLIANCES –

Part 2: Dry vacuum cleaners for household or similar use –
Methods for measuring the performance

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International Standard IEC 62885-2 has been prepared by subcommittee 59F: Surface cleaning appliances, of IEC technical committee 59: Performance of household and similar electrical appliances.

This second edition of IEC 62885-2 cancels and replaces the first edition published in 2016. This edition constitutes a technical revision.

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

- a) Inclusion of requirements for **water filter vacuum cleaners** throughout document
- b) Clause 4.6 on operation of the **dry vacuum cleaner** has been revised.
- c) Add new paragraph 4.11, consolidating test area and **stroke length** from 5.1.2, 5.3.2, 6.2.2 and 6.16.2.2. Added new 4.12 for **stroke speed**.
- d) Added debris pick-up test for hard floor and carpet. Includes new Annex E.

- e) Clause 6.2.2 – Clarification of the carpet to be used; reference 4.11 for test area. Remove restriction limiting carpets to motion resistance only. Clarify the use of a mechanical operator.
- f) A durability test for secondary hoses has been included.
- g) The informative annexes relating to the description and maintenance of the **reference vacuum cleaner system RSB** have been updated.

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

Draft	Report on voting
59F/434/FDIS	59F/438/RVD

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

The language used for the development of this International Standard is English.

A list of all the parts in the IEC 62885 series, under the general title *Surface cleaning appliances*, can be found on the IEC website.

In this standard, the following print types are used:

- terms defined in Clause 3: **bold type**.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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SURFACE CLEANING APPLIANCES –

Part 2: Dry vacuum cleaners for household or similar use – Methods for measuring the performance

1 Scope

This part of IEC 62885 is applicable for measurements of the performance of mains-operated **dry vacuum cleaners**, including **water filter vacuum cleaners** for household or similar use.

NOTE 1 Measurements of the performance of mains-operated commercial **dry vacuum cleaners** are found in IEC 62885-8.

The purpose of this document is to specify essential performance characteristics of **dry vacuum cleaners** which are of interest to users and to describe methods for measuring these characteristics.

NOTE 2 Due to the influence of environmental conditions, variations in time, origin of test materials and proficiency of the operator, some of the described test methods will give more reliable results when applied for comparative testing of a number of appliances at the same time, in the same laboratory and by the same operator.

NOTE 3 The methods here can be applied with modifications for surface-cleaning product types or technologies not currently covered within the scope.

For safety requirements, reference is made to IEC 60335-1.

A recommendation on information for the consumer at the point of sale is given in Annex B.

2 Normative references

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

IEC 60688, *Electrical measuring transducers for converting A.C. and D.C. electrical quantities to analogue or digital signals*

IEC 60704-2-1, *Household and similar electrical appliances – Test code for the determination of airborne acoustical noise – Part 2-1: Particular requirements for vacuum cleaners*

IEC TS 62885-1:2020, *Surface cleaning appliances – Part 1: General requirements on test material and test equipment*

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 12103-1, *Road vehicles – Test dust for filter evaluation – Part 1: Arizona test dust*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

active depth of the cleaning head

distance from the front edge of the **cleaning head** to its rear edge or a line 10 mm behind the rear edge of the suction opening on the underside of the **cleaning head**, whichever is the shortest

3.2

active nozzle

cleaning head provided with a driven agitation device to assist dirt removal

Note 1 to entry: The agitation device can be driven by an incorporated electric motor (motorized nozzle), an incorporated turbine powered by the air flow (air-turbine nozzle), or an incorporated friction or gear mechanism actuated by moving the **cleaning head** over the surface to be cleaned (mechanical nozzle).

3.3

cleaning head

plain nozzle or brush attached to a connecting **tube**, or a power nozzle, separate or part of the cleaner housing, and that part of a **dry vacuum cleaner** which is applied to a surface to be cleaned

3.4

cleaning head width

B

external maximum width of the **cleaning head**, in metres

3.5

cordless active nozzle

cleaning head provided on a mains-operated machine with an agitation device to assist dirt removal driven by a battery-operated motor

3.6

cylinder vacuum cleaner

portable **dry vacuum cleaner** having a nozzle separated from the cleaner housing by a hose; in use, only the nozzle is guided over the surface area to be cleaned

Note 1 to entry: These **dry vacuum cleaners** are generally floor-supported.

Note 2 to entry: The **dry vacuum cleaner** can have detachable passive or **active nozzles**, attachments, and **tubes** for both floor and above the floor cleaning.

3.7

double stroke

one forward and one backward movement of the **cleaning head** performed according to the appropriate **stroke pattern**

3.8

dry vacuum cleaner

electrically operated appliance that removes dry material (for example, dust, fibre, threads) from the surface to be cleaned by an air flow created by a vacuum developed within the unit, the removed material being separated in the appliance and the cleaned suction air being returned to the ambient air

3.9

forward stroke

forward movement of a **stroke pattern**

Note 1 to entry: On test carpets, **forward strokes** are carried out in the direction of the carpet pile.

3.10

hand-held cleaner

dry vacuum cleaner that will not be used on the floor by the user from an erect standing position

Note 1 to entry: The hand-held **dry vacuum cleaner** can also be used on stairs from a standing position.

3.11

hybrid vacuum cleaner

dry vacuum cleaner that can be either mains and/or battery-operated

3.12

in-house reference vacuum cleaner

electrically operated laboratory equipment designated for internal comparison within a laboratory

3.13

maximum operational power

power level that the machine is not capable of exceeding in any operating condition set either by the user or automatically by the appliance

3.14

parallel pattern

stroke pattern where the **forward strokes** and the **return strokes** are congruent and are carried out in the direction of the carpet pile (direction of manufacture) unless otherwise specified

3.15

passive nozzle

cleaning head without any driven agitation device

3.16

reference vacuum cleaner system RSB

electrically operated laboratory equipment intended to provide different laboratories with a similarly constructed vacuum cleaner to measure the reference dust removal ability on carpets for passive and **active nozzles** to improve the reproducibility of results

Note 1 to entry: The **reference vacuum cleaner system RSB** may be used with active or **passive nozzles**.

Note 2 to entry: The **reference vacuum cleaner system RSB** is not intended for tests other than dust pick-up from Wilton test carpets.

Note 3 to entry: The **reference vacuum cleaner system RSB** is described in Annex C. Maintenance of the RSB is described in Annex D.

Note 4 to entry: The **reference vacuum cleaner system RSB** is required for measurements in accordance with legislation in the European Union.

3.17

return stroke

backward movement of a **stroke pattern**

3.18

self-propelled cleaning head

cleaning head provided with a propulsion mechanism

3.19

stroke

single traverse of the **cleaning head** over the **test area**

3.20

stroke length

distance between the two parallel lines defining the limits of a **stroke pattern**

3.21**stroke pattern**

arrangement of the **forward strokes** and **return strokes** on the surface to be cleaned

3.22**stroke speed**

speed of the **cleaning head**, moved as uniformly as possible, during a **forward stroke** or a **return stroke**

3.23**test**

entirety or superset of all **trials** and **trial** batches of all samples to be measured for a single **vacuum cleaner** model

3.24**trial**

single instance of a performance measurement carried out under identical conditions that can be repeated multiple times

3.25**tube**

rigid length or lengths of hollow pipe that connect the end of the hose to various vacuum cleaner accessories

Note 1 to entry: The **tube** may be of fixed length, in multiple parts or telescopic, passive or energized.

3.26**upright vacuum cleaner**

self-standing and floor-supported **dry vacuum cleaner** with the **cleaning head** forming an integral part of, or permanently connected to, the cleaner housing, the **cleaning head** normally being provided with an agitation device to assist dirt removal and the complete cleaner housing being moved over the surface to be cleaned by means of an attached handle

3.27**water filter vacuum cleaner**

dry vacuum cleaner that uses water as the main filter medium, whereby the suction air is forced through the water entrapping the removed dry material as it passes through

3.28**water filter system**

removable water filter components that are in contact with the water

4 General conditions for testing**4.1 Atmospheric conditions**

Unless otherwise specified, the **test** procedures and measurements shall be carried out under the following conditions:

Standard atmosphere 23/50

Temperature: (23 ± 2) °C

Relative humidity: (50 ± 5) %

Absolute air pressure: 91,3 kPa to 106,3 kPa

Temperature and humidity conditions within the specified ranges are required for good repeatability and reproducibility. Care should be taken to avoid changes during a **test**.

For **test** procedures and measurements carried out at other than standard atmospheric conditions, the ambient temperature shall be maintained at $(23 \pm 5) ^\circ\text{C}$.

4.2 Test equipment and materials

4.2.1 General

To minimize the influence of electrostatic phenomena, measurements on carpets shall be carried out on a flat floor consisting of a smooth untreated pine plywood or equivalent panel, at least 15 mm thick and of a size equal to or larger than the test carpet.

Equipment and materials for measurements (devices, test carpets, test dust, etc.) to be used in a **test** shall, prior to the **test**, be stored for at least 16 h at standard atmospheric conditions in accordance with 4.1.

Carpets that have already been used shall be stored unbeaten at standard atmospheric conditions in accordance with 4.1.

When not in use, carpets shall be hanging free, or lying flat, pile upwards and uncovered. Carpets shall not be rolled when stored between **tests**. Carpets that have been rolled shall be laid flat for a minimum of 16 h before use.

4.2.2 Pile direction

Machine or manufacturing direction is an indication of the projected pile direction for carpet production. Pile direction is what is important for dust pick-up (DPU) testing.

If the pile direction is clearly parallel to the test bed, as is required by the applicable **test** procedures, the carpet is acceptable for use for that **test**. If the pile direction is at an angle to the test bed, the laboratory will be required to decide as to that carpet panel's usability for relevant comparative testing.

NOTE The procedure for determining pile direction can be found in IEC TS 62885-1.

4.3 Voltage and frequency

Unless otherwise stated, measurements shall be carried out at rated voltage with a tolerance of $\pm 1\%$ and, if applicable, at rated frequency.

Dry vacuum cleaners designed for DC only shall be operated on DC. **Dry vacuum cleaners** designed for both AC and DC shall be operated at AC. **Dry vacuum cleaners** not marked with rated frequency shall be operated at either (50 ± 1) Hz or (60 ± 1) Hz with a total harmonic distortion of $\leq 3\%$, as is common in the country of use.

For **dry vacuum cleaners** with a rated voltage range, measurements shall be carried out at the mean value of the voltage range if the difference between the limits of the range does not exceed 10 % of the mean value. If the difference exceeds 10 % of the mean value, measurements shall be carried out both at the upper and lower limits of the voltage range.

If the rated voltage differs from the nominal system voltage of the country concerned, measurements carried out at rated voltage can give test results that are misleading for the consumer, and additional measurements can be required. If the test voltage differs from the rated voltage, this shall be reported.

4.4 Running-in of dry vacuum cleaner

Prior to the first **test** on a new **dry vacuum cleaner**, it shall be kept running with unrestricted air flow for at least 2 h to ensure adequate running-in. For **active nozzles**, the agitation device shall be running but not in contact with the floor.

Prior to conducting any series of **tests**, the age, condition, and history of the product shall be recorded.

4.5 Equipment of the dry vacuum cleaner

If the **dry vacuum cleaner** is designed to be used with disposable dust receptacles, it shall, prior to each measurement, be equipped with a new dust receptacle of the type recommended or supplied by the manufacturer of the **dry vacuum cleaner**.

If the **dry vacuum cleaner** is provided with a reusable dust receptacle (as the sole original dust receptacle or as an enclosure for disposable dust receptacles), the dust receptacle and any additional filters removable without the aid of tools shall, prior to each measurement, be cleaned according to the manufacturer's instructions until its mass is within 1 % or 2 g of its original mass, whichever is the lower.

Some reusable receptacles consist of a rigid container and an integral filter. In this case, the container and the filter are considered to be the receptacle and should be treated as if they were a single component.

For **dry vacuum cleaners** equipped with separation devices being part of the appliance, which are used to separate the dust from the air flow and/or having additional filters to be changed or cleaned by the user without the use of tools, the change in mass of such specific devices shall be taken into account for dust removal ability.

Dry vacuum cleaners with disposable or reusable dust receptacles may have secondary filtration stage devices which do not collect meaningful dust in removal ability **tests**, but which do impact on filtration and life **tests**. Replacement and/or maintenance of such devices shall be in accordance with relevant clauses and carried out in accordance with the manufacturer's instructions.

4.6 Operation of the dry vacuum cleaner

4.6.1 General

The grip of cleaners with suction hose or the handle of other cleaners shall be held at a height of (800 ± 50) mm above the test surface. Any telescopic **tubes** or sticks shall be extended to maximum length. For nozzles without pivoting connectors, it shall be ensured that the bottom of the **cleaning head** be made parallel with the test surface by adjusting the handle height within the tolerances. If this is not possible, the length of a telescopic **tube** or stick may be adjusted. Any adjustment shall be reported.

During measurements where the agitation device of an **active nozzle** is not used as in normal operation, the agitation device shall be running but not in contact with any surface.

The following wording regarding declaration and compliance shall also apply to IEC 60704-2-1: "For declaration and compliance purposes, related **tests** conducted on a surface type (carpet or hard surface with or without crevice) shall be conducted with the same **dry vacuum cleaner** setting configurations such as power, **cleaning head** and **cleaning head** setting."

Related **tests** are:

- **tests** measuring the dust removal from carpet, the debris removal from carpet, the energy consumption for cleaning a carpet, and the noise level on carpet.
- **tests** measuring the dust removal from hard floor with crevices, the debris removal from hard floor, the energy consumption for cleaning a hard floor with crevices, and the noise level on hard floor.

Unless otherwise specified, the **dry vacuum cleaner** setting configurations, such as power, **cleaning head** and **cleaning head** setting, shall be used, and adjusted in accordance with the manufacturer's instructions for the surface to be cleaned (e.g., carpet or hard floor) for the **test** to be carried out.

In the absence of unambiguous instructions within the manufacturer's instructions, the product shall be tested with settings that are in accordance with any explicitly clear text, symbol or pictogram that is identifiable on the product.

If, after following the above order of checks, the tester believes the device under test to be in a configuration that is ambiguous, or that multiple configurations are possible with no way to clearly determine which is the most suitable for a given task, then the manufacturer shall be contacted for additional guidance.

Complete details of the settings used for each cleaning task, such as suction power, height settings and the like shall be recorded in the **test** documentation.

If values for the performance of a product measured in accordance with this document are published/declared, e.g., in the technical documentation, accurate and unambiguous details of the settings that were used during the **test** procedure shall be provided.

NOTE Performance in other settings or combinations can differ from the results in the declaration settings, however this document does not address those results.

4.6.2 Operation of water filter vacuum cleaners, additional requirements

4.6.2.1 Determining the water loss

Prior to the preconditioning the water loss of the **water filter vacuum cleaner** shall be determined.

The **water filter vacuum cleaner** shall be run according to the manufacturer's instructions for a period of 10 min with the suction nozzle lifted 20 mm from the floor in accordance with 4.1. Before and after this running time of 10 min, the mass of the **water filter system** shall be measured with an accuracy of at least 0,1 g. This **trial** shall be repeated 3 times and an average of these 3 **trials** shall be noted.

Since ambient conditions have a significant influence on the water loss, standard conditions shall be carefully maintained.

4.6.2.2 Filter conditions

4.6.2.2.1 For dust and debris removal from hard flat floors and from carpets

If the value measured in accordance with 4.6.2.1 is lower than 0,1 g/min, the **water filter vacuum cleaner** shall be used in accordance with the manufacturer's instructions for the dust removal from hard flat floors and carpet.

The **water filter vacuum cleaner** should not be moved to minimize loss of water.

NOTE 1 The mass of water lost during the measuring time is low and has no relevant influence on the **test** result.

If the value measured in accordance with 4.6.2.1 is equal to or higher than 0,1 g/min and the **water filter vacuum cleaner** is equipped with a dust collection system that does not use water, this collection system shall be included to determine the dust and debris removal from hard flat floors and dust and debris removal from carpet.

The air data in accordance with 5.11 shall be measured with the **water filter system** used in accordance with the manufacturer's instructions. Then, the vacuum cleaner shall be equipped

with the dust collection system without water and the maximum airflow shall be adjusted to $\pm 3\%$ of the measured values with the **water filter system**.

In all other cases, the dust and the debris removal from hard flat floors and from carpets shall be performed using the dust collecting box (see 7.3.15) as pre-filter system. The vacuum cleaner shall be used in accordance with the manufacturer's instructions.

The dust collecting box is equipped with a synthetic filter bag properly sized for the dust collecting box.

NOTE 2 The filter bag from the **reference vacuum cleaner system RSB** in accordance with 3.16 can be used. For measuring dust pick-up, the filter bag can be handled in the same way it is handled in the **reference vacuum cleaner system RSB**.

4.6.2.2.2 For all other tests with water filter vacuum cleaners

The vacuum cleaner and its attachments shall be used and adjusted in accordance with the manufacturer's instructions for normal operation for the **test** to be carried out.

4.7 Conditioning prior to each test

If the **dry vacuum cleaner** is unused and de-energized for more than 1 h, then the **dry vacuum cleaner** and attachments to be used shall be kept running for at least 10 min under the provisions given in 4.4 to allow for them to stabilize.

4.8 Mechanical operator

In order to achieve reliable results, certain **tests** require the **cleaning head** to be moved at uniform speed over the test area and without exerting an additional force against the test surface.

It is recommended to simulate the handling of the **dry vacuum cleaner** by using a mechanical operator such as that described in 7.3.12.

The linear drive may be motorized or operated by hand. The method of operation shall be reported.

4.9 Number of samples

All measurements of performance shall be carried out on the same sample(s) of the **dry vacuum cleaner** with its attachments, if any.

For increased confidence in the test results, a minimum of three samples of a **dry vacuum cleaner** should be tested. Some performance **tests** may require additional samples or replacement parts if performance is adversely impacted by testing. If additional samples or replacement parts are used, they should be recorded in the report.

Tests carried out to simulate stresses that a **dry vacuum cleaner** may be exposed to during normal use, possibly causing impairment of the cleaner's performance, can require additional samples of replaceable parts. Such **tests** shall be carried out at the end of the **test** programme.

4.10 Carpets for testing

NOTE 1 The reference cleaner referred to in this document is a product designated within a laboratory for internal comparison and is not suitable for inter-laboratory comparisons.

Test carpets used in a laboratory for the determination of dust removal ability will, over time, change from their original condition, for instance due to wear or gradual filling with dust.

Therefore, the **in-house reference cleaner** as defined in 3.12 shall be used to regularly check the carpet conditions as a verification of the **test** results obtained and recorded.

If a **RSB reference vacuum cleaner system RSB** as defined in 3.16 is present, this should be used for monitoring Wilton test carpet conditions by comparing the values for calibrated and reference dust pick-up, DPU_{cal} and DPU_{ref} , of the RSB.

NOTE 2 DPU_{cal} and DPU_{ref} are defined in Clause C.5.

If the difference between DPU_{cal} and DPU_{ref} is greater than 5 percentage points, it is recommended to:

- replace the carpet, and/or
- re-adjust the RSB, and/or
- check the laboratory conditions and testing procedure.

Given that dust pick-up ability can differ between carpets used for **active nozzles** or **passive nozzles**, the result from **tests** between **active nozzles** and **passive nozzles** shall not be compared.

Test carpets designated for testing of **passive nozzles** shall only be cleaned with a **passive nozzle** on the face. Test carpets designated for testing **active nozzles** shall only be cleaned with an **active nozzle** on the face.

4.11 Stroke length and test area

Unless otherwise specified within the document, the length of the test area is (700 ± 5) mm and the width of the test area is equal to the **cleaning head width** (see 3.4).

A length of at least 200 mm shall be added before the beginning of the test area and at least 300 mm after the end of the test area in order to allow acceleration and deceleration of the **cleaning head**.

Thus, the **stroke length** is at least 1 200 mm for the given test length of 700 mm. The centre line of the front edge of the **cleaning head** is aligned to the centre line of the beginning of the acceleration area at the commencement of the **stroke**, allowing the distance of 200 mm to be used for acceleration. The **cleaning head** shall reach the end of the **stroke** when the rear edge of the **active depth of the cleaning head** is at least 200 mm past the end of the test area, thus allowing a suitable distance for deceleration. The **return stroke** is carried out in the same manner until the front edge of the **cleaning head** is once again lined up with the beginning of the acceleration length in front of the test area.

4.12 Stroke speed

Unless otherwise specified within the document, the **active depth of the cleaning head** shall move at uniform **stroke speed** $(0,50 \pm 0,02)$ m/s and in a straight line over the test area.

For optimum control of the **double stroke** movement, an electromechanical operator (see 4.8) should be used.

Two hold-downs in accordance with 7.3.4 act as guides to keep the **cleaning head** in a straight line as it is moved over the test area and to ensure an undisturbed flow.

Dry vacuum cleaners equipped with a self-drive device shall be operated at the prescribed **stroke speed** of $(0,5 \pm 0,02)$ m/s, if possible. Otherwise, the **stroke speed** will be determined by the **dry vacuum cleaner**.

5 Dry vacuum cleaning tests

5.1 Dust removal from hard flat floors

5.1.1 Test equipment

A floor test plate in accordance with 7.3.1 shall be used.

5.1.2 Test area and stroke length

The test area and **stroke length** are specified in 4.11, except that the test width is $(B - 0,02)$ m. The **stroke speed** is specified in 4.12.

5.1.3 Removal of remaining dust

The hard surface shall be dry cleaned so that no dust remains prior to any subsequent **test**.

5.1.4 Distribution of test dust

Mineral dust – Type 1 in accordance with 5.2.1 of IEC TS 62885-1:2020, shall be distributed with a mean coverage of 50 g/m^2 as uniformly as possible over the test area.

The amount of test dust to be used is calculated from the formula $(B - 0,02) \times 0,7 \text{ m} \times 50 \text{ g/m}^2$, where B is the **cleaning head width** in metres and $0,7 \text{ m}$ is the length of the test area.

5.1.5 Preconditioning of dust receptacle

In order to minimize the effects of humidity, the dust receptacle shall be preconditioned as follows.

The **dry vacuum cleaner** under **test** is equipped with a clean dust receptacle and allowed to run with an unimpeded air flow with the nozzle clear of the surface for 2 min or until input power has stabilized.

After the preconditioning, the dust receptacle, and any filters removable without tools are removed from the **dry vacuum cleaner** to be weighed. The mass shall be noted, and the items are replaced.

Since the **dry vacuum cleaner** air flow can have an effect on the mass of the dust receptacle during the 2-min preconditioning, the mass of the dust receptacle shall be allowed to stabilize before weighing.

The requirements of 4.6.2 shall be followed for **water filter vacuum cleaners**.

5.1.6 Determination of dust removal ability

Three separate **trials**, each comprising one **double stroke**, shall be carried out. After each **double stroke**, the **cleaning head** shall be lifted at least 50 mm clear of the surface before the **dry vacuum cleaner** is switched off.

After each **trial**, the surface of the test plate is wiped with a dry suitable cloth having good dust adherence, which is weighed before and after the wiping to determine the amount of dust remaining after the cleaning. Any dust pushed out of the test area shall be included. The dust removal ability in per cent is calculated as the mean value from the measurements.

The mean value for three **trials** $K_B(3)$ is calculated in accordance with the following formula:

$$K_B(3) = (K_{B1} + K_{B2} + K_{B3}) / 3$$

Where:

$$K_{B_i} = 100 \% \times (m_{d_i} - m_{r_i}) / m_{d_i}$$

and

K_{B_i} is the mean dust removal for i^{th} **trial** expressed in %.

m_{d_i} is the dust quantity distributed on the test floor of the i^{th} **trial**, in g.

m_{r_i} is the amount of dust wiped off with a suitable cloth of the i^{th} **trial**, in g.

The cloth shall be capable of removing a minimum of 99 % of the dust from the floor surface, and not leave any residue.

When the mean value is lower than 90 % and the range of measurements is greater than three percentage units, two additional **trials** are carried out and the mean value of all the measurements should be given as the result.

When the mean value is equal to or higher than 90 % and the range of the measurements is greater than $0,3 \times (100 \% - \text{mean value})$, two additional **trials** are carried out and the mean value of all the measurements shall be given as the result.

Consideration shall be given to the control of repeatability within the laboratory and the design or manufacture of the **dry vacuum cleaner** or **cleaning head** in order to ascertain whether any factors not previously observed may adversely affect the repeatability.

The requirements of 4.6.2 shall be followed for **water filter vacuum cleaners**.

5.2 Dust removal from hard floors with crevices

5.2.1 General

The cleaning effectiveness for dust removal from hard floor with crevices and hard floor with debris is measured using the appropriate vacuum cleaner settings, **cleaning head**, and **cleaning head** settings for the function. The settings used shall be recorded in the test report.

5.2.2 Test surface and crevice

The surface, in accordance with 7.3.2, consists of a wooden test plate incorporating a removable aluminium insert with a crevice, the angle between the crevice and the direction of **strokes** being 45°.

The test plate may be fitted to the test rig in accordance with 7.3.12 or, if being used for testing by hand, is placed upon the floor.

Two hold-downs in accordance with 7.3.4 act as guides to keep the **cleaning head** in a straight line as it is moved over the test area. The guides should have a distance of 10 mm from the surface to ensure an undisturbed flow.

5.2.3 Distribution of test dust

The insert is weighed, and its crevice thereafter filled with mineral dust – Type 1, in accordance with 5.2.1 of IEC TS 62885-1:2020. After levelling the surface of the dust with a rubber scraper, the insert is again weighed and carefully replaced in the test plate, avoiding shaking.

The linear density of the dust inside the crevice shall be between 34,0 g/m and 29,0 g/m along the crevice's length. Otherwise, the filling shall be repeated.

The inserts are emptied of dust after the last **trial** of each **test**.

5.2.4 Determination of dust removal ability

The vacuum cleaner settings, **cleaning head** and **cleaning head** settings shall be in accordance with 4.6.1. **Stroke speed** is in accordance with 4.12.

During a **test**, the **cleaning head** is passed over the crevice by performing five **double strokes** in a **parallel pattern** at a **stroke speed** of $(0,50 \pm 0,02)$ m/s, keeping the **cleaning head** to the centre of the test plate. The quantity of dust removed from the crevice after five **double strokes** is determined as the difference in mass of the insert before and after cleanings, both values being recorded.

The dust removal ability, in per cent, is calculated in accordance with the following formula as the ratio of the quantity of dust removed to the quantity of dust in that part of the crevice which is determined by the **cleaning head width** (see 3.4) and accounting for the oblique angle of 45°:

$$k_{cri} = \frac{m_{Li} - m_{ri}}{m_{Li}} \left(\frac{L}{B} \right) \cos(45^\circ) \times 100 \%$$

Where:

k_{cri} is the dust removal ability for the i^{th} **trial**, in per cent;

m_{Li} is the dust quantity in the crevice before cleaning of the i^{th} **trial**, in g;

m_{ri} is the dust quantity remaining in the crevice after cleaning of the i^{th} **trial**, in g;

L is the length of the crevice, in m;

B is the **cleaning head width**, in m.

The mean value of dust removal ability for three **trials** is calculated as follows:

$$k_{cr \text{ mean}} = \left(\frac{k_{cr1} + k_{cr2} + k_{cr3}}{3} \right)$$

Three separate **trials** shall be carried out to establish a mean value of the dust removal ability for five **double strokes**.

NOTE It is possible to obtain a cleaning effectiveness of greater than 100% using this test.

5.3 Debris removal from hard floors

5.3.1 Test equipment

The surface shall be in accordance with Annex E. The test area is in accordance with 4.11, except that test width is $(B - 0,02)$ m.

Two hold-downs in accordance with 7.3.4 act as guides to keep the **cleaning head** in a straight line as it is moved over the test area. The guides should be spaced 10 mm above the surface to ensure an undisturbed air flow.

5.3.2 Test surface

The **test surface** is specified in Annex E and Figure E.1. The **test surface** shall be mounted on 18 mm plywood or MDF. When plywood is used, it is important that it remains flat. Horizontally, the deviation shall be < 1mm/m. The longitudinal deviation ($\Delta//$) shall be < 1 mm. The perpendicular deviation ($\Delta\perp$) shall be < 0,5 mm. Flatness may be checked using any suitable means.

The test surface layout shall be prepared as shown in Figure E.2.

5.3.3 Distribution of debris

Medium size debris, in accordance with IEC TS 62885-1:2020, 5.3 is weighed separately to the nearest 0,05 g for each material. The total mass of debris (D_T) to be used is calculated from the formula

$$D_T = (B - 0,02 \text{ m}) \times 0,7 \text{ m} \times 30 \text{ g/m}^2$$

where:

B is the **cleaning head width**.

Equal mass of separate debris materials shall be spread randomly over the complete test area using any convenient means. There should be no area of (5 × 5) cm without any debris.

The test area is cleaned of remaining debris after each cleaning **trial**.

NOTE The debris can be reused provided it has been inspected and has not been damaged.

5.3.4 Determination of debris removal ability

The **dry vacuum cleaner** settings, **cleaning head** and **cleaning head** settings shall be the same as in 5.2.1.

Conditioning of the dust receptacle shall be in accordance with 5.1.5. At the end of conditioning, the dust receptacle shall be weighed and its weight recorded (WT_{Initial}).

During a **trial**, the **cleaning head** is passed over the test area by performing three **double strokes** at a **stroke speed** of (0,50 ± 0,02) m/s, keeping the **cleaning head** in the centre of the test plate. The **stroke** shall begin in the acceleration area and the **stroke speed** shall remain constant through the test area and into the deceleration area until the direction is reversed.

At the end of the final **stroke** the nozzle shall remain stationary outside the test area, and the **dry vacuum cleaner** shall operate for an additional 5 s. During this period, the hose is agitated to allow any debris within the vacuum cleaner to be collected in the dust receptacle while avoiding picking up further debris around the nozzle. The dust receptacle is carefully removed and weighed (WT_{Final}).

The debris removal ability K_d , in per cent, is calculated in accordance with the following formula:

$$K_{di} = \left(\frac{WT_{\text{Final}} - WT_{\text{Initial}}}{D_T} \right) \times 100\%$$

A number of separate **trials** shall be run to determine the cleaning effectiveness. The mean cleaning effectiveness is calculated as

$$\bar{K}_d = \frac{K_{d1} + K_{d2} + \dots + K_{di}}{i}$$

Where:

i is the number of **trials** ($i \geq 3$);

K_d is the debris removal ability (in %).

The number of **trials** used, and the direction of the beginning **stroke** (forward or backward) shall be recorded in the test report.

5.4 Dust removal from carpets

5.4.1 General

The cleaning effectiveness for carpet cleaning with dust and carpet cleaning with debris are measured using the appropriate vacuum cleaner settings, **cleaning head** and **cleaning head** settings. The settings used shall be recorded in the test report.

5.4.2 Test carpet and equipment

A test carpet, in accordance with IEC TS 62885-1:2020, 4.1 shall be used; the type of carpet selected shall be recorded. It shall have been prepared in accordance with IEC TS 62885-1:2020, 4.3. Owing to the significant influence of humidity on this **test**, the carpet shall be left in the test environment at standard atmospheric conditions for at least 16 h before the **test** is due to commence.

The preferred carpet for comparative testing purposes is the Wilton test carpet (see IEC TS 62885-1:2020, 4.1). If additional carpet(s) are desired for testing, the carpet(s) shall be selected from those specified in 7.2.1.3.

During **trials**, the carpet is kept in position on the test floor by the use of carpet hold-downs (see 7.3.4). The carpet shall be fixed on the test floor at the end where the **forward stroke** starts. A force of 60^{+10}_{-0} N shall be applied at the other end of the test carpet to define the tension on the carpet during testing.

5.4.3 Test area and stroke length

The test area and **stroke length** are specified in 4.11, except that the test width is $(B - 0,02)$ m. The **stroke speed** is specified in 4.12.

5.4.4 Conditioning of test carpet

5.4.4.1 General

Prior to each **trial**, the test carpet shall be cleaned to remove remaining dust and preconditioned as described in 5.4.4.2 and 5.4.4.3.

5.4.4.2 Removal of remaining dust

For cleaning of the test carpet, it is recommended to use a suitable carpet-beating machine such as that described in 7.3.3.

If the carpet-beating machine has a housing, the carpet shall be removed immediately after the **trial** to avoid drying of the carpet fibres.

If a carpet-beating machine is not used, the carpet shall be placed upside down on a rigid mesh support and be beaten by hand or with an **active nozzle**. After the beating, one **trial** with a **dry vacuum cleaner** having good dust removal ability should be carried out to remove

the remaining dust. Test carpets designated for testing of **passive nozzles** shall only be cleaned with a **passive nozzle** on the face (although an **active nozzle** may be used on the back).

5.4.4.3 Verification and preconditioning

After cleaning of the test carpet, the **dry vacuum cleaner** under **test** shall be equipped with a clean dust receptacle (see 4.5) and be used to verify that the carpet has been cleaned to the point where no dust pick-up is discernible. This point is considered to be reached if the amount of dust removed from the carpet during five **double strokes** is less than 0,2 g. If the amount is greater than 0,2 g, this step is repeated until the requirement is achieved.

NOTE Even if the equipment for removing remaining dust from the carpet is known to be sufficiently reliable to leave the carpet in an acceptable condition, it is still important to carry out this procedure of preconditioning to ensure that the effect of humidity on the carpet is minimized.

To prevent a gradual filling of the carpet with dust, the mass of the test carpet should be maintained as close as possible to that of the initially clean carpet.

The requirements of 4.6.2 shall be followed for **water filter vacuum cleaners**.

5.4.5 Distribution of test dust

Mineral dust – Type 2, in accordance with IEC TS 62885-1:2020, 5.2.2 shall be distributed with a mean coverage of $(125 \pm 0,1) \text{ g/m}^2$ as uniformly as possible over the test area.

The amount of test dust to be used is calculated from the formula $(B - 0,02 \text{ m}) \times 0,7 \text{ m} \times 125 \text{ g/m}^2$, where B is the **cleaning head width** in metres and the length of the test area is 0,7 m. Any means of spreading the test dust may be used, provided it produces a uniform distribution of dust over the test area minus 10 mm on each side. One example of a dust spreading means is the dust spreader as described in 7.3.5. The adjustment of the device is checked by visual examination of the test dust on the carpet.

5.4.6 Embedding of dust into carpet

The dust shall be embedded into the test carpet by carrying out 10 **double strokes** over the carpet parallel with the direction of the pile with a roller, fabricated in accordance with 7.3.6.1. The speed of the roller over the test area shall be a uniform $(0,50 \pm 0,02) \text{ m/s}$ with the **forward stroke** being in the direction of the pile. It is important to ensure that the test area is completely and evenly rolled. The carpet is then left for a period of 10 min to recover from rolling.

5.4.7 Preconditioning of dust receptacle

Follow the procedure specified in 5.1.5.

5.4.8 Determination of dust removal ability

Prior to each **trial**, the sequence of preparations outlined in 5.4.5 to 5.4.7 shall be performed in total.

Three separate **trials**, each comprising five **double strokes**, shall be carried out. After the fifth **double stroke**, the **cleaning head** shall be lifted at least 50 mm clear of the carpet. At the end of each **trial**, all hoses and **tubes** of the **dry vacuum cleaner** shall be agitated before the **dry vacuum cleaner** is switched off. The dust receptacle shall not be removed before the motor has completely stopped.

Once the **dry vacuum cleaner** has completely stopped, the receptacle(s) and removable filters are carefully removed and reweighed. Due to effects of possible static charge build up

during the time the **dry vacuum cleaner** is picking up dust, it is necessary to ensure that the receptacle has completely stabilized prior to recording the mass.

The dust removal ability is calculated as the ratio of the mass increase of the dust receptacle and removable filters as defined in 4.5 during the five **double strokes** to the mass of the test dust distributed on the test area. The mean value for three **trials** is calculated as follows:

$$K_T(3) = (K_{T1} + K_{T2} + K_{T3})/3$$

Where:

$$K_{T_i} = \frac{(m_{DRf_i} - m_{DRe_i})}{m_D} \times 100 \%$$

and

$K_T(3)$ is the mean dust removal of 3 **trials**, in %.

K_{T_i} is the dust removal for a single **trial** i , in %.

m_D is the mass of the dust distributed on the test area for a single **trial**, in g.

m_{DRe_i} is the total mass of the preconditioned dust receptacle(s) and removable filter(s) for a single **trial**, in g.

m_{DRf_i} is the total mass of the dust receptacle(s) and removable filter(s) after five **double strokes**, in g.

If the range of values for K_{T_i} is greater than three percentage points, two additional **trials** shall be performed. In this case, the mean dust removal ability shall be calculated as follows:

$$K_T(5) = (K_{T1} + K_{T2} + K_{T3} + K_{T4} + K_{T5})/5$$

EXAMPLE The values for K_{T_i} of 45 %, 47 % and 49 % give a range of four percentage units. Thus, two additional **trials** shall be carried out.

If a problem with the repeatability continues and a downward trend is observed with the results, refer to 4.5 and consider the equipment being weighed during the **test**.

If the results of the first **trial** differ by more than 3 % from the following two **trials**, it is permissible to repeat that test before applying the rules of the two additional **trials**.

For the dust removal ability, the mean value, the value range, and the number of **trials** shall be recorded as well as the type of carpet used.

The requirements of 4.6.2 shall be followed for **water filter vacuum cleaners**.

NOTE For correction of dust removal figures using the **reference vacuum cleaner system RSB**, see Clause C.5.

5.5 Debris removal from carpet

5.5.1 Test equipment

The test carpet and conditioning shall be as described in 5.4.1 to 5.4.3. The test area is in accordance with 4.11, except that the test area width is specified as $(B - 0.02)$ m.

Two hold-downs in accordance with 7.3.4 act as guides to keep the **cleaning head** in a straight line as it is moved over the test area. The guides should be spaced 10 mm above the surface to ensure an undisturbed air flow.

5.5.2 Distribution of debris

Medium size debris, in accordance with IEC TS 62885-1:2020, 5.3 is weighed separately to the nearest 0,05 g for each material. The total mass of debris to be used is calculated from the formula:

$$D_T = (B - 0,02 \text{ m}) \times 0,7 \text{ m} \times 30 \text{ g/m}^2$$

where:

B is the **cleaning head width**, in metres.

Equal mass of separate debris materials shall be spread randomly over the complete test area using any convenient means. There should be no area of (5 × 5) cm without any debris.

The test area is cleaned of remaining debris after each cleaning **trial**.

NOTE The debris can be reused provided it has been inspected and has not been damaged.

5.5.3 Determination of debris removal ability

The **dry vacuum cleaner** settings, **cleaning head** and **cleaning head** settings shall be in accordance with 4.6.1.

Conditioning of the dust receptacle shall be carried out in accordance with 5.1.5. At the end of conditioning, the dust receptacle shall be weighed, and its weight recorded (WT_{Initial}).

During a **trial**, the **cleaning head** is passed over the test area by performing three **double strokes** at a **stroke speed** of (0,50 ± 0,02) m/s, keeping the **cleaning head** in the centre of the test area. The **stroke** shall begin in the acceleration area and the **stroke speed** shall remain constant through the test area and into the deceleration area until the direction is reversed.

At the end of the final **stroke**, the nozzle shall remain stationary outside the test area, and the **dry vacuum cleaner** shall operate for an additional 5 s. During this period, the hose is agitated to allow any debris within the **dry vacuum cleaner** to be collected in the dust receptacle while avoiding picking up further debris around the nozzle. The dust receptacle is carefully removed and weighed (WT_{Final}).

The debris removal ability (K_d), in per cent, is calculated in accordance with the following formula:

$$K_{di} = \left(\frac{WT_{\text{Final}} - WT_{\text{Initial}}}{D_T} \right) \times 100\%$$

A number of separate **trials** shall be run to determine the cleaning effectiveness. The mean cleaning effectiveness is calculated as

$$\bar{K}_d = \frac{K_{d1} + K_{d2} + \dots + K_{di}}{i}$$

Where:

i is the number of **trials** ($i \geq 3$);

K_d is the debris removal ability.

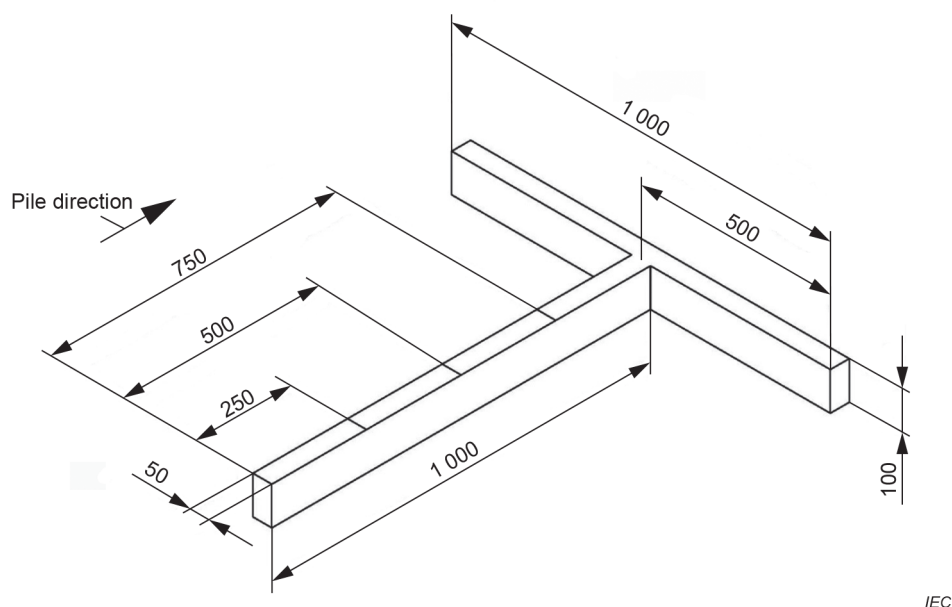
The number of **trials** used and the direction of the beginning **stroke** (forward or backward) shall be recorded in the test report.

5.6 Dust removal along walls

5.6.1 Test equipment and materials

A right-angled T in accordance with Figure 1, formed by two pieces of wood or other suitable material, shall be used for this **test**. It shall be sufficiently heavy to remain in position during the **tests** or be kept in position using clamps or weights.

Dimensions in millimetres



Tolerances

Width and height dimensions: ± 5 mm

Scale dimensions: ± 1 mm

Figure 1 – Right-angled T

For **tests** on carpets, a Wilton test carpet in accordance with IEC TS 62885-1:2020, 4.1 shall be used. For **tests** on hard flat floors, a floor test plate in accordance with 7.3.1 shall be used.

5.6.2 Distribution of test dust

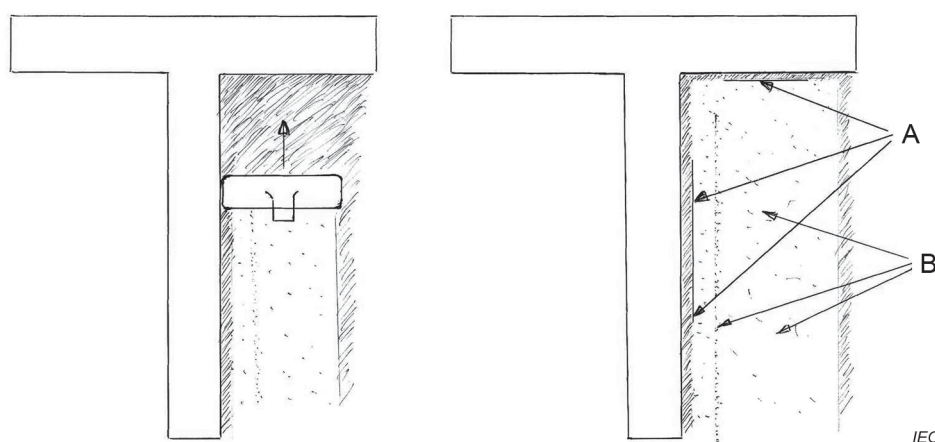
Mineral dust – Type 1, in accordance with IEC TS 62885-1:2020, 5.2.1 shall be distributed over an area of the test surface corresponding to the extremities of the T to ensure good visible coverage.

5.6.3 Determination of dust removal ability along walls

The T is placed over the dust-covered area of the test surface and, if necessary, secured by clamps or weights. When placed on a test carpet, the leg of the T shall be located parallel with the direction of the carpet pile (see Figure 1).

One **double stroke** is carried out at a speed of $(0,25 \pm 0,05)$ m/s with the **cleaning head** guided along both sides of the leg of the T, pausing for 2 s to 3 s at the end of the **forward stroke** to define the limit of the front edge cleaning.

The width of the visible uncleaned area is measured at three equally spaced points along the leg and along the crossbar of the T to establish, to the nearest millimetre, three mean values representing the dust removal ability along both sides and in the front of the **cleaning head**, all values being reported. See Figure 2 for guidance.



Shows **cleaning head** being moved forward through applied dust until the cross of the "T" is reached.

After **cleaning head** is removed, measurements are made where the dust is most undisturbed (**A**). Random remaining dust particles, or possibly where a belt guard is situated, are ignored (**B**).

Figure 2 – Determination of cleaning area

5.7 Fibre removal from carpets

5.7.1 General

The **dry vacuum cleaner** shall be equipped with the **cleaning head** designed for the surface to be cleaned.

5.7.2 Test carpet

A Wilton test carpet, in accordance with IEC TS 62885-1:2020, 4.1 shall be used. Test carpets designated for fibre removal **tests** shall not be used for other **tests**.

Prior to each **trial**, the surface of the test carpet shall be cleaned thoroughly until the carpet surface is visually free of remaining fibres.

5.7.3 Distribution of fibres

For the distribution of fibres, a stencil, in accordance with Figure 3, shall be used. The stencil shall be 3 mm in thickness, have 95 holes of 30 mm in diameter, and be free from burrs. The stencil shall be placed on the test carpet with its 1 000-mm long sides parallel to the warp.

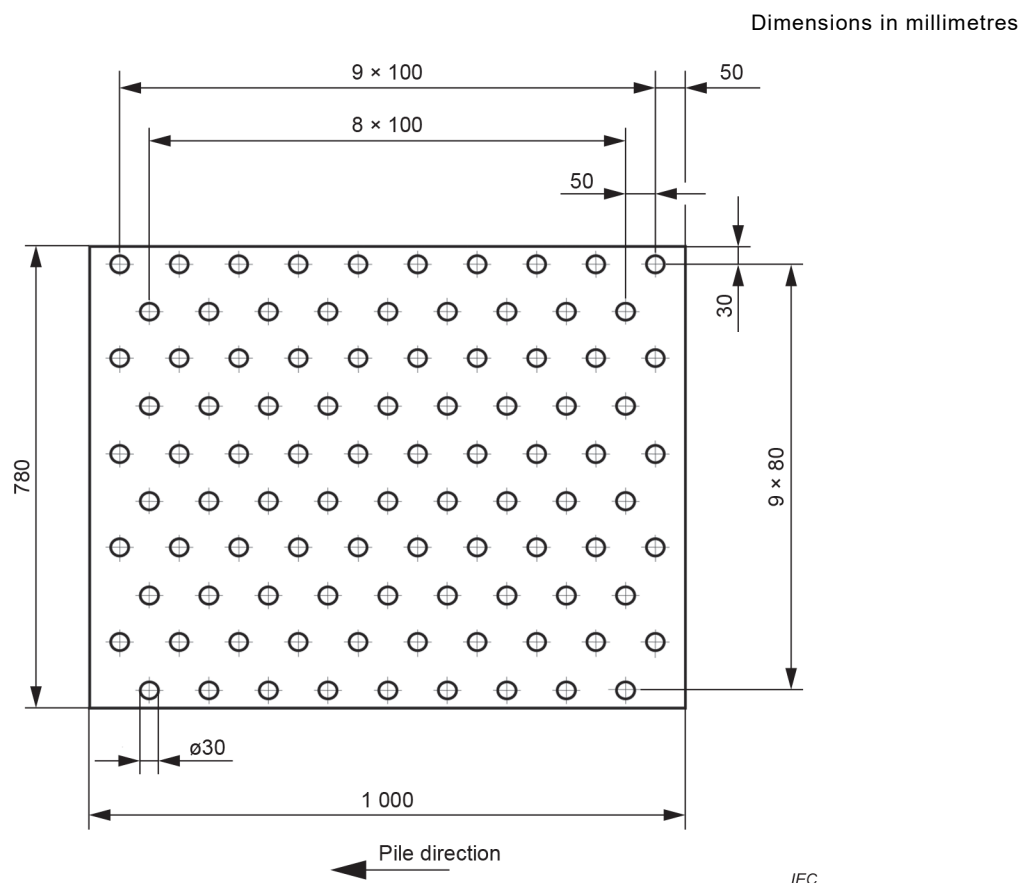


Figure 3 – Stencil for distribution of fibres on test carpets

(150 ± 5) mg of fibre material, in accordance with 7.2.3, shall be plucked by hand into 95 approximately equal portions, which are then pressed lightly by the thumb, without rubbing or twisting, in the centres of the holes of the stencil.

After removing the stencil, the fibres are embedded into the carpet by carrying out five **double strokes** with a roller, in accordance with 7.3.6.2. The direction of the **strokes** shall be at right angles to the warp of the carpet, and the **stroke speed** shall be about 0,5 m/s. If the roller is less than 1 m in length, the rolling schedule is repeated until the entire test area has been covered.

5.7.4 Determination of fibre removal ability from carpets

Prior to each **trial**, fibres sticking to the **cleaning head** shall be removed.

The **cleaning head** is passed once over the fibre-covered area in a zigzag pattern as shown in Figure 4 with the **forward strokes** at right angles to the warp. If **cleaning head width** is not an exact multiple of the test area width, make sure the final **stroke** ensures that the test area has been completely covered. The final stop position is shown in Figure 4.

The number of **double strokes** (N_{STR}) required for full geometrical coverage of the test area is calculated as follows:

$$N_{STR} = \frac{W_T}{B}$$

Where:

N_{STR} is the number of **double strokes**, rounded up to the next integer.

W_T is the test width (1 m).

B is the **cleaning head width**, in m.

Remaining fibres may then be removed by carrying out **strokes** in the direction of the pile not following a specific pattern. The **stroke speed** shall be $(0,5 \pm 0,05)$ m/s and care shall be taken that the **cleaning head** is in full contact with the test carpet during the cleaning.

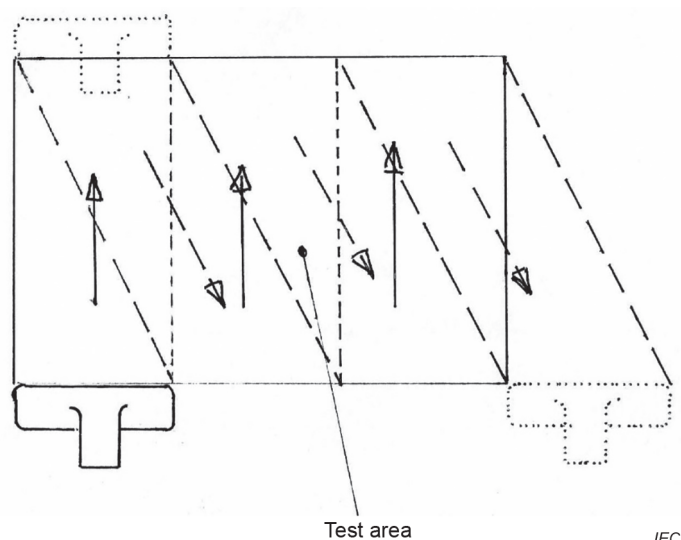


Figure 4 – Zigzag stroke pattern

The cleaning time for fibre removal is the time needed for full geometric coverage of the test area plus the time needed for removal of the remaining fibres.

The time for full geometric coverage, t_c , in seconds, is calculated as follows:

$$t_c = N_{STR} \times \frac{L + \sqrt{B^2 + L^2}}{v_s}$$

Where:

L is the length, equal to the **active depth of the cleaning head** (m) + 0,78 m;

B is the **cleaning head width**, in m;

v_s is the **stroke speed**, in m/s.

The time to remove all fibres (judged visually by the operator from a standing position) shall be recorded. If the cleaning time exceeds 180 s, the cleaning is discontinued.

Three separate **trials** shall be carried out to establish a mean value of the fibre removal ability. The time to remove fibres sticking to the **cleaning head** shall not be taken into account.

5.8 Fibre removal from upholstery

5.8.1 General

The **dry vacuum cleaner** shall be equipped with the **cleaning head** designed for the surface to be cleaned.

5.8.2 Test cushion

A test cushion, in accordance with 7.2.6, shall be used. Prior to each **trial**, the surface of the test cushion shall be cleaned thoroughly until the cushion surface is visually free of remaining fibres.

The test cushion shall be placed in a wooden frame, in accordance with Figure 5, to give a working height of approximately 480 mm above the floor. The frame shall be provided with an adjustable stop strip, which shall rest on the test cushion and be immovable during the **trials**.

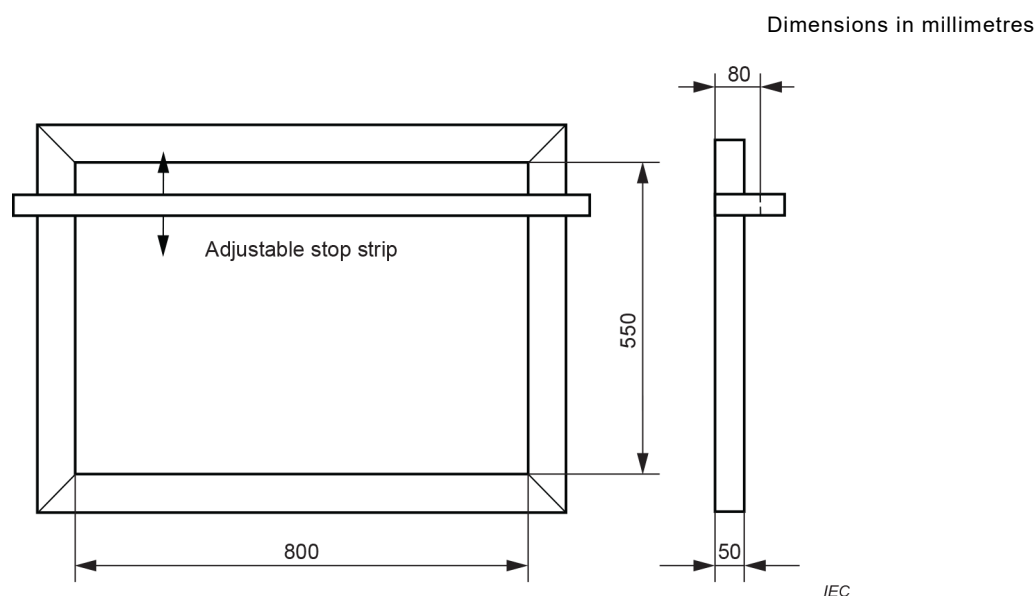


Figure 5 – Frame for test cushion

5.8.3 Distribution of fibres

For the distribution of fibres, a stencil, in accordance with Figure 6, shall be used. The stencil shall be 2 mm in thickness, have 23 holes of 30 mm diameter, and be free from burrs.

Dimensions millimetres

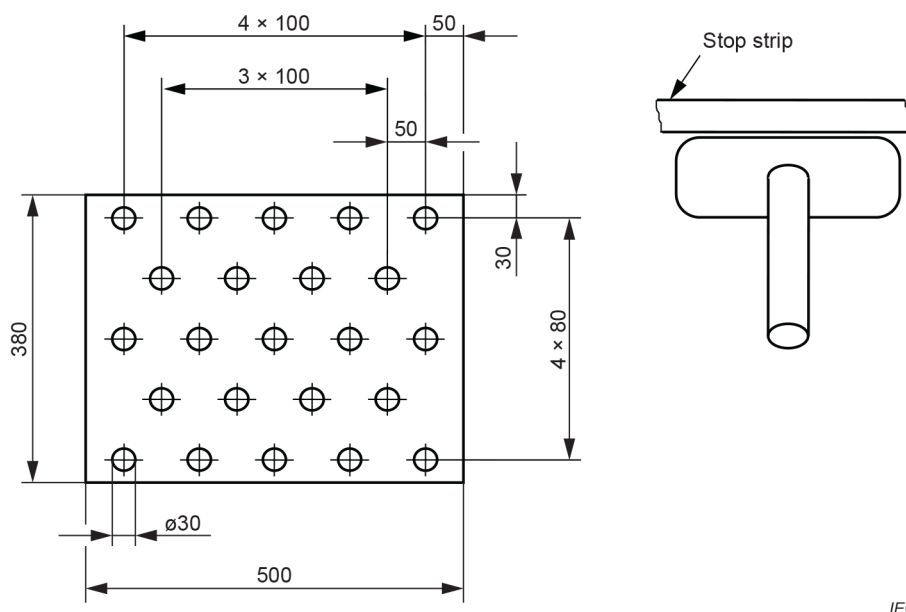


Figure 6 – Stencil for distribution of fibres on upholstery

The stencil shall be placed on the test cushion with its 500-mm long sides parallel to the 800-mm long sides of the cushion in such a way that the distance between the stop strip and the centre line of the nearest row of holes is equal to the **active depth of the cleaning head**.

(45 ± 1) mg of fibre material, in accordance with 7.2.3, shall be plucked by hand into 23 approximately equal portions, which are then pressed lightly by the thumb, without rubbing or twisting, in the centres of the holes of the stencil.

5.8.4 Determination of fibre removal ability from upholstery

Prior to each **trial**, fibres sticking to the **cleaning head** shall be removed.

After removing the stencil, the **cleaning head** is passed once over the fibre-covered area in a zigzag pattern as shown in Figure 4 with the **forward strokes** at right angles to the stop strip. Remaining fibres may then be removed by carrying out **strokes** parallel to the stop strip not following a specific pattern. Fibres that have been pushed against the stop strip may be removed by **strokes** along the strip. The **stroke speed** shall be (0,5 ± 0,05) m/s and the **cleaning head** shall be in full contact with the test cushion during the cleaning. The final stop position is shown in Figure 4.

The number of **double strokes** (N_{STR}) required for full geometrical coverage of the test area is calculated as shown below:

$$N_{STR} = W_T / B$$

Where:

N_{STR} is the number of **double strokes**, rounded up to the next integer;

W_T is the test width (0,5 m);

B is the **cleaning head width**, in m.

The cleaning time for fibre removal is the time needed for full geometric coverage of the test area plus the time needed for removal of the remaining fibres.

The time for full geometric coverage, t_c , in s, is calculated as follows:

$$t_c = N_{STR} \times \frac{L + \sqrt{B^2 + L^2}}{v_s}$$

Where:

L is the length, equal to the **active depth of the cleaning head** (m) + 0,38 m;

B is the **cleaning head width**, in m;

v_s is the **stroke speed**, in m/s.

The time to remove all fibres (judged visually by the operator from a standing position) shall be recorded. If the cleaning time exceeds 300 s, the cleaning is discontinued.

Three separate **trials** shall be carried out to establish a mean value of the fibre removal ability. The time to remove fibres sticking to the **cleaning head** shall not be taken into account.

5.9 Thread removal from carpets

5.9.1 Test carpet

A Wilton test carpet in accordance with IEC TS 62885-1:2020, 4.1 shall be used.

5.9.2 Distribution of threads

Forty pieces of thread, that comply with 7.2.4, shall be arranged on the test carpet in four rows parallel with the pile direction according to the pattern shown in Figure 7. Each row shall have a length of 0,7 m and the distance between rows is adapted to the **cleaning head width**.

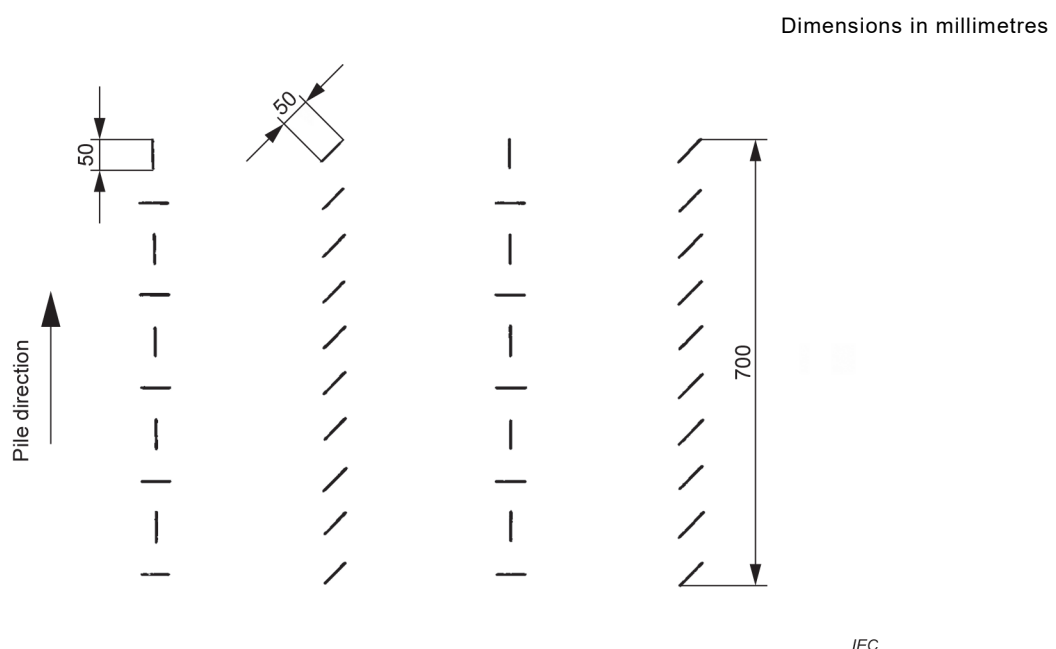


Figure 7 – Arrangement of threads in the thread removal test

The threads are embedded into the carpet by carrying out five **double strokes** with a roller, that complies with 7.3.6.2, over each row and at a **stroke speed** of $(0,50 \pm 0,05)$ m/s.

5.9.3 Determination of thread removal ability

The **cleaning head** shall be adjusted for carpet cleaning and, if applicable, utilize such special arrangements that are provided to assist thread removal.

Prior to each **trial**, threads sticking to the **cleaning head** shall be removed.

During a **trial**, each row of threads is cleaned with one **double stroke** at a **stroke speed** of $(0,50 \pm 0,05)$ m/s, unless the **cleaning head** is a **self-propelled cleaning head**, the **stroke length** being in accordance with 5.1.2 (see Figure 8). The ratio of the number of threads removed from the carpet to the number of distributed threads is calculated and recorded.

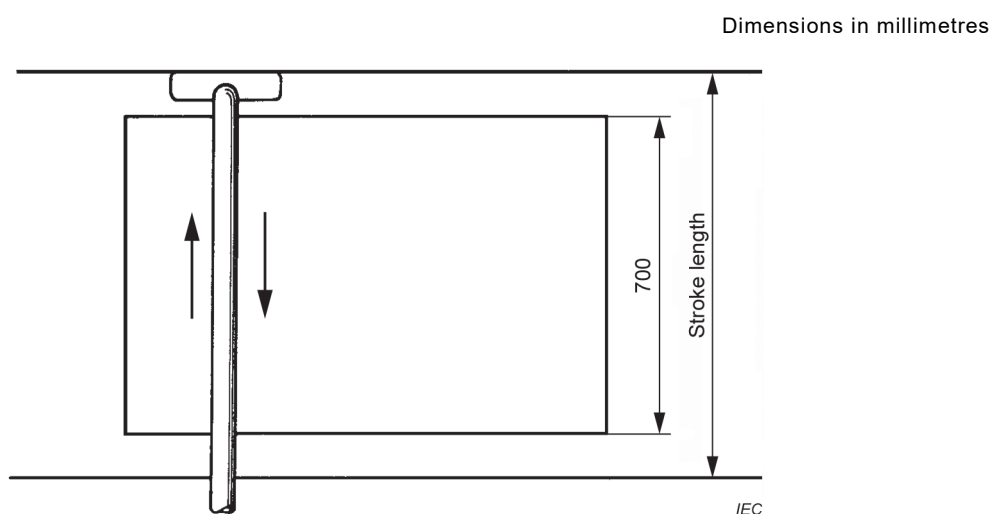


Figure 8 – Stroke length in tests

Three separate **trials** shall be carried out to establish a mean value of the thread removal ability, in per cent.

Threads sticking to the **cleaning head** are considered to be removed from the carpet. A suitable observation should be made in the test report.

5.10 Maximum usable volume of the dust receptacle

5.10.1 General

The purpose of this **test** is to determine the maximum useable, i.e., geometrical volume of a dust receptacle. This **test** is not intended to include any clogging effects.

5.10.2 Conditions for test

The **dry vacuum cleaner** shall be equipped with a clean dust receptacle (see 4.5) and placed in its normal position of operation. **Upright vacuum cleaners** shall be tested in their vertical position. If a paper bag and similar material as fleece is used, 10 mg of fine powdered chalk per cm² of the bag filter area shall be introduced slowly into the **dry vacuum cleaner** to inflate the bag completely.

NOTE 1 An alternative to chalk powder is under consideration.

Some bag materials such as fleece can require larger quantities of chalk dust. It is permissible to use alternative methods of inflation in this case if they do not artificially inflate

the bag more than would be the case with normal use. For example, a balloon of appropriate size may be used to inflate the bag. For this, the balloon is inserted through the air inlet of the vacuum cleaner and blown up by means of compressed air until the filter bag is inflated completely.

Cylinder vacuum cleaners and **handheld vacuum cleaners** with the dust receptacle fill line oriented at an angle in the normal position of operation shall be rotated such that the fill line is orientated in a horizontal position prior to introducing the moulding granules. The vacuum cleaner shall remain in this orientation during the **test**.

Moulding granules, that comply with 7.2.5, shall be used for the **test**.

The granules may be reused provided they are relieved of excessive chalk and have not been damaged.

NOTE 2 Standard atmospheric conditions in accordance with 4.1 are not required.

5.10.3 Introduction of moulding granules

The moulding granules are introduced into the **dry vacuum cleaner** at a rate of 1 l/min to a visible maximum level mark, if present, or until the **dry vacuum cleaner** will not accept any more.

For **water filter vacuum cleaners**, the visible maximum level mark shall be checked with the vacuum cleaner off.

For **upright vacuum cleaners** without provision for optional use of a hose, the granules shall be fed through a nozzle adaptor. For other **dry vacuum cleaners**, the granules shall be fed through the hose provided.

If the manufacturer's instructions are unclear, the manufacturer shall be contacted to determine when the dust receptacle is considered to be full. If this is not possible, granules shall be fed into the product until the bottom of the maximum level mark is reached.

5.10.4 Determination of maximum usable volume of dust receptacle

Measure the mass of 1 l of granules 10 times to determine its density prior to feeding into the **dry vacuum cleaner**. Weigh the dust receptacle before feeding and then again after feeding. The difference divided by the density determines the volume. Do not tap or shake the measurement vessel while determining the density of the pellets.

Three **trials** shall be carried out to establish a mean value, which represents the maximum usable volume of the dust receptacle being tested.

For **water filter vacuum cleaners**, the water loss during the feeding time shall be taken into consideration. The ON duration during the feeding time shall be measured and multiplied with the water loss measured in accordance with 4.6.2.1. This lost mass shall be added to the calculated usable volume.

For **water filter vacuum cleaners**, consideration shall be given to the fact that the density of the moulding granules could change due to contact with water.

5.11 Air data

5.11.1 Purpose

The purpose of the determination of air data is to compare the specified parameters between **dry vacuum cleaners** and to determine certain parameter values for other **tests**. The

following parameters, referred to as standard air density, $\rho = 1,20 \text{ kg/m}^3$ (at 20 °C, 101,3 kPa and 50 % relative humidity), are considered:

q is the air flow, in litres per second (l/s).

h is the vacuum, in kPa.

P_1 is the input power, in W.

P_2 is the suction power, in W.

η is the efficiency, in percent.

NOTE Standard atmospheric conditions in accordance with 4.1 are not required.

Measured air data should be corrected to standard air density (see 7.3.7.5).

5.11.2 Conditions for test

Dry vacuum cleaners shall be connected to the measuring chamber as described in 5.11.4. Air data may be measured at the end of the **tube** and/or at the base of the nozzle. When connected at the end of the **tube**, the hose shall be fully collapsed and if the connecting **tube** is telescopic, it shall be fully extended. Whichever location(s) is measured shall be reported.

The **dry vacuum cleaner** shall be prepared and operated as stated in 4.3 to 4.7.

5.11.3 Test equipment

Either of the alternative test equipment described in 7.3.7 may be used. For both alternatives, a plenum chamber of $(500 \times 500 \times 500) \text{ mm}^3$ or $(460 \times 460 \times 250) \text{ mm}^3$ shall be used.

If the air flow is greater than 40 l/s, the use of the larger plenum chamber is recommended for both alternative A and alternative B.

NOTE A plenum chamber in accordance with ASTM F431 is acceptable for conducting both alternative tests.

5.11.4 Mounting dry vacuum cleaner to test chamber for air data test

For end of hose/**tube** air performance – **Dry vacuum cleaners**, which in normal operation are equipped with hose and/or connecting **tube**, and **upright vacuum cleaners** with the option to be operated with a hose connection are connected to the measuring chamber at the end of the **tube** with the hose fully collapsed (minimum length).

For nozzle air performance – For **dry vacuum cleaners** equipped with a nozzle and **upright vacuum cleaners**, the nozzle is adapted to the measuring chamber by any convenient means to provide an airtight seal between the nozzle base and the measuring chamber. The largest cross-sectional area possible shall be maintained throughout the adaptor interface. This will prevent impeding the air flow between the plenum chamber and the test vacuum cleaner nozzle.

If the vacuum cleaner nozzle incorporates slots along the side edges or along the front and rear edge of the bottom plate for the purpose of cleaning, these slots shall be sealed by any convenient means such as clay, tape, foam, and the like. Leaks resulting from testing the **dry vacuum cleaner's** construction, except at the adaptor/nozzle interface as described in the previous paragraph, shall not be sealed.

For **dry vacuum cleaners** with an optional motorized nozzle rotating brush and for **upright vacuum cleaners** with the option to de-energize the nozzle rotating brush, the nozzle rotating brush shall be energized during the **test**.

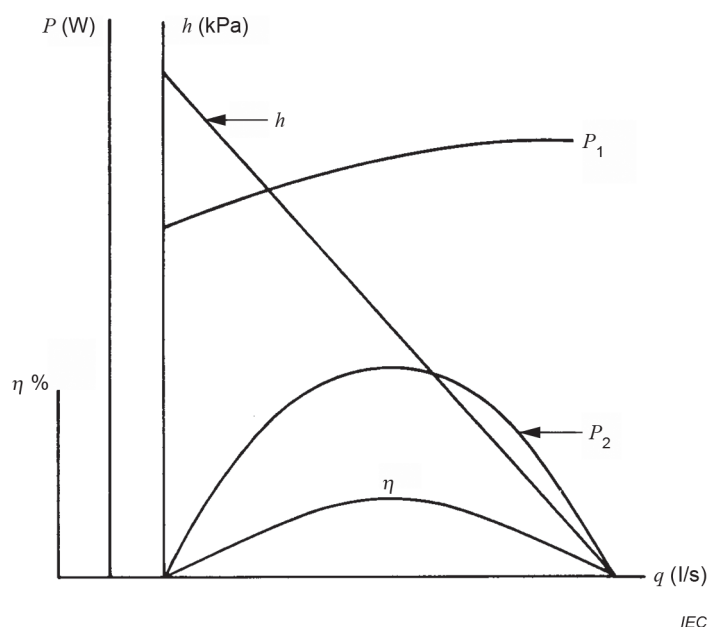
5.11.5 Determination of air data

Air flow, vacuum and input power are determined for a number of throttlings sufficient for plotting curves of vacuum and input power against the air flow (see Figure 9).

Prior to the sequence of measurements, the **dry vacuum cleaner** shall be operated unthrottled in accordance with 4.7 to establish a reference value of the exhaust air temperature for further measuring points.

For each measuring point, the air flow, vacuum, and input power are recorded 30 s after the throttling. The cleaner is then again operated unthrottled to attain the reference conditions, which is checked by measuring the exhaust air temperature. This procedure is continued until all the entire curves have been plotted, the measuring point for maximum vacuum being the last one.

For each measuring point, the suction power P_2 is obtained as the product of the air flow q and the vacuum h . The efficiency η is calculated as the ratio of corresponding values of the suction power and input power. Curves of suction power and of efficiency are also plotted against the air flow (see Figure 9).



Key

- h vacuum in the measuring box, in kilopascals
- q air flow, in litres per second (l/s)
- P_1 input power, in watts
- P_2 suction power, in watts
- η air data efficiency, in per cent

Figure 9 – Air data curves

The maximum value of the suction power $P_{2\max}$ and the theoretical maximum value of the air flow $q_{\max}$ shall be estimated according to the procedure given in 7.3.7.6.

5.12 Performance with loaded dust receptacle

5.12.1 Purpose

NOTE This method is used to determine the effects, if any, of dust loading during a single filling of the receptacle. It is not a long-term sustained performance **test**, which is being developed separately for a future edition, and is not intended to represent a specific point of filling of the receptacle. The dust receptacle is considered loaded if any of the three conditions referenced in 5.12.2.3 is reached. The point reached will be somewhere between empty and full and performance **tests** undertaken at this point will give an indication as to how well the **dry vacuum cleaner** can perform as the receptacle fills and/or the filters fill with dust.

The purpose of this procedure is to provide the means to measure the performance of a **dry vacuum cleaner** with a loaded dust receptacle. The test **dry vacuum cleaner** shall be evaluated in both the unloaded and simulated loaded condition using applicable subclauses.

The **test** is not intended to measure the capacity of the receptacle or the filter.

5.12.2 Determination of suction pressure change with loaded dust receptacle

5.12.2.1 Test conditions

The **dry vacuum cleaner** shall be operated under the same conditions as for the determination of performance characteristics. The change of the suction pressure in the adaptor when vacuuming specified test material shall be measured.

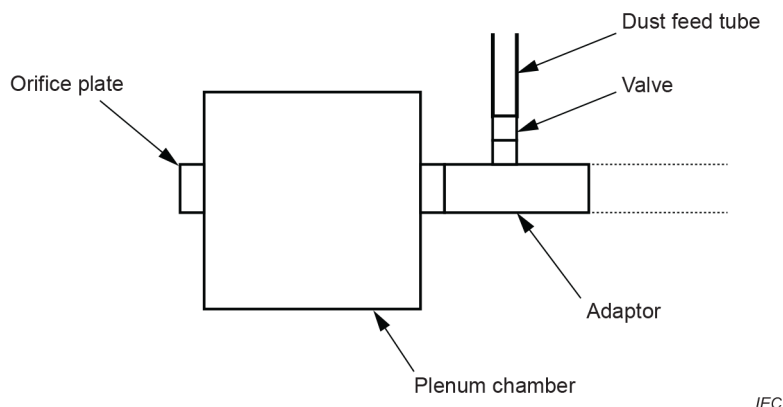
- For this purpose, the hose, for **cylinder vacuum cleaners** and **upright vacuum cleaners** with hose, is connected to the plenum chamber, as described in 5.11.3, via an adaptor, as shown in Figure 10. The adaptor, which shall not alter the original air flow of the **dry vacuum cleaner** by being restrictive or by creating turbulence, has an opening for a feed **tube** for test dust with a diameter of (19 ± 2) mm at a distance of at least 150 mm from the pressure tapping. This opening shall be capable of being sealed closed during the measurements of suction.

It is permissible to use the pressure tapping on the plenum chamber to measure pressure.

The openings in the adaptor shall not impair the air flow.

The feed **tube** shall be connected to a flexible **tube** and a probe with which the test material is picked up evenly as described in 5.12.2.3. The feed setup shall not impair the properties of the test material in accordance with IEC TS 62885-1:2020, 5.1.2.

- The plenum chamber shall be fitted with a 23-mm orifice plate.



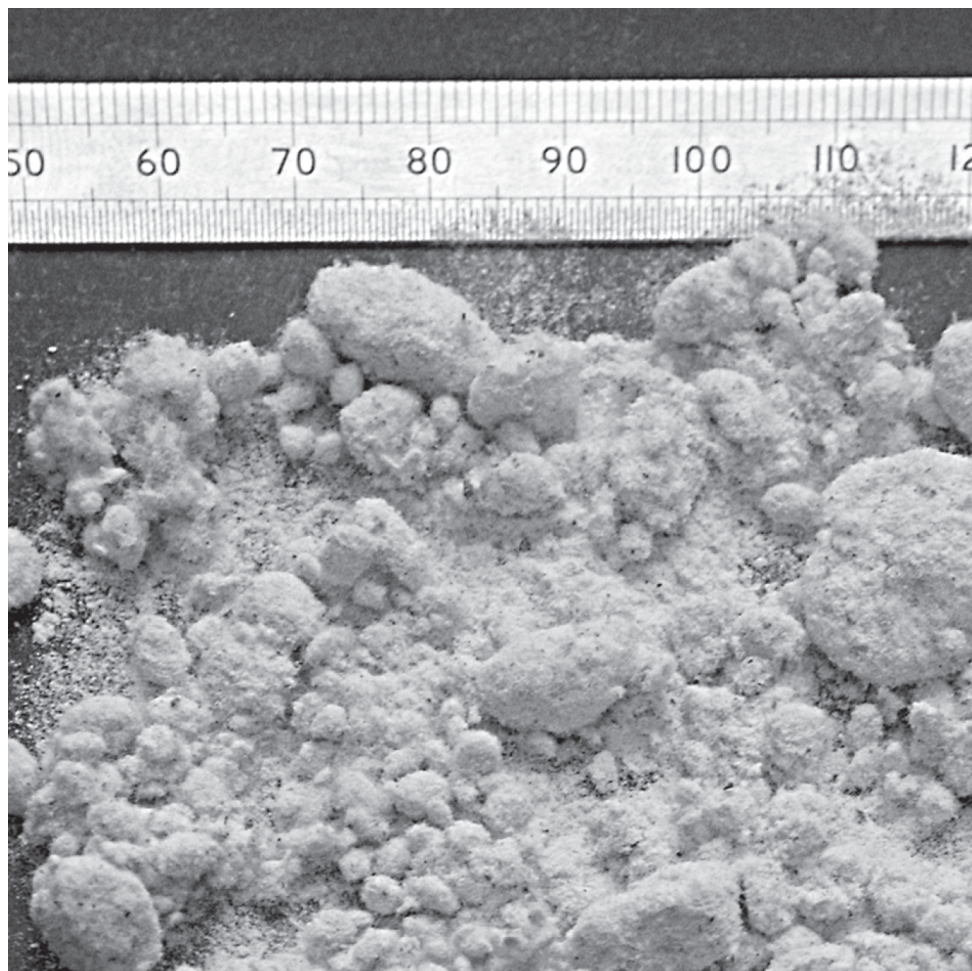
IEC

Figure 10 – Connecting tube opening

For an **upright vacuum cleaner** where it is not possible to fit a hose, it is permissible to mount the **upright vacuum cleaner** on to the plenum chamber as shown in Figure 26. The pressure may be measured using the pressure tapping on the plenum chamber. A suitable position in the ducting from the nozzle to the dirt receptacle shall be found to fit a dust feed **tube** as described for the adaptor above. In this case, the mounting method shall be reported.

5.12.2.2 Test dust

Test dust, see Figure 11, in accordance with IEC TS 62885-1:2020, 5.1.2 shall be used for loading the dust receptacle.



IEC

Figure 11 – Test dust for loading dust receptacle

5.12.2.3 Procedure

The **dry vacuum cleaner** shall be prepared in accordance with 5.12.2.1.

With the feed **tube** closed, the **dry vacuum cleaner** is run for at least 10 min. Subsequently, the initial vacuum, h_0 , shall be determined.

For dust receptacles with a maximum useable volume greater than or equal to 1 l, the test material shall be fed in 50 g batches, which are representative of the overall mixture over a time period of 60 s each (50 g/min). If the quantity is not evenly divisible by 50, the final load shall consist of the remainder of the test dust and the time of the last feeding shall be adjusted to maintain the standard feed rate of 50 g/min.

For dust receptacles with a volume of less than 1 l, the batch size is reduced to 10 g batches in order to provide sufficient data points and shall be fed over a time period of 12 s each (50 g/min). If the quantity of test dust is not evenly divisible by 10, the final load shall consist of the remainder of the test dust and the time of the last feeding shall be adjusted to maintain the standard feed rate of 50 g/min. For **dry vacuum cleaners** with automatic filter cleaning or

dust compressor functions, the cleaner shall be operated in accordance with the manufacturer's instructions after each batch of dust.

If the maximum air flow of the **dry vacuum cleaner** is less than 15 l/s, then the feeding rate is reduced to 25 g/min.

After each batch, the feed **tube** shall be closed. The pressure measurement, h , shall be recorded 30 s after the feed **tube** has been closed. Then, the feed **tube** is reopened, and the feeding of the next batch continued.

The injection of test dust is terminated when one of the following conditions is first reached:

- Condition 1: An indicator on the **dry vacuum cleaner** signals that the dust receptacle should be emptied or replaced. Where a product has a full bin indicator on the front of its bin, the full bin indication as described in the manufacturer's instructions shall determine the stopping point.
- Condition 2: The observed value of the vacuum h_f has dropped to $40^{+0.5}_{-0}$ % of h_0 .
- Condition 3: The amount of injected test dust has reached a total of 100 g/l of the maximum usable volume of the dust receptacle (see 5.10).

The values for h_0 , h_f in relation to the total amount of test material taken up and the condition for termination shall be recorded.

NOTE If $h_f < 40$ % of h_0 , the restriction will be created to provide a suction value equal to 40 % of the initial reading.

5.12.3 Throttling to simulate loaded dust receptacle

The **dry vacuum cleaner** shall be equipped with a clean dust receptacle and filters in accordance with 4.5.

It shall be operated in accordance with 5.12.2.1 with the feed **tube** closed.

The volume flow of the **dry vacuum cleaner** whilst connected to the plenum chamber shall be suitably throttled until the value h_f from 5.12.2.3 is obtained.

The throttling is undertaken by inserting a suitable device between dust receptacle and motor/fan chamber. However, it is essential that the throttling shall not alter the characteristics of the effects of loading with the dust and shall not restrict the manner in which the dirt is transported from the surface being cleaned to the receptacle. If it is not possible to insert a device between the motor/fan chamber and the dust receptacle, such as in a dirty-air (fan first) system, other suitable means may be used that do not adversely affect the air flow. Whatever means is used to throttle the **dry vacuum cleaner** shall be fully and accurately described in the report.

NOTE Clamping of the hose to throttle the air flow has been shown to have potentially adverse effects on the transport of dust and create variability in the results. If this method of throttling is used, it may have a negative effect on the results.

5.12.4 Determination of performance with loaded dust receptacle

Any applicable **tests** shall be performed with the throttling described in 5.12.3.

The throttled **dry vacuum cleaner** may be submitted to air data **tests** in order to complement data obtained in the cleaning performance **tests**.

5.13 Total emissions while vacuum cleaning

5.13.1 Purpose

The purpose of this **test** is to determine a measurement of the particulate generated by the vacuuming process. This **test** is applicable to all types of household **dry vacuum cleaners**. The **test** is applicable to dust removal from floor coverings, not the removal of surface litter or debris.

Complete details for this **test** can be found in latest edition of ASTM F2608.

5.13.2 Test conditions

The test room conditions shall be as specified in 4.1.

5.13.3 Test equipment

Equipment required for the **test** is specified in 7.3.14.

5.13.4 Test carpet

A test carpet in accordance with IEC TS 62885-1:2020, 4.1 shall be used; the type of carpet selected shall be recorded. It shall have been prepared in accordance with IEC TS 62885-1:2020, 4.3. Owing to the significant influence of humidity on this **test**, the carpet shall be left in the test environment at standard atmospheric conditions for at least 16 h before the **test** is due to commence.

During the tests, the carpet is kept in position on the test floor with carpet hold-downs (see 7.3.4). The carpet shall be fixed on the test floor at the end where the **forward stroke** starts.

NOTE A force of 60 N can be applied at the other end of the test carpet to define the tension on the carpet during testing.

5.13.5 Test chamber setup and conditioning

All components shall be conditioned in a controlled environment for at least 16 h prior to testing.

Using any suitable method, all surfaces of the test chamber shall be cleaned to remove all residual dust. Equipment should then be cleaned with a tack cloth or damp rag to remove any dust.

5.13.6 Test sample and material setup

With the carpet secured to the supporting surface, the particle sampling system is located $1\,500\text{ mm} \pm 24\text{ mm}$ above the carpet, at the carpet centre line, facing up.

The test carpet is marked with a baseline area. The length of the area is 1,016 m. The width of the area is the **cleaning head width** (B) plus an additional 0,076 m per side.

Test dust in accordance with 7.2.2 is used. The amount of test dust, m , in g, required for the **test** is calculated for the overall test area based upon a concentration of $38,75\text{ g/m}^2$ as follows:

$$m(\text{g}) = (B + 0,152\text{ m}) \times 1,106\text{ m} \times 38,75\text{ g/m}^2$$

The test dust is spread uniformly over the test area using any convenient spreading means.

The dust is embedded by dragging the "locked" embedding tool over the test area in 15 **double strokes**. The embedding tool is moved at $0,5^{+0,05}_{-0}$ m/s. The first **stroke** should be in the direction of the carpet pile. Clean the embedding tool as needed.

5.13.7 Positioning the test unit

Upright vacuum cleaners are positioned on the test carpet 100 mm to 150 mm in front of the test area. The handle height is set to (800 ± 50) mm. The conveyor is set to also include 100 mm to 150 mm after the test area.

Cylinder vacuum cleaners are positioned to either side of the test carpet at the same height as the test carpet, with the main axis perpendicular to the test carpet to ensure that exhaust air does not blow across the embedded surface. The nozzle is positioned on the test carpet 100 mm to 150 mm in front of the test area. The handle height is set to (800 ± 50) mm. The conveyor is set to also include 100 mm to 150 mm after the test area. For nozzles without pivoting connectors, the bottom of the **cleaning head** shall be made parallel with the test surface by adjusting the handle height within the tolerances.

5.13.8 Test procedure

Once the test unit is in place, the test room is exited, and the particle counter is initiated (same for the photometer if also being used). The instruments are set to take continuous readings for the duration of the **test**.

The test room purge/room air purifier is energized until the baseline particulate level is under 35 300 particles/m³ in the 0,3 µm to 0,5 µm range and count variation is under 10 % for five minutes in the 0,3 µm to 0,5 µm range. For the photometer, the µg/m³ baseline shall be less than 1 µg/m³ with a variation of less than 10 % of the mean.

When the room is stabilized, the room purge/room air purifier and room-conditioning equipment is de-energized for the duration of the **test**.

The test unit is energized, and the particle counts (and concentration from photometer) are monitored for ten minutes. The nozzle shall not be in contact with the surface during this time.

The nozzle is lowered to be in contact with the surface and then the conveyor is energized to allow back and forth vacuuming at $0,5^{+0,05}_{-0}$ m/s. Continue to monitor particle counts for an additional 10 min.

At the end of the **trial** the conveyor is de-energized with the **dry vacuum cleaner** in its original position, and then the **dry vacuum cleaner** is de-energized.

Particulate counts are monitored for an additional 5 min after de-energizing the **dry vacuum cleaner**.

Prior to entering the test room, the test room purge/room air purifier shall be energized to remove the remaining contaminants.

5.13.9 Reporting

5.13.9.1 Report all particle count and/or particle concentration data (count at each size or µg/m³).

5.13.9.2 Report maximum particle count at 0,3 µm and greater and, if measured, maximum particle concentration in µg/m³. Maximum particle count data are converted to Log₁₀ data for evaluating results.

5.14 Dust re-emission and fractional filtration efficiency of the dry vacuum cleaner

5.14.1 General

The aim of this **test** is to determine the ability of a vacuum cleaner to retain dust, depending on particle size, from the intake aerosol containing a predefined concentration of test dust.

This **test** is not suitable for determining permeability of filters or filter materials.

Additionally, the equipment described in ASTM F1977 is also suitable for use in conducting this **test** and should be used in accordance with the description contained in that test method for feeding dust or equivalent particles.

5.14.2 Test conditions

NOTE A relative humidity of 45 % RH to 55 % RH is recommended for control of static.

Measuring equipment required for the **test** is specified in 7.3.8.

In preparation of the **test**, the vacuum cleaner should be equipped with a new or thoroughly cleaned dust receptacle and new filters according to the specifications. The vacuum cleaner shall be set to operate at maximum airflow.

The vacuum cleaner is placed centrally under the test hood in its normal operation condition.

Dust will be fed:

- to **dry vacuum cleaners** with a suction hose, through this hose,
- to **dry vacuum cleaners** without a suction hose through a suitable auxiliary hose which is connected and sealed tightly to the suction nozzle by use of a nozzle adaptor.

For **water filter vacuum cleaner** distilled water shall be used for measuring the filtration efficiency. The amount of water shall be taken from the manufacturer's instructions. In order not to measure water droplets, a diffusion dryer shall be added to the inlet of the particle counter.

5.14.3 Determining the test dust quantity

For the entire duration of dust, according to 7.2.2 being fed, the dust concentration c shall be 0,1 g/m³ in the intake aerosol channel. Therefore, the maximum airflow q for the vacuum cleaner with the given filter equipment shall be determined.

The quantity m of dust to be fed for duration t_{DUST} (s) is calculated consequently as

$$m = c \times t_{\text{DUST}} \times q$$

5.14.4 Dust re-emission for the entire range of particle size

5.14.4.1 Particle neutralization

Electrically neutral particles shall be used for accurate filtration efficiency testing. This can be accomplished through one or more of the following three methods:

- Neutralizing the challenge – The challenge particles may be neutralized in any manner that brings the charge to less than 1 000 ions per cm³. Neutralization shall be verified at least once per year, or when any change to the system is made.
- Using conductive sampling lines.

- Grounding the test stand itself.

5.14.4.2 Void

5.14.4.3 Test procedure

5.14.4.3.1 General

A test run can be conducted either by using two particle counters which read intake and exhaust values simultaneously, or by using a single particle counter which is switched for reading intake and exhaust values.

Counting of particles is done by a particle analysing system (see 7.3.8.4), which can be operated with a suitable aerosol dilution system to adapt the count rate capacity and the particle concentration of the aerosol. The intake and exhaust channels are measured alternately. The results of any single **trial** shall be recorded as follows:

- Counter events / class, i.e., the number of events recorded by the particle counter, separately for each range of particle size as well as for aerosol intake channel and exhaust channel.
- Sample air volumes, VA_{ex} (exhaust) and VA_{in} (intake); i.e., the volumes of the aerosol samples analysed by the particle counter combined during the **trial**.
- dilution factors k_{VA} (intake or exhaust) of the particle analysis system, i.e., the ratio between the volume of the air sample extracted from the channel and the sample air volume analysed by the particle counter.

The procedures in 5.14.4.3.2 and 5.14.4.3.3 for a single **trial** may be repeated with several **dry vacuum cleaners** of identical type. Then, the final result of the test run shall be averaged arithmetically.

Proper dilution ratio needs to be verified. Prove that the air is not over-concentrated by serial dilution and prove that it is not over-diluted on the exhaust by lessening the dilution serially; see 7.3.8.4.

5.14.4.3.2 Single particle counter procedure

A single **trial** proceeds as follows:

- the **dry vacuum cleaner** is operated without dust being fed until acceptable and stable conditions are achieved (minimum 10 min, maximum 30 min). This method stability is $\pm 10\%$ for particle counts over 100 for 30 s, or less than 100 particle counts per 30 s over at least 10 min;
- conditioning: dust is fed for 10 min while the particle concentration in the aerosol intake channel is monitored (quantity of test dust according to 5.14.3);
- sampling: feeding of dust is continued for approximately 10 min during which 5 test cycles are carried out, each consisting of:
 - counting of particles from aerosol intake channel for 30 s (intake measurement);
 - flushing of particle analysing system with the applicable sample stream for ≥ 10 s.
 - counting of particles from exhaust channel for 30 s (exhaust measurement);
 - flushing of particle analysing system with the applicable sample stream for ≥ 10 s.

5.14.4.3.3 Dual particle counter procedure

If two particle counters are used, they need to be verified to match in calibration and count rate. Their particle counts shall be within 10 % in each range of particle size for particle counts over 100 for 30 s.

A single **trial** proceeds as follows:

- the **dry vacuum cleaner** is operated without dust being fed until acceptable and stable conditions are achieved (minimum 10 min, maximum 30 min). This method stability is $\pm 10\%$ for particle counts over 100 for 30 s, or less than 100 particle counts per 30 s over at least 10 min.
- conditioning: dust is fed for 10 min while the particle concentration in the aerosol intake channel is monitored (quantity of test dust according to 5.14.3).
- sampling: feeding of dust is continued for 150 s during which 5 test cycles are carried out, each consisting of continuous counting of particles from both the aerosol intake channel (intake measurement) and the exhaust channel (exhaust measurement) for 30 s.

5.14.4.4 Evaluation

5.14.4.4.1 General

Based on the particle counts obtained in the 5 test periods, for aerosol intake channel and exhaust channel, the evaluation can be done either for:

- fractional filtration efficiency (for each class of particle size); or
- dust re-emission for the entire range of particle size (i.e., from 0,3 μm to 10 μm).

Filtration efficiency E for the entire range of particle size is 1 minus the ratio of number of particles exhaust and number of particles intake.

Dust re-emission R for the respective range of particle size is defined as 1 minus E , which is the ratio of number of particles exhaust and number of particles intake.

The basic formulae are:

$$E = 1 - R$$

$$R = 1 - E$$

The detailed determination of E and R for a range of particle size including consideration of the 95 % confidence level is shown in 5.14.4.4.2.

5.14.4.4.2 Evaluation of dust re-emission, logarithmic dust penetration and overall filtration efficiency

The individual measurements represent samples of a full distribution, and a statistical analysis is performed accordingly.

Given the particle counts $z(k, l)_{\text{in}}$ of the aerosol intake channel for particle class k obtained from each individual test period l , the corresponding lower limits (LL) of the 95 % confidence range $(Z_{\text{LL}})(k)_{\text{in}}$ are obtained as follows:

- summation of intake particle counts obtained for the entire range of particle size between 0,3 μm and 10 μm in 5 individual test periods.

$$(Z_{\text{LL}})(k)_{\text{in}} = \sum_{l=1}^5 z(k, l)_{\text{in}}$$

Where:

- k is the index of particle class,
- l is the running index of the individual test period,

$(z)(k,l)_{\text{in}}$ is the intake particle count in class k from the individual test period l ;

- summation of particle counts for 5 test periods.

$$Z_{0,3-10\text{in}} = \sum_{i=1}^5 Z_{0,3-10\text{in}}(l)$$

Where:

l is the running index of the individual test period,

$Z_{0,3-10\text{in}}$ is the intake sum of particles between 0,3 µm and 10 µm,

$Z_{0,3-10\text{in}}(l)$ is the intake sum of particles between 0,3 µm and 10 µm from the individual test period l .

- determination of the 95 % lower – confidence limits $(Z_{LL})_{0,3-10\text{in} 0,95}$ for the particle sums

$Z_{0,3-10\text{in}}$:

$$\text{If } Z_{0,3-10\text{in}} > 50 : (Z_{LL})_{0,3-10\text{in} 0,95} = Z_{0,3-10\text{in}} - 1,96 \times (Z_{0,3-10\text{in}})^{\frac{1}{2}}$$

If $Z_{0,3-10\text{in}} \leq 50 : (Z_{LL})_{0,3-10\text{in} 0,95}$ from Table 1.

Given the particle counts $z(k,l)_{\text{ex}}$ of the exhaust channel for particle class k obtained from each individual test period l , the corresponding upper limits (UL) of the 95 % confidence range, $(Z_{UL})(k,l)_{\text{ex} 0,95}$ are similarly derived by:

- summation of particle counts obtained for the entire range of particle size between 0,3 µm and 10 µm in 5 individual measurements exhaust:

$$Z_{0,3-10\text{ex}}(l) = \sum_{k=k_{0,3}}^{k_{10}} z(k,l)_{\text{ex}}$$

Where:

k is the index of particle class,

l is the running index of the individual test period,

$z(k,l)_{\text{ex}}$ is the particle count exhaust in class k from the individual test period l ,

$Z_{0,3-10\text{ex}}(l)$ is the exhaust sum of particles between 0,3 µm and 10 µm the from individual test period l .

- summation of particle counts for 5 test periods:

$$Z_{0,3-10\text{ex}} = \sum_{i=1}^5 Z_{0,3-10\text{ex}}(l)$$

Where:

l is the running index of the individual test period,

$k_{0,3}$ is the class with the lower limit of 0,3 µm,

k_{10} is the particle class with the upper limit of 10 µm,

$Z(k)_{\text{ex}}$ is the particle sum exhaust in class k from all 5 test periods,

$Z_{0,3-10\text{ex}}$ is the exhaust sum of particles between 0,3 µm and 10 µm.

- determination of corresponding upper limits of the 95 % confidence range $(Z_{UL})_{0,3-10_{ex},95}$ from particle sums $Z_{0,3-10_{ex}}$:

$$\text{If } Z_{0,3-10_{ex}} > 50 : (Z_{UL})_{0,3-10_{ex},95} = Z_{0,3-10_{ex}} - 1,96 \times (Z_{0,3-10_{ex}})^{\frac{1}{2}}$$

$$\text{If } Z_{0,3-10_{ex}} \leq 50 : (Z_{UL})_{0,3-10_{ex},95} \text{ from Table 1.}$$

From the statistical limits calculated above, the lower limit of the 95 % confidence range of the filtration efficiency $(E_{LL})_{0,3-10,95}$ is obtained:

$$(E_{LL})_{0,3-100,95} = \left(\frac{(V_{UL})_{0,3-10_{ex},95} \times k_{VA_{ex}} \times \left(\frac{VA_{in}}{VA_{ex}} \right)}{(Z_{LL})_{0,3-10_{in},95} \times k_{VA_{in}}} \right)$$

$$(R_{UL})_{0,3-100,95} = 1 - (R_{LL})_{0,3-100,95}$$

Where:

$(E_{LL})_{0,3-10,95}$	is the lower limit of confidence for filtration efficiency of particles between 0,3 µm and 10 µm;
$(R_{UL})_{0,3-10,95}$	is the upper limit of confidence for dust re-emission of particles between 0,3 µm and 10 µm;
$k_{VA_{ex}}$	is the exhaust dilution factor of particle analysis system;
$k_{VA_{in}}$	is the intake dilution factor of particle analysis system;
VA_{ex}	is the exhaust sample air volume analysed;
VA_{in}	is the intake sample air volume analysed;
$(Z_{UL})_{0,3-10_{ex},95}$	is the upper limit of confidence for particle sum of particles between 0,3 µm and 10 µm from exhaust measurements.
$(Z_{LL})_{0,3-10_{in},95}$	is the lower limit of confidence for particle sum of particles between 0,3 µm and 10 µm from intake measurements.

This evaluation shall be carried out in every test.

Table 1 – Confidence limits of a Poisson distribution for 95 % confidence range

<i>Z</i>	$(Z_{LL})_{0,95}$	$(Z_{UL})_{0,95}$	<i>Z</i>	$(Z_{LL})_{0,95}$	$(Z_{UL})_{0,95}$	<i>Z</i>	$(Z_{LL})_{0,95}$	$(Z_{UL})_{0,95}$	<i>Z</i>	$(Z_{LL})_{0,95}$	$(Z_{UL})_{0,95}$	<i>Z</i>	$(Z_{LL})_{0,95}$	$(Z_{UL})_{0,95}$
0	0,0	3,7	10	4,7	18,4	20	12,2	30,8	30	20,2	42,8	40	28,6	54,5
1	0,1	5,6	11	5,4	19,7	21	13,0	32,0	31	21,0	44,0	41	29,4	55,6
2	0,2	7,2	12	6,2	21,0	22	13,8	33,2	32	21,8	45,1	42	30,3	56,8
3	0,6	8,8	13	6,9	22,3	23	14,6	34,4	33	22,7	46,3	43	31,1	57,9
4	1,0	10,2	14	7,7	23,5	24	15,4	35,6	34	23,5	47,5	44	32,0	59,0
5	1,6	11,7	15	8,4	24,8	25	16,2	36,8	35	24,3	48,7	45	32,8	60,2
6	2,2	13,1	16	9,2	26,0	26	17,0	38,0	36	25,1	49,8	46	33,6	61,3
7	2,8	14,4	17	9,9	27,2	27	17,8	39,2	37	26,0	51,0	47	34,5	62,5
8	3,4	15,8	18	10,7	28,4	28	18,6	40,4	38	26,8	52,2	48	35,3	63,6
9	4,0	17,1	19	11,5	29,6	29	19,4	41,6	39	27,7	53,3	49	36,1	64,8
10	4,7	18,4	20	12,2	30,8	30	20,2	42,8	40	28,6	54,5	50	37,0	65,9

A logarithmic scale is often used to express classes with respect to filtration efficiency or dust re-emission. A logarithmic scale can also be useful to express the dust re-emission of vacuum cleaners.

The logarithmic dust penetration L is introduced for this purpose. The mathematical relationship between dust re-emission R and logarithmic dust penetration L is:

$$L = -\log_{10} \left(\frac{R}{100\%} \right)$$

$$R = 10^{-L} \times 100\%$$

or with the filtration efficiency over all particle size classes $E = 100\% - R = 1 - R$:

$$L = -\log_{10} \left(1 - \frac{E}{100\%} \right)$$

$$E = \left[1 - 10^{-L} \right] \times 100\%$$

The L value indicates that each 10 to the power of how many dust particles the vacuum cleaner does not filter out but allows through. Or in other words: the L value can be described as 1 dust particle out of 10 to the power of what the vacuum cleaner does not filter out but allows through.

Examples:

$$R = 0,1 \% \text{ leads to } L = 3.$$

$$R = 0,000 1 \% \text{ leads to } L = 6.$$

5.14.4.5 Particle concentration and dilution

For proper counting of particles and analysis, it shall be monitored and controlled such that the particle concentration at the counter is within its specified range of proper operation and