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PRE-STANDARD

Vacuum cleaners for commercial use – Methods for measuring performance

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VACUUM CLEANERS FOR COMMERCIAL USE – METHODS FOR MEASURING PERFORMANCE

FOREWORD

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A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public.

IEC-PAS 62611 has been processed by subcommittee 59F: Floor treatment appliances, of IEC technical committee 59: Performance of household and similar electrical appliances.

The text of this PAS is based on the following document:

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document

Draft PAS	Report on voting
59F/184/PAS	59F/185/RVD

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

This PAS is based on the 4th edition of IEC 60312 (*Vacuum cleaners for household use – Method of measuring the performance*), and has been adapted to the operating environment of commercial appliances.

This PAS shall remain valid for an initial maximum period of 3 years starting from the publication date. The validity may be extended for a single 3-year period, following which it shall be revised to become another type of normative document, or shall be withdrawn.

INTRODUCTION

This PAS specifies provisional methods of measuring the performance of commercial vacuum cleaners for use in offices, shops and similar commercial establishments taking into account the differences in operation compared to household vacuum cleaners.

It is the intention of subcommittee SC 59F to review this PAS based on experience achieved and publish an International Standard on this subject.

VACUUM CLEANERS FOR COMMERCIAL USE – METHODS FOR MEASURING PERFORMANCE

1 Scope

These test methods are applicable to vacuum cleaners for commercial use.

The purpose of this PAS is to specify essential performance characteristics of vacuum cleaners being of interest to the users and to describe methods for measuring these characteristics.

NOTE Due to the influence of environmental conditions, variations in time, origin of test materials and proficiency of the operator, most 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.

For safety requirements, refer to IEC 60335-1, IEC 60335-2-2 and IEC 60335-2-69.

2 Normative references

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

IEC 60312, *Vacuum cleaners for household use – Methods of measuring the performance*

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

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*

ISO 554, *Standard atmospheres for conditioning and/or testing – Specifications*

ISO 679, *Cement – Test methods – Determination of strength*

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*

EN 1822, *Classification of HEPA and ULPA filters*

ASTM F2608, *Total emissions of a vacuum cleaner*

ASTM F1977, *Fractional filtration efficiency of a vacuum cleaner*

3 Terms and definitions

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

3.1
cleaning head
plain nozzle or a brush attached to a connecting tube, or a power nozzle, separate or part of the cleaner housing, and that part of a vacuum cleaner which is applied to a surface to be cleaned

3.2
power nozzle
cleaning head provided with an agitation device to assist dirt removal. The agitation device may 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
self-propelled cleaning head
cleaning head provided with a propulsion mechanism

3.4
upright cleaner
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

3.5
double stroke
one forward and one backward movement of the cleaning head performed in a parallel pattern

3.6
forward stroke
forward movement of a stroke pattern

NOTE On test carpets, forward strokes are carried out in the direction of the carpet pile (direction of manufacture).

3.7
return stroke
backward movement of a stroke pattern

3.8
stroke length
distance between the two parallel lines defining the limits of a stroke patter

3.9
stroke pattern
arrangement of the forward and return strokes on the surface to be cleaned

3.10
parallel pattern
stroke pattern where the forward and the return strokes are congruent and are carried out in the direction of the carpet pile (direction of manufacture) unless otherwise specified

3.11
commercial vacuum cleaner
mobile vacuum cleaner used in offices, shops and other similar commercial premises

3.12
multi-motor vacuum cleaners
vacuum cleaner with more than one vacuum motor in series

3.13
industrial vacuum cleaner
vacuum cleaner used in an environment where industrial processes take place and skilled operation is required.

3.14
test width
outside width of the cleaning head less 20 mm

3.15
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

3.16
stroke speed
speed of the cleaning head, moved as uniformly as possible, during a forward or a return stroke

3.17
cleaning cycle
for a given measurement, the sequence of forward and return strokes to be carried out at a specified stroke speed over the test area according to the appropriate stroke pattern

3.18
vacuum cleaner
electronically operated appliance that removes dry material (dust, fibre, threads) from the surface to be cleaned by an airflow created by a vacuum developed within the unit. The material thus removed is separated in the appliance and the cleaned suction air is returned to the ambient

3.19
wet cleaning appliance
electrically operated appliance that removes dry and/or wet material (soil) from the surface to be cleaned by an airflow created by a vacuum developed within the unit. The material thus removed is separated in the appliance and the cleaned suction air is returned to the ambient

3.20
passive nozzle
cleaning head without any agitation devices

3.21
cleaning head width
the external maximum width of the cleaning head in mm

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 (in accordance with ISO 554):

Standard atmosphere 23/50

Temperature:	(23 ± 2) ºC
Relative humidity	(50 ± 5) %
Air pressure:	86 kPa to 106 kPa

NOTE 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 which may be carried out at other than standard atmospheric conditions, the ambient temperature shall be maintained at (23 ± 5) °C.

4.2 Test equipment and materials

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 appropriate for the test.

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

NOTE It is recommended that carpets that are already being used shall be stored unbeaten at standard atmospheric conditions according to 4.1. When not in use they should be hanging free, not lying or rolled.

4.3 Voltage and frequency

Measurements shall be carried out at rated voltage with a tolerance of ±1 % and, if applicable, at rated frequency.

Vacuum cleaners designed for d.c. only shall be operated at d.c. Vacuum cleaners designed for both a.c. and d.c. shall be operated at a.c. Vacuum cleaners not marked with rated frequency shall be operated at either 50 Hz or 60 Hz, as is common in the country of use.

For 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 may give test results misleading for the consumer and additional measurements may be required. If the test voltage differs from the rated voltage, this shall be reported.

4.4 Running-in of vacuum cleaner and attachments

Prior to the initial test, the vacuum cleaner, wet cleaning appliances and their attachments, if any, shall be kept running with unrestricted air flow for at least 2 h to ensure adequate running-in. For upright cleaners or power nozzles, the agitation device shall be running but not in contact with the floor.

4.5 Equipment of the vacuum cleaner

If the 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 vacuum cleaner.

If the vacuum cleaner is provided with a permanent dust receptacle (as the sole original dust receptacle or as an enclosure for disposable dust receptacles), the dust receptacle shall, prior to each measurement, be cleaned by shaking or beating until its weight is within 1 % or 2 g of its original weight whichever is the lower. Brushing or washing of textile receptacles is not allowed; however, plastic receptacles may be washed and dried thoroughly. (A question has been raised as to whether this is still relevant in today's marketplace.)

Some permanent 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.

4.6 Operation of the vacuum cleaner

The vacuum cleaner and its accessories shall be used and adjusted in accordance with the manufacturer's instructions for normal operation for the test to be carried out. Height adjustment controls for the cleaning head shall be set as appropriate for the surface to be cleaned and the position noted. Any electrical controls shall be set for maximum continuous air flow and, unless the manufacturer's instruction states otherwise, any air by-pass openings for reduction of the suction power shall be closed.

NOTE This only applies to those air by-pass opening devices that may be operated by the user during normal operation. Any safety device shall be allowed to operate.

The tube grip of cleaners with suction hose or the handle of other cleaners shall be held as for normal operation at a height of (800 ± 50) mm above the test floor.

4.7 Conditioning prior to tests

The vacuum cleaner and attachments to be used shall then be kept running for at least 10 min under the provisions given in 4.4 to allow them to stabilise.

4.8 Initial application of dust

Prior to tests where the quantity of the dust collected is to be weighed, dust shall initially be applied to all parts of the vacuum cleaner through which the air passes before reaching the dust receptacle by carrying out, on the appropriate test surface, two preliminary measurements of dust removal, the results of which are not taken into account.

4.9 Mechanical operator

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

In such cases, it is recommended to simulate the handling of the vacuum cleaner by using a mechanical operator such as described in 7.2.12. The tube grip of cleaners with suction hose or the handle of other cleaners shall then be attached to the linear drive so that its centre pivots at a height of (800 ± 50) mm above the test surface. The linear drive may be motorized or operated by hand.

4.10 Number of samples

All measurements of performance shall be carried out on the same sample of the vacuum cleaner with its accessories and attachments, if any.

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

4.11 In-house reference cleaner system(s)

Test carpets used in a laboratory for the determination of dust removal ability will, over time, change from their original conditions, for instance due to wearing or gradual filling with dust. It is therefore required that in-house reference cleaner system(s) be used to regularly check the carpet conditions as a verification of the test results obtained and being recorded.

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

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 7.2.1 shall be used.

5.1.2 Test area and stroke length

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 1200 mm for the given test length of 700 mm but shall not be greater than 1600 mm.The centreline 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, i.e. there shall be 10 mm overlap at each edge of the test area, 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 reverse 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.

The active depth of the cleaning head shall move at uniform stroke speed (0,50 m/s ± 0,02 m/s) and in a straight line over the test area.

For optimum control of the double stroke movement it is recommended that an electromechanical operator (see 4.9) be used.

NOTE 1 The two hold-downs serve the purpose of acting as guides to keep the cleaning head in a straight line as it is moved over the test area.

NOTE 2 Vacuum cleaners equipped with a self drive device should be operated at the prescribed stroke speed of (0,5 m/s ± 0,02 m/s) if possible. Otherwise, the stroke speed will be determined by the vacuum cleaner.

5.1.3 Removal of remaining dust

Under consideration

5.1.4 Distribution of test dust

Test dust, Type 1 in accordance with 7.1.2.1, shall be distributed with a mean coverage of 125 g per square metre as uniformly as possible over the test area.

NOTE The amount of test dust to be used is calculated from the formula Tw × 0,7 × 125 g, where Tw is the test width in metres. For uniform distribution of the test dust over the test area, it is recommended that a dust spreader as described in 7.2.5 be used. The adjustment of the device is checked by visual examination of the test dust on the carpet.

5.1.5 Preconditioning of dust receptacle

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

The vacuum cleaner under test is equipped with a clean dust receptacle and allowed to run with an unimpeded air flow for 8 min.

After the preconditioning, the dust receptacle is removed from the cleaner to be weighed. The weight is noted and the dust receptacle is replaced.

NOTE The cleaner air flow can have an effect on the weight of the dust receptacle during the 8 min preconditioning; caution should be taken that the weight of the dust receptacle has stabilised before weighing.

5.1.6 Determination of dust removal ability

Three separate measurements, each comprising one double stroke, shall be carried out. After the double stroke, the cleaning head shall be lifted at least 100 mm clear of the surface before the vacuum cleaner is switched off. The dust receptacle shall not be removed before the motor has completely stopped.

Once the cleaner has completely stopped, the receptacle is carefully removed and reweighed. Due to effects of possible static charge build up during the time the vacuum cleaner is picking up dust, it is necessary to ensure that the receptacle has completely stabilised prior to recording the weight.

The dust removal ability is calculated as the ratio of the weight increase of the dust receptacle during the double stroke to the weight of the test dust distributed on the test area. The mean value for 3 measurements is calculated:

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

$K_B(i)$ = mean dust removal for i measurements in per cent

K_{Bi} = dust removal for measurement i in per cent

M_D = weight of the dust distributed on the test area in grams

m_{DRf} = weight of the preconditioned dust receptacle in grams

m_{DRf} = weight of the dust receptacle after cleaning in grams

NOTE When the mean value is lower than 90 %: should the range of measurements be greater than 3 percentage units, two additional measurements are carried out and the mean value of all the measurements should be given as the result.

When the mean value is equal or higher than 90 %: should the range of the measurements be greater than (0,3 × 100 % – mean value), two additional measurements are carried out and the mean value of all the measurements should be given as the result.

In both cases, consideration should be given to the control of repeatability within the laboratory and the design or manufacture of the cleaner or cleaning head in order to ascertain whether any factors not previously observed may affect the repeatability adversely.

5.2 Dust removal from hard floors with uneven surfaces

5.2.1 Test equipment

The equipment, in accordance with 7.2.2, consists of a test plate with an uneven surface.

NOTE The test area and stoke length is the same as for 5.1.

The type of test plate selected must be recorded.

5.2.2 Distribution of test dust

The surface is spread with the specified quantity of mineral dust, in accordance with 7.1.2.1.

5.2.3 Determination of dust removal ability

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

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

$K_B(i)$ = mean dust removal for i measurements in per cent

K_{Bi} = dust removal for measurement i in per cent

M_D = weight of the dust distributed on the test area in grams

m_{DRf} = weight of the preconditioned dust receptacle in grams

m_{DRf} = weight of the dust receptacle after cleaning in grams

5.3 Dust removal from carpets

5.3.1 Test carpet

A test carpet, in accordance with 7.1.1, shall be used; the type of carpet selected shall be recorded. It shall have been prepared in accordance with 7.1.2 and 7.1.3. Due to the significant influence of humidity on this test, it is important that the carpet is left in the test environment at standard atmospheric conditions for at least 16 h before the test is due to commence.

For international comparative purposes, only the Wilton carpet as defined by 7.1.1.2.1 shall be used.

During measurements the carpet is kept in position on the test floor by the use of carpet hold downs (see 7.2.4). The carpet is to be fixed on the test floor at the end where the forward stroke starts. A force of 60 N + 10 N must be applied at the other end of the test carpet to define the tension on the carpet during testing.

5.3.2 Test area and stroke length

The direction of the stroke on the test area shall be in the direction of the carpet pile. The length of the test area is (700 ± 5) mm. The width of the test area is equal to the test width of the cleaning head (see 3.14).

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

Thus, the stroke length is at least 1200 mm for the given test length of 700 mm but shall not be greater than 1 600 mm. The centreline 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, i.e. there shall be 10 mm overlap at each edge of the test area, 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 reverse 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.

The active depth of the cleaning head shall move at uniform stroke speed (0,50 m/s ± 0,02 m/s) and in a straight line over the test area.

NOTE 1 For optimum control of the double stroke movement it is recommended that an mechanical operator (see 4.9) be used.

NOTE 2 The two carpet hold-downs serve the purpose of holding the test carpet in position during measurement and of acting as guides to keep the cleaning head in a straight line as it is moved over the test area.

NOTE 3 Vacuum cleaners equipped with a self drive device should be operated at the prescribed stroke speed of (0,5 m/s ± 0,02 m/s) if possible. Otherwise, the stroke speed will be determined by the vacuum cleaner.

5.3.3 Conditioning of test carpet

Prior to each measurement, the test carpet shall be cleaned to remove remaining dust and preconditioned as described below.

5.3.3.1 Removal of remaining dust

For cleaning of the test carpet, it is recommended to use a suitable carpet-beating machine such as described in 7.2.3.

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. After the beating, four to six cleaning cycles with a vacuum cleaner having good dust removal ability should be carried out to remove remaining dust. Test carpets designated for testing of passive nozzles shall only be cleaned with a passive nozzle on the face (although an agitator cleaner or a power nozzle may be used on the back).

5.3.3.2 Verification and preconditioning

After cleaning of the test carpet, the 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 cleaning cycles 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 1 Even if the equipment for removing remaining dust from the carpet is known to be sufficiently reliable to leave the carpet in 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.

NOTE 2 To prevent a gradual filling of the carpet with dust, the weight of the test carpet should be maintained as close as possible to that of the initially clean carpet (see 7.1.2).

5.3.4 Distribution of test dust

Test dust, in accordance with 7.1.2.2, shall be distributed with a mean coverage of 125 g per square metre as uniformly as possible over the test area.

NOTE The amount of test dust to be used is calculated from the formula $T_w \times 0,7 \times 125$ g, where T_w is the test width in metres. For uniform distribution of the test dust over the test area, it is recommended that a dust spreader as described in 7.2.5 be used. The adjustment of the device is checked by visual examination of the test dust on the carpet.

5.3.5 Embedding of dust into carpet

The dust shall be embedded into the test carpet by carrying out 30 double strokes over the carpet parallel with the direction of the pile with a roller, in accordance with 7.2.6.1. The speed of the roller over the test area shall be a uniform 0,5 m/s ± 0,02 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.

5.3.6 Preconditioning of dust receptacle

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

The vacuum cleaner under test is equipped with a clean dust receptacle and allowed to run with an unimpeded air flow for 8 min, for instance during the 10 min period the carpet recovers from rolling.

After the preconditioning, all dust receptacle(s) and removable filters are removed from the cleaner to be weighed. The weights are noted and the items are replaced.

NOTE Since the cleaner air flow due to electrostatic build-up can have an effect on the weight of the dust receptacle during the 8 min preconditioning, caution should be taken that the weight of the dust receptacle has stabilized before weighing.

5.3.7 Determination of dust removal ability

Prior to each cleaning cycle, the sequence of preparations outlined in 5.3.4 to 5.3.6 shall be performed in total.

Three separate cleaning cycles, each comprising five double strokes, shall be carried out. After the fifth double stroke, the cleaning head shall be lifted at least 100 mm clear of the carpet. At the end of each cleaning cycle all hoses and tubes of the vacuum cleaner must be agitated before the vacuum cleaner is switched off. The dust receptacle shall not be removed before the motor has completely stopped.

Once the 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 vacuum cleaner is picking up dust it is necessary to ensure that the receptacle has completely stabilised prior to recording the weight.

The dust removal ability is calculated as the ratio of the weight increase of the dust receptacle during the 5 double strokes to the weight of the test dust distributed on the test area. The mean value for 3 measurements is calculated:

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

where

$$K_{Ti} = 100 \times (m_{DRf} - m_{DRe})/m_D$$

and

$K_r(i)$ is the mean dust removal for i measurements in per cent;

K_{ri} is the dust removal for measurement i in per cent;

m_D is the weight of the dust distributed on the test area in grams;

m_{DRc} is the total weight of the preconditioned dust receptacle(s) and removable filter(s) in grams;

m_{DRf} is the total weight of the dust receptacle(s) and removable filter(s) after 5 double strokes in grams.

If the range of values for K_T is greater than three percentage units, two additional cleaning cycles shall be performed. In this case, the mean dust removal ability shall be calculated as follows:

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

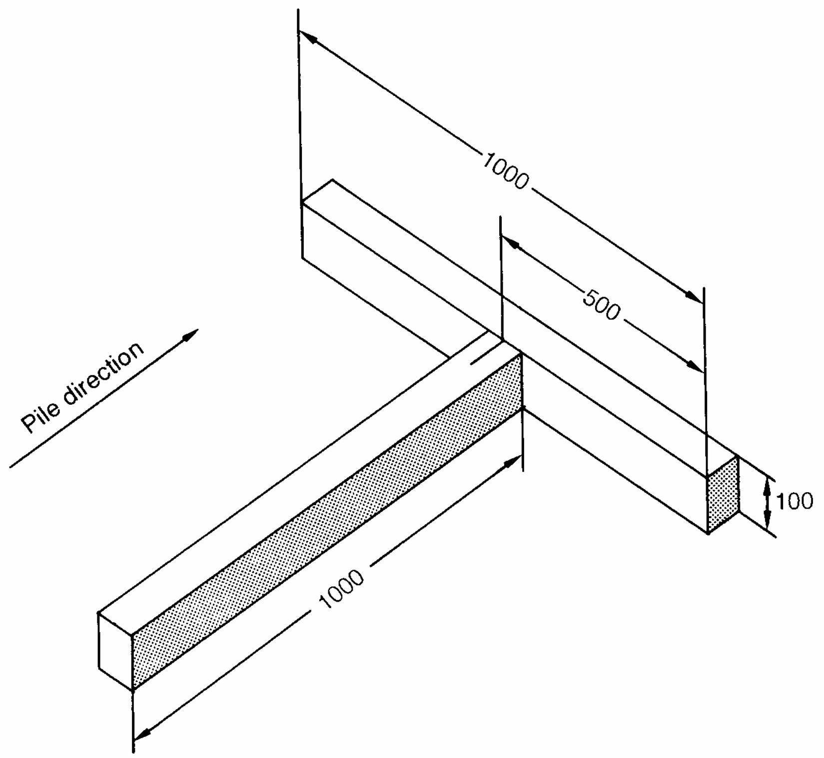
NOTE As an example, the values for *Kr* of 45 %, 47 % and 49 % give a range of 4 percentage units. Thus, two additional measurements shall be carried out.

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

5.4 Dust removal along walls

5.4.1 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 measurements or be kept in position by the use of clamps or weights.



Dimensions in millimetres

Figure 1 – Right-angled T

For measurements on carpets, a test carpet in accordance with 7.1.1 shall be used. For measurements on hard flat floors, a floor test plate in accordance with 7.2.1 shall be used.

(Insert a Figure (Figure 3) showing guidance on evaluation the edge cleaning results.)

5.4.2 Distribution of test dust

A sufficient amount of mineral dust, in accordance with 7.1.2.1, shall be distributed over an area of the test surface corresponding to the extremities of the T to ensure good visible coverage.

5.4.3 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 2).

One double stroke is carried out at a speed of (0,25 ± 0,05) m/s with the cleaning head guided along one side 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 cross-bar of the T to establish, to the nearest millimetre, two mean values representing the dust removal ability along walls, at the side and in the front of the cleaning head, both values being reported. Uncleaned area includes areas of dust that has been disturbed but not removed completely. See Figure 3 for guidance.

If the cleaning head is not symmetrically constructed, the test is repeated along the other side of the leg of the T.

5.5 Fibre removal from carpets

Method described in IEC 60312 to be used.

5.6 Maximum usable volume of the dust receptacle

The maximum usable volume of the dust receptacle is determinated as follows.

5.6.1 Conditions for measurement

The 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 is used, a sufficient amount of fine powdered chalk shall be introduced slowly into the cleaner to inflate the bag completely.

Moulding granules, in accordance with 7.1.4, shall be used for the test.

NOTE 1 Standard atmospheric condition according to 4.1 not required.

NOTE 2 The granules may be reused provided they are relieved of excessive chalk and have not been damaged.

NOTE 3 For vacuum cleaners equipped with bags, an option exists to utilise a balloon to inflate the bag prior to granule introduction.

5.6.2 Introduction of moulding granules

The moulding granules are gradually introduced into the cleaner in 1 l increments until the cleaner will not accept any more, each litre of granules being carefully measured by pouring them gently into a 1 l container ensuring that they are evenly packed.

NOTE 1 For upright cleaners without provision for optional use of a hose, the granules are fed through a nozzle adaptor (see 5.10.1 5) with the handle of the cleaner in normal position of use. For other cleaners, the granules are fed through the hose provided.

NOTE 2 Vacuum cleaners equipped with a dust receptacle having a visible maximum level mark should not be filled beyond this mark.

5.6.3 Determination of maximum usable volume of dust receptacle

The volume of granules collected in the dust receptacle is determined by recording each litre and fraction of litre (not less than 0,1 l) of the granules introduced into the cleaner system and deducting the volume of any granules left in the hose, ducts, cleaning head, etc. Measure the mass of one litre of granules 10 times to determine its density prior to feeding into the vacuum cleaner. Weigh the dust receptacle before feeding and then again after feeding. The difference divided by the density determines the volume.

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

5.7 Air data

The purpose of the determination of air data is to compare the specified parameters between vacuum cleaners and also to determine certain parameter values for other tests. The following parameters, referred to standard air density p = 1,20 kgl 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 kilopascals;

P1 is the input power, in watts;

P2 is the suction power, in watts;

17 is the efficiency, in per cent.

NOTE 1 Standard atmospheric condition according to 4.1 not required.

NOTE 2 Measured air data should be corrected to standard air density (see 7.2.7.4).

5.7.1 Conditions for measurement

Vacuum cleaners, which in normal operation are equipped with hose, shall be connected to the measuring chamber at the end of the hose with the hose fully collapsed.

Upright cleaners without a hose connection to the cleaner head shall be adapted to the measuring chamber with their suction opening sealed to the measuring chamber. For upright cleaners with an option to be operated with or without a hose, the air data shall be obtained for both options and be reported separately.

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

5.7.2 Test equipment

Either of the alternative test equipment described in 7.2.7 may be used. For both alternatives a plenum chamber of 500 × 500 × 500 mrn" or 500 × 500 × 250 mrn" shall be used.

5.7.3 Determination of air data

The specific values are to be determined for at least 10 throttle settings (option A) or for each orifice size (option B (see 7.2.7.2)).

Prior to the sequence of measurements, the 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.

The sequence of measurements commences with the greatest opening of the throttle or the largest orifice size.

The values for air flow, vacuum and input power are recorded 1 min after the throttling.

The cleaner is then again operated unthrottled to attain the reference conditions again checked by measuring the exhaust air temperature.

All measured air data is to be referred to the standard air density.

With the corrected air data the suction power P_z and the efficiency N shall be calculated for each measuring point as follows:

$$P_z = qxh$$

$$N = P_2 / P_1$$

The values *P*« P_2 and *17* shall be presented against the "y" axis against q on the "x" axis in a table or diagram, see Figure 2.

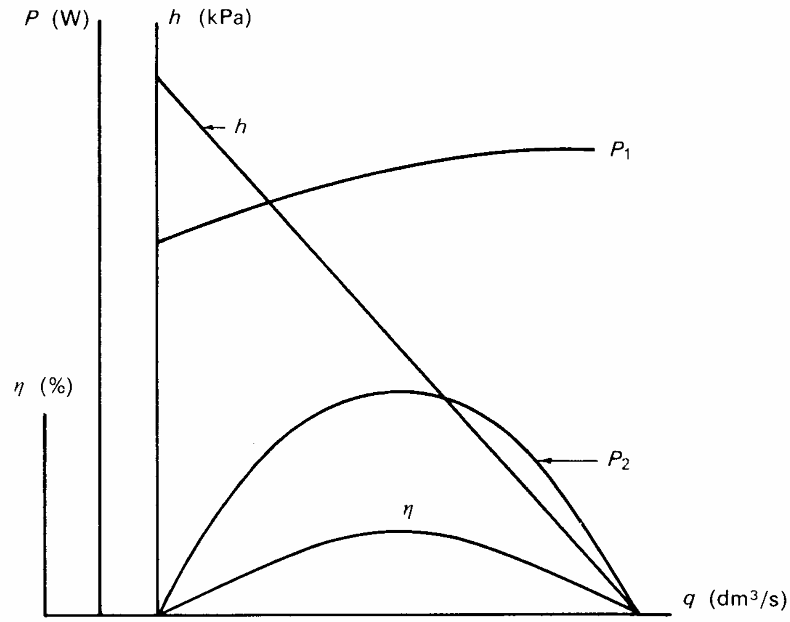


Figure 2 – Air data curves

h vacuum in the measuring box, in kilopascals

q air flow, in litre per seconds (l/s)

P1 input power, in watts

P_2 suction power, in watts

n efficiency, in percent

5.8 Performance with loaded dust receptacle

The purpose of this procedure is

– to provide means to measure the performance of a vacuum cleaner as in 5.1 to 5.6 with loaded dust receptacle;

– to obtain information about changes of the air data when the dust receptacle is loaded with the test material according to 7.1.2.3 to complement the performance data.

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

5.8.1 Determination of suction pressure change with loaded dust receptacle

5.8.1.1 Test conditions

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

For this purpose the path by which dirt travels from the floor nozzle to the dust receptacle of the vacuum cleaner is prepared as follows, see Figures 3a and 3b:

– a pressure tapping at a distance of ca. 50 mm from the nozzle;

– an opening for the feed tube for test dust with 12 mm at a distance of at least 150 mm from the pressure tapping. This opening must be capable of being sealed closed during the measurements of suction.

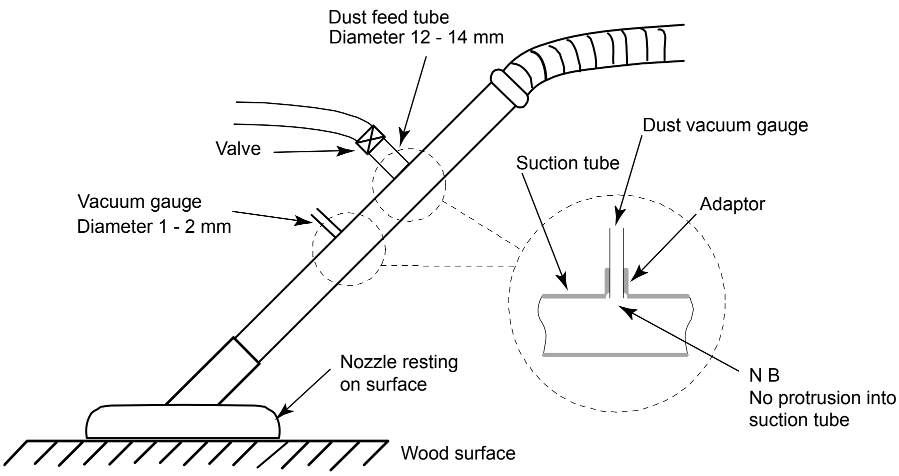


Figure 3a – Connecting tube openings

(Add figure (figure 3b) to show how an Upright Cleaning head may be adapted)

The openings in the connecting tube 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 from an even hard floor surface. The feed set-up shall not impair the properties of the test material according to 7.1.2.3.

NOTE A revision whereby the hose is connected to a plenum chamber with suitable adapter with fixed pressure tube is under consideration.

5.8.1.2 Test dust

Test dust, see Figure 4, in accordance with 7.1.2.3, shall be used for loading the dust receptacle.

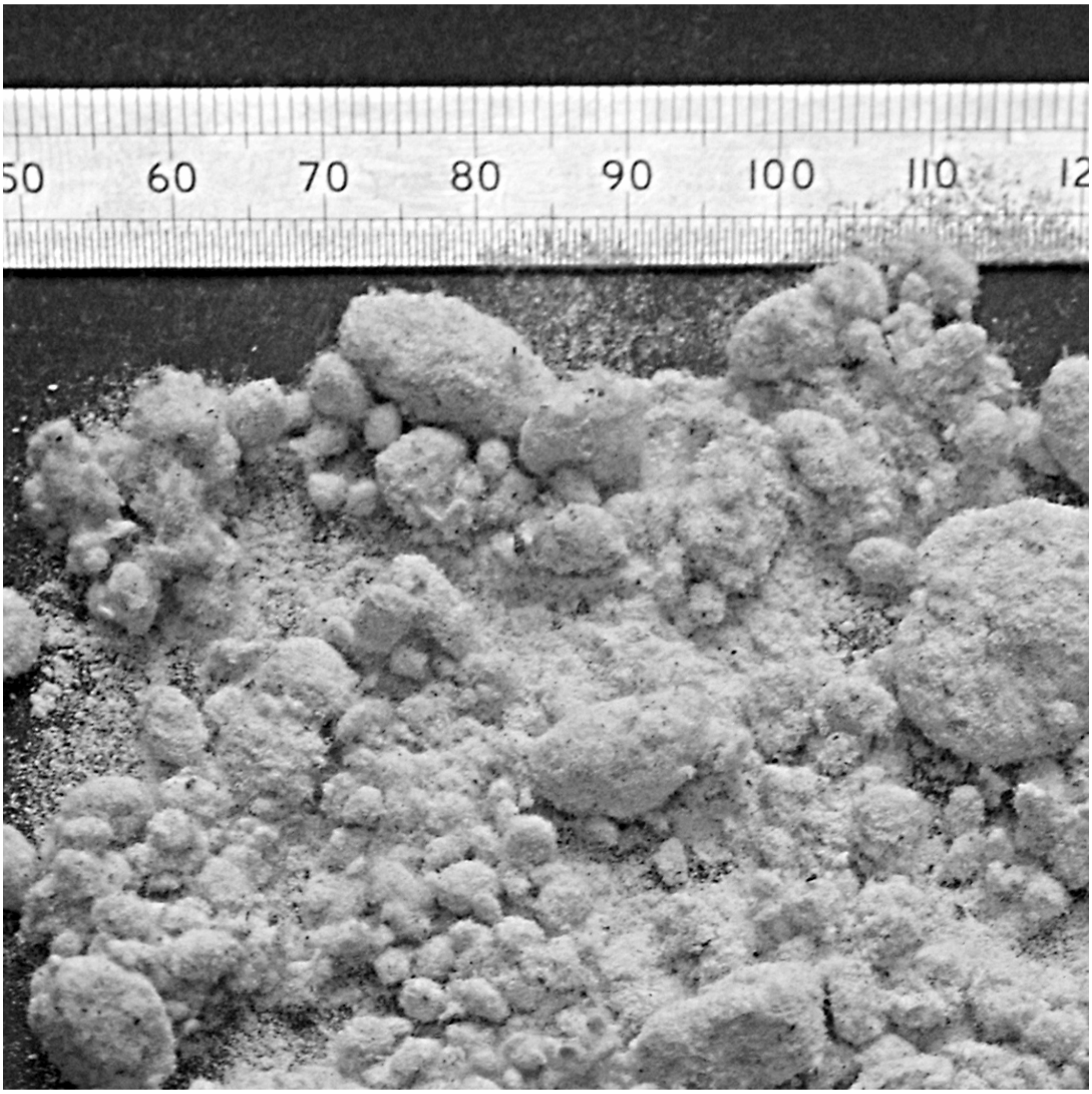


Figure 4 – Test dust for loading dust receptacle

5.8.1.3 Test method

The vacuum cleaner shall be equipped with a suction hose and tube for carpet cleaning. The cleaning head is set onto a hard surface according to 7.2.1.

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

The test material shall be fed in 50 g batches which are representative for the overall mixture over a time period of 60 s each, see Figure 5.

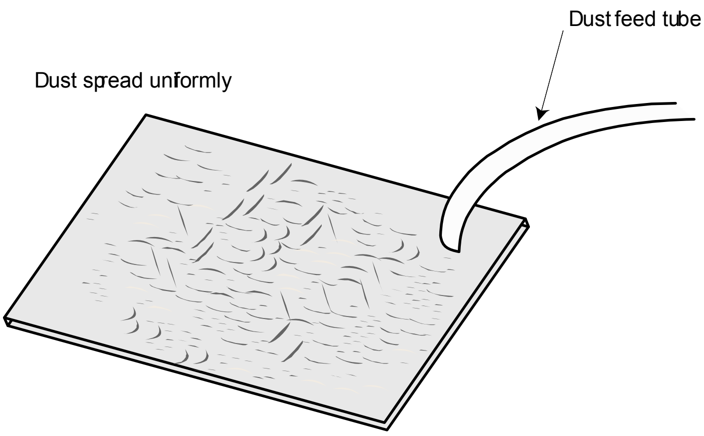


Figure 5 – Dust spread uniformly on surface

After each batch, the feed tube shall be closed. The vacuum in the connecting tube, hl, shall be determined. Then, the feed tube is reopened and the feeding of the next batch of 50 g continued.

If the volume of receptacle is less than 1 l or the maximum airflow of the vacuum cleaner is less than 15 l/s, then the feeding rate is reduced to 25 g/min.

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

Condition 1: An indicator on the vacuum cleaner signals that the dust receptacle should be emptied or replaced.

Condition 2: The observed value of the vacuum *h* has dropped to $40^{+0,5}_{-0}$ % of ho.

Condition 3: The amount of injected test dust has reached a total of 501 g per l of the maximum usable volume of the dust receptacle (see 5.7).

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

NOTE if h. < 40% of ho, the restriction will be created to provide a suction value equal to 40 % of the initial reading.

5.8.2 Throttling to simulate loaded dust receptacle

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

It shall be operated according to 5.9.1 with the feed tube closed.

The volume flow of the vacuum cleaner with the cleaning head on the hard surface shall be suitably throttled until the value ti of 5.9.1 is obtained.

The throttling can be brought about directly at the suction hose or by inserting a suitable device between dust receptacle and motor/fan chamber. However, it is essential that the throttling must not alter the characteristics of the effects of loading with the dust and must not restrict the manner in which the dirt is transported from the surface being cleaned to the receptacle.

5.8.3 Determination of performance with loaded dust receptacle

Any of the tests described in 5.1 to 5.6 with simulated dust receptacle load shall be performed with the throttling described in 5.8.2.

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

5.9 Filtration efficiency of the vacuum cleaner

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.

5.9.1 Test conditions

NOTE A relative humidity of 45-55 % RH is recommended for control of static. It is also recommended that in a single test series, the humidity for each filter be within 10 % of the other samples test

Measuring equipment required for the test is specified in 7.2.8.

In preparation of the test, the vacuum cleaner should be equipped with a new dust receptacle and new filters according to specifications. It is to 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 vacuum cleaners with a suction hose, through this hose,
- to vacuum cleaners without a suction hose (for instance uprights) through a suitable auxiliary hose which is connected and sealed tightly to the suction nozzle by use of a nozzle adaptor.

5.9.2 Determining the test dust quantity

For the entire duration of dust according 7.1.2.4 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} is calculated consequently as

$$m = c * t_{DUST} * q .$$

5.9.3 Test procedure

With the vacuum cleaner prepared according to 5.9.2, the test proceeds as follows:

- the vacuum cleaner is operated without dust being fed until acceptable and stable conditions are achieved,
- particle counts are taken for 30 s from the aerosol intake channel and from the exhaust channel in order to determine backgrounds,
- dust is fed for 10 min while the particle concentration in the aerosol channel is monitored,
- meanwhile 5 measurement cycles are carried out, each consisting of
  - particle registration from aerosol intake channel for 30 s (upstream measurement),
  - if a single particle counter is used: flushing of particle analyzing system for 15 s,

- particle registration from exhaust channel for 30 s (downstream measurement),
- flushing of particle analyzing system for 15 s,
- if two particle counters are used: continuous measurement.

Particle registration is by optical particle counter which can be operated with a suitable aerosol dilution system to adapt count rate capacity and the particle concentration of aerosol intake and of exhaust channel, respectively. The results of these measurement cycles 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,
- sample air volumes, VA_D (downstream) and VA_U (upstream); i.e. the volumes of the aerosol samples analyzed by the particle counter combined in the course of the test,
- applicable dilution factors k_{VA} (upstream or downstream) 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 analyzed by the particle counter.

The test procedure shall be repeated with at least 3 vacuum cleaners of identical type.

NOTE Proper dilution ratio needs to be verified. Prove not over-concentrated by serial dilution and prove not over-diluted on the downstream by lessening the dilution serially. See 7.2.8.4.

5.9.4 Evaluation

Based on the particle counts obtained in the 5 measurement cycles, for aerosol intake channel and exhaust channel, the fractional filtration efficiency is derived for each particle class.

The individual measurements are considered to be samples of a full distribution, and a statistical analysis is performed accordingly.

Given the particle counts $z(k,l)_U$ of the aerosol intake channel (upstream) for particle class k obtained from each individual measurement cycle l, the corresponding lower limits of the 95 % confidence range, $\underline{Z(k)}_U$, are obtained as follows:

– Summation of particle counts obtained for particle class k in 5 individual measurements upstream

$$Z(k)_U = \sum_{l=1}^{5} z(k,l)_U$$

where

k is the index of particle class,

l is the running index of individual measurement cycles,

z(k,l) $z(k,l)_U$ is the article count upstream in class k from individual measurement cycle *l*,

$Z(k)_U$ is the particle sum upstream in class k from all 5 measurement cycles.

– Determination of the 95 % lower-confidence limits $\underline{Z(k)_{U\ 95}}$ for the particle sums $Z(k)_U$:

If $Z(k)_U > 50$: $\underline{Z(k)}_{U\_0,95} = Z(k)_U - 1{,}96 * \left(Z(k)_U\right)^{\frac{1}{2}}$

If $Z(k)_U \le 50$: $\underline{Z(k)}_{U\_0,95}$ from Table 1.

Given the particle counts $z(k,l)_D$ of the exhaust channel (downstream) for particle

class *k* obtained from each individual measurement cycle *l*, the corresponding upper limits of the 95 % – confidence range, $\overline{Z(i)}_{D\_0.95}$ are similarly derived by:

– Summation of particle counts obtained for particle class I in 5 individual measurements downstream:

$$Z(k)_D = \sum_{l=1}^{5} z(k,l)_D$$

where

k is the index of particle class,

l is the running index of individual measurement cycles,

$z(k,l)_D$ is the particle count downstream in class k from individual measurement cycle *l*,

$Z(k)_D$ is the particle sum downstream in class k from all 5 measurement cycles.

– Determination of corresponding upper limits of the 95 % – confidence range $\overline{Z(k)}_{D\_0.95}$ from particle sums $Z(k)_D$:

If $Z(k)_D > 50$: $\overline{Z(k)}_{D\_0,95} = Z(k)_D + 1{,}96 * \left(Z(k)_D\right)^{\frac{1}{2}}$

If $Z(k)_D \leq 50$: $\overline{Z(k)}_{D\_0,95}$ from Table 1.

From the statistical limits calculated above, the lower limit of the 95 % – confidence range of the fractional filtration efficiency, $\underline{E(k)}_{0,95}$, is obtained for each particle class *k* :

$$\underline{E(k)}_{0,95} = 1 - \left(\frac{\overline{Z(k)}_{D\_0,95} * k_{VA\_D} * \left(\frac{VA_U}{VA_D} \right)}{\underline{Z(i)}_{U\_0,95} * k_{VA\_U}} \right)$$

where

k is the index of particle class,

$E(k)_{0,95}$ is the lower limit of confidence for filtration efficiency of particle class *k*,

k_{VA_D} is the downstream dilution factor of particle analysis system,

k_{VA_U} is the upstream dilution factor of particle analysis system,

VA_D is the downstream sample air volume analyzed,

VA_U is the upstream sample air volume analyzed,

$Z(k)_{D\_0,95}$ is the upper limit of confidence for partial sum class k from downstream measurements,

$Z(k)_{U\ 0,95}$ is the lower limit of confidence for particle sum class *k* from upstream measurements.

This evaluation shall be carried out in every test.

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

Z	$\underline{Z}_{0,95}$	$\overline{Z}_{0,95}$	Z	$\underline{Z}_{0,95}$	$\overline{Z}_{0,95}$	Z	$\underline{Z}_{0,95}$	$\overline{Z}_{0,95}$	Z	$\underline{Z}_{0,95}$	$\overline{Z}_{0,95}$	Z	$\underline{Z}_{0,95}$	$\overline{Z}_{0,95}$
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

5.9.5 Particle concentration and dilution

For flawless particle registration and analysis it has to be monitored and maintained that the particle concentration at the counter is within its specified range of proper operation and that each individual particle count z_{SAMPLE} is well below the maximum count $z_{COUNTER\_MAX}$, such that

$$z_{SAMPLE} < 0.2\ z_{COUNTER\_MAX}.$$

To verify that it is not over-concentrated, increase the dilution to a known amount, and verify that the counts are decreased by the same ratio.

To verify that it is not over-diluted, decrease the dilution and verify that the counts increase by this same change in dilution ratio.

5.9.6 Record keeping

A record with the following information must be kept for each test of fractional filtration efficiency:

- electrical and air-technical data of the type of at least 3 devices being tested
- information on its dust receptacle and filter system
- quantity of test dust being fed in the procedure
- information on the particle analysis system:
  - particle counter and size ranges of analyzed particle classes
  - dilution factors upstream and downstream
- for each particle count:
  - dilution factor
  - sample air volume analyzed in the particle counter
  - particle counts in each class registered by the particle counter
- filtration efficiency (lower limit of 95 % – confidence range) of each particle class

5.10 HEPA filtration equivalence of the vacuum cleaner

5.10.1 Object of the test

The purpose of this test is to measure the fractional filtration efficiency of the most penetrative particle size in order to determine HEPA filtration equivalence of the vacuum cleaner.

5.10.2 Test procedure

5.10.2.1 Determination of the most penetrative particle size

The main or primary filter of the vacuum cleaner is subjected to the procedure according to EN 1822 whereby the most penetrative particle size is determined.

5.10.2.2 Measurement of fractional filtration efficiency

With all filters in place according to the manufacturer's instructions, the vacuum cleaner is prepared in accordance with **Error! Reference source not found.** to **Error! Reference source not found.**.

Measurement of fractional filtration efficiency is made in accordance with ASTM F1977 and the measurement of the most penetrative particle size as measured in 5.10.2.1 is recorded.

NOTE ASTM F1977 requires a Krypton based process to neutralise static charges; in those countries where the use of Krypton is not permitted, alternative neutralisation methods may be employed.

5.10.3 Determination of HEPA equivalence

The fractional filtration efficiency of the most penetrative particle size must be greater than 99,95 % in order to declare a HEPA filtration level for the vacuum cleaner under test. This corresponds with the H12 value for HEPA efficiency as specified in EN 1822.

5.11 Total emissions of the vacuum cleaner

The purpose of this test is to determine the average dust concentration in the exhaust air of a vacuum cleaner when operating at its maximum air flow and fed with test dust at a specified rate.

Prior to the test, the vacuum cleaner shall have been subjected to air data measurements (see 5.8) in order to establish the maximum air flow of the cleaner.

NOTE Standard atmospheric conditions according to 4.1 are not required.

5.11.1 Test method

Undertake the test in accordance with ASTM F2608.

6 Miscellaneous tests

The tests described in this section are intended for the determination of such characteristics of a vacuum cleaner which relate to ease of handling or to the performance of the cleaner when its accessories or attachments have been subjected to stresses likely to appear during normal use. The ability of a cleaner to resist such stresses may be verified by submitting it to the appropriate tests of Clause 5 as applicable.

6.1 Motion resistance

The purpose of this test is to determine the motion resistance, both for forward and for backward strokes, caused by friction when the cleaning head is moved over a carpet under normal operation conditions.

NOTE This test is not applicable to self-propelled cleaning heads.

6.1.1 Test carpet and test equipment

A test carpet, in accordance with 7.1.1, which is free from dust, shall be used.

Test carpets designated for measurement of motion resistance shall not be used for other tests and shall be stored permanently at standard atmospheric conditions, hanging or lying, but not rolled.

The test carpet shall be fastened to a testing device, capable of measuring motion resistance within the range of 10 N to 100 N with an accuracy of 5 % of the measured value.

The principle construction of a suitable testing device is described in 7.2.9.

NOTE It is recommended to use a mechanical operator to simulate the test so that no additional force is exerted pressing the cleaning head against the carpet during the measurements (see 7.2.12).

6.1.2 Determination of motion resistance

The cleaning head is moved in double strokes with a stroke speed of (0,50 ± 0,02) m/s over the test carpet. The cleaning head shall only be moved in pile direction, i.e. no tilting moment shall occur at the handle.

For conditioning 5 double strokes shall be performed without measurement. Subsequently, the motion resistance for 5 double strokes is measured when the cleaning head is moved with stroke speed by recording the force exerted to the test area either continuously or with a time slot pattern of ~ 100 ms.

On the basis of the measured values the mean value and the range for the motion resistance are determined separately for forward and backward direction.

NOTE For a connecting tube with adjustable length, the length should be the same as that used during measurement of dust removal from carpets.

6.2 Cleaning under office furniture

The purpose of the test is to determine the free furniture height, measured from the floor, for which the cleaning head can pass to reach a given insertion depth. The insertion depth is the depth, measured from the front surface of the furniture, from which test dust distributed on the surface to be cleaned can be removed (see Figure 6).

NOTE Standard atmospheric conditions according to 4.1 not required.

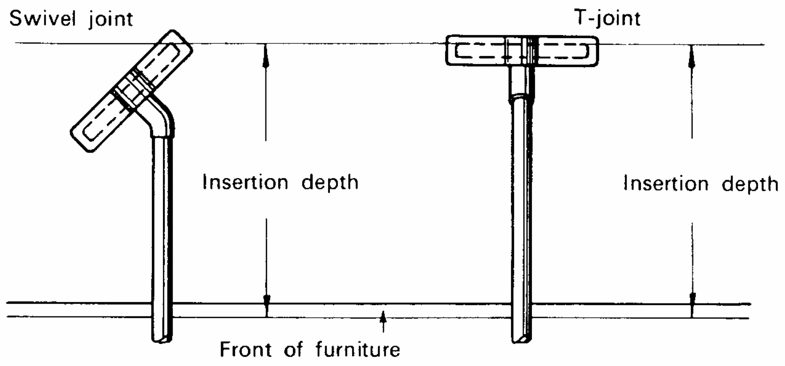


Figure 6 – Insertion depth

6.2.1 Distribution of test dust

Mineral dust, in accordance with 7.1.2.1, shall be distributed over a test carpet or a hard test floor. When distributed over a test carpet, the test dust shall not be embedded into the carpet.

6.2.2 Determination of free office furniture height

The cleaning head is adjusted to the position intended for operation under furniture.

With the vacuum cleaner running at maximum continuous air flow, determine the free furniture height, in millimetres, necessary for the cleaning head to remove test dust up to the following insertion depths:

1,00 m: representing cleaning under a bed, a couch, etc.;

0,60 m: representing cleaning under a wardrobe, a cupboard, etc.

6.3 Maximum radius of operation

The purpose of the test is to determine the maximum distance between an electric socket-outlet and a spot on the surface to be cleaned.

6.3.1 Conditions for measurement

The tube grip of cleaners with suction hose or the handle of other cleaners shall be held as for normal operation (see 4.6), the force applied in the direction of operation being 10 N maximum. The front edge of the cleaning head shall be at right angles to the direction of operation.

NOTE Standard atmospheric conditions according to 4.1 not required.

6.3.2 Determination of radius of operation

The radius of operation is determined as the maximum distance, to the nearest 0,05 m, between the front edge of the cleaning head and the face of the electric plug.

6.4 Impact resistance

The purpose of this test is to determine the ability of a cleaning head to resist impacts against walls, thresholds, etc., as in normal use, or other forms of careless handling, which otherwise might affect the performance of the vacuum cleaner.

NOTE Standard atmospheric conditions according to 4.1 not required.

6.4.1 Test equipment

A drum for drop test, in accordance with 7.2.10, shall be used for this test.

6.4.2 Determination of impact resistance

The cleaning head is placed in the drum, which then is set in operation. During the test, the cleaning head is taken out from the drum at suitable intervals to be inspected.

The test is continued until the cleaning head displays damage deemed to impair the performance of the cleaner, for example cracks causing leakage, joints no longer functioning, etc., or presence of sharp edges that could damage carpets, skirting boards, etc.

NOTE It is recommended that the test is discontinued after a maximum of 500 revolutions.

6.5 Deformation of hose and connecting tubes

The purpose of this test is to determine the ability of the hose or connecting tubes to sustain a load, equivalent to a moderately heavy person, without being permanently deformed so as to impair the performance of the cleaner.

NOTE Standard atmospheric conditions according to 4.1 not required.

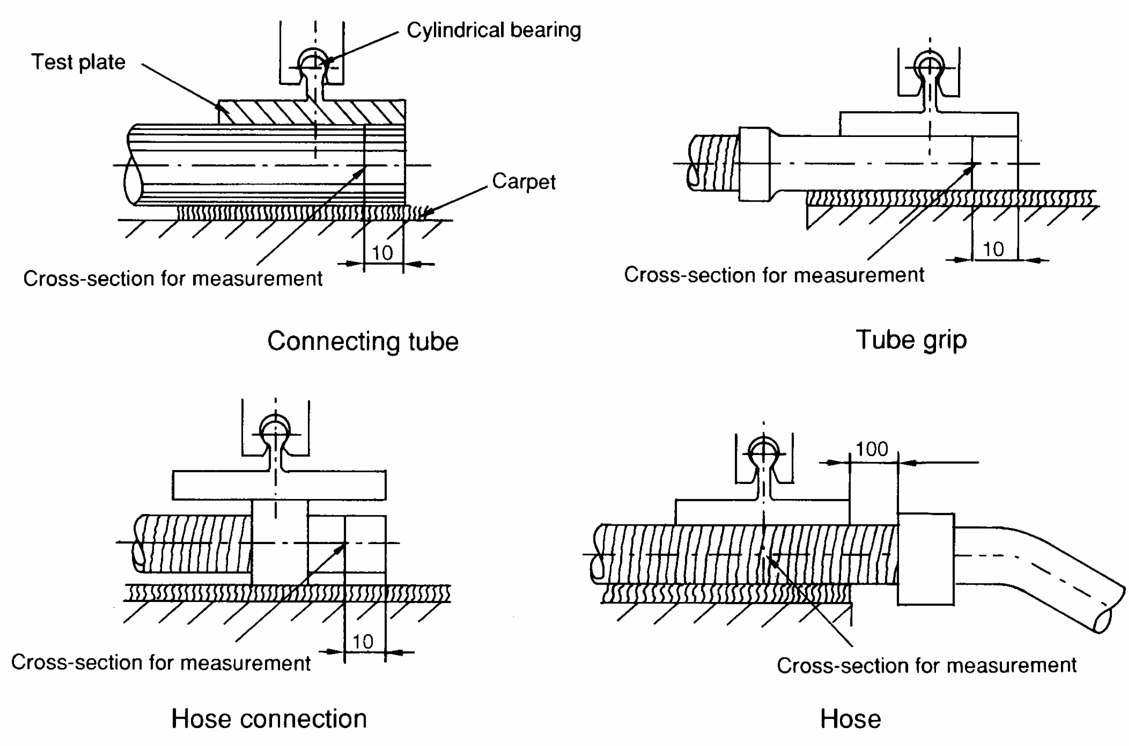
6.5.1 Test equipment

The test equipment, as described in 7.2.11, consists of a screw press for applying a force on the test object; the force being read on a load indicator.

6.5.2 Determination of permanent deformation

Prior to the test, the outside cross-sectional diameter of the test object is measured by a vernier or digital calliper.

The test object is placed between the test plate and the carpet, according to Figure 17, and the screw is adjusted until the load indicator shows 0 on the scale. The force is increased to 700 N and kept at this level for 10 s, after which time the force is reduced to zero. In the case of a hose, it shall be left in free state (not stretched or compressed) during the test.



Dimensions in mm

Figure 7 – Position of test object and cross-section for measurement of deformation

The reduced outside dimension is then measured after at least 1 min at the cross-section indicated in Figure 7 and the permanent deformation is expressed as the percentage reduction in the original outside diameter.

6.6 Bump test

The purpose of this test is to determine the ability of vacuum cleaners to sustain stresses incurred when overrunning thresholds and bumping against doorposts. The test is only applicable to vacuum cleaners that in normal use are pulled by the user with the tube grip of the suction hose.

NOTE Standard atmospheric conditions according to 4.1 are not required.

6.6.1 Test equipment

The test shall be carried out on a flat hardwood floor allowing a running distance of (2 ± 0,1) m and with provisions for fastening of the following test obstacles:

– a threshold made from polyamide 6 or of wood of equivalent hardness, with crosssectional dimensions according to Figure 8a, positioned at right angles to the centre line of the test surface at a distance of 1 m beyond the start position of the cleaner (see Figure 8b);

– a doorpost made from sheet steel, with dimensions according to Figure 8b, positioned at either side of the centre line at a distance of 2 m beyond the start position of the cleaner.

NOTE The wooden floor may be covered with a transport belt of rubber plastic for resetting the cleaner to its start position (see 6.6.3).

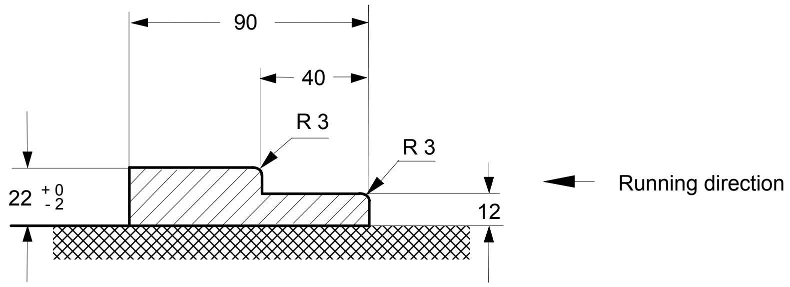


Figure 8a – Profile of threshold

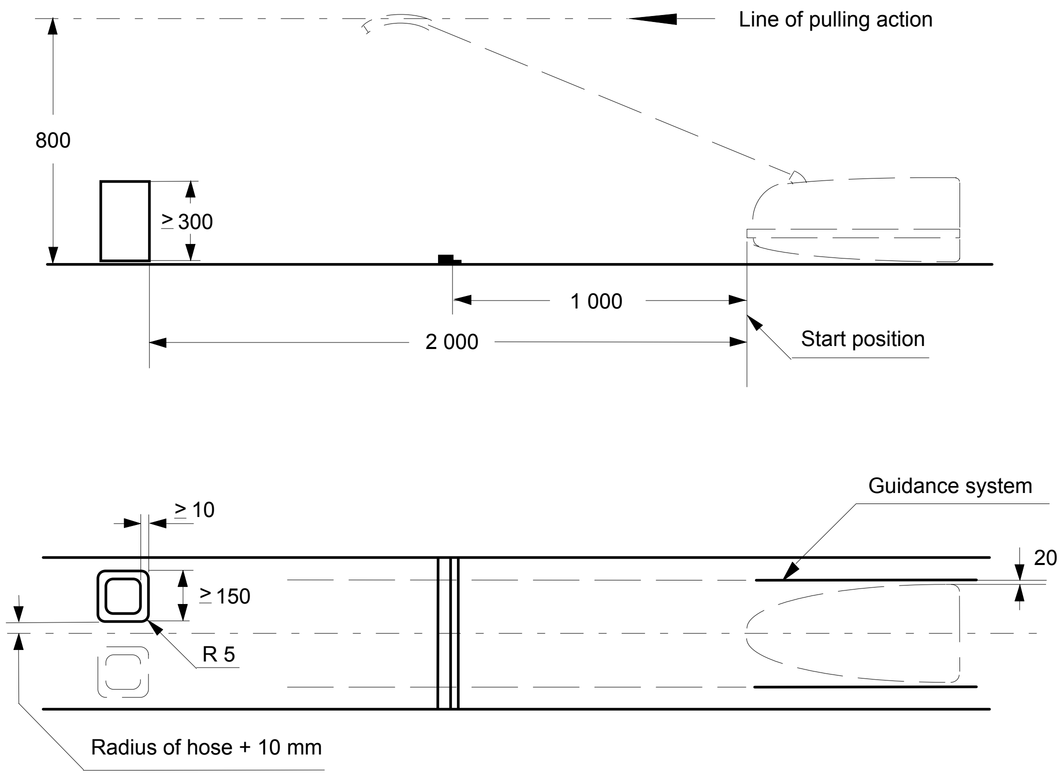


Figure 8b – Arrangements for bump test

The forward movement of the cleaner is brought about by applying a force to the tube grip, at a height of (800 ± 50) mm above the test surface and along its centre line, so as to give the cleaner a velocity of 1 $^{+0}_{-0,1}$ m/s at a distance of 0,8 $^{+0,1}_{-0}$ m beyond its start position.

In order to keep the cleaner close to the centre line during the test, it is recommended to use either a guidance system with suitably low friction allowing a clearance of 20 $^{+0}_{-5}$ mm on either side of the cleaner or a synchronous running trolley with adjustable side boards.

6.6.2 Test cycle

Each test cycle consists of a sequence of 22 forward runs comprising

- 10 overrunnings of the threshold;
- 1 bumping against a doorpost to the left (or right);
- 10 overrunnings of the threshold;

— 1 bumping against a doorpost to the right (or left).

6.6.3 Test procedure

Prior to the test, the cleaner shall be equipped with a clean dust receptacle and filters according to 4.5.

In the case of overrunning of the threshold, the cleaner shall be allowed to come to rest softly at the end of the running distance by ceasing to apply the force to the tube grip when the cleaner has reached a distance of 1,5 m beyond its start position and by using an absorber made from foam rubber.

In the case of bumping against a doorpost, the force applied to the tube grip shall be such as to maintain the test velocity until the moment just before the bump.

After each run, the cleaner is reset to its start position avoiding the loading of its wheels or slide bars. Between each run, a pause of at least 5 s should be allowed.

NOTE For details of automated equipment incorporating a transport belt for resetting the cleaner to its start position, see A.11.

During the test, the cleaner shall run intermittently with periods of 15 min on and 15 min off, which will not necessarily be synchronous with the test cycles.

After every 50th test cycle, the cleaner shall be examined for damages and for its proper function.

NOTE It is recommended that the test is discontinued after 500 test cycles.

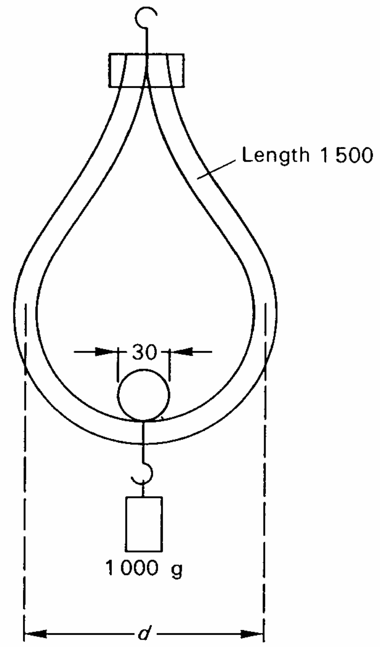
6.7 Flexibility of the hose

The purpose of this test is to determine the ability of the hose to avoid creasing that would restrict the air flow through the hose.

NOTE Standard atmospheric conditions according to 4.1 not required.

6.7.1 Preparation of test object

A length of 1,5 m of the hose is bent in shape of a U, in accordance with Figure 9, the free ends of the hose being clamped close together.



Dimensions in millimetres

Figure 9 – Preparation of hoses for testing flexibility

6.7.2 Determination of the flexibility of the hose

With the test object suspended by the clamp, the greatest distance d_0 between the centre lines of the two legs of the U is measured 1 min after it has been hung up. The greatest distance $d_{1\,000}$ between the centre lines of the two legs is measured again 1 min after the lowest point of the U has been loaded with a weight of 1 000 g.

The flexibility of the hose – higher values implies more flexibility – is calculated from the following formula:

$$\text{flexibility} = \frac{d_0 - d_{1\,000}}{d_0}$$

NOTE If the hose collapses, it should be stated in the test report.

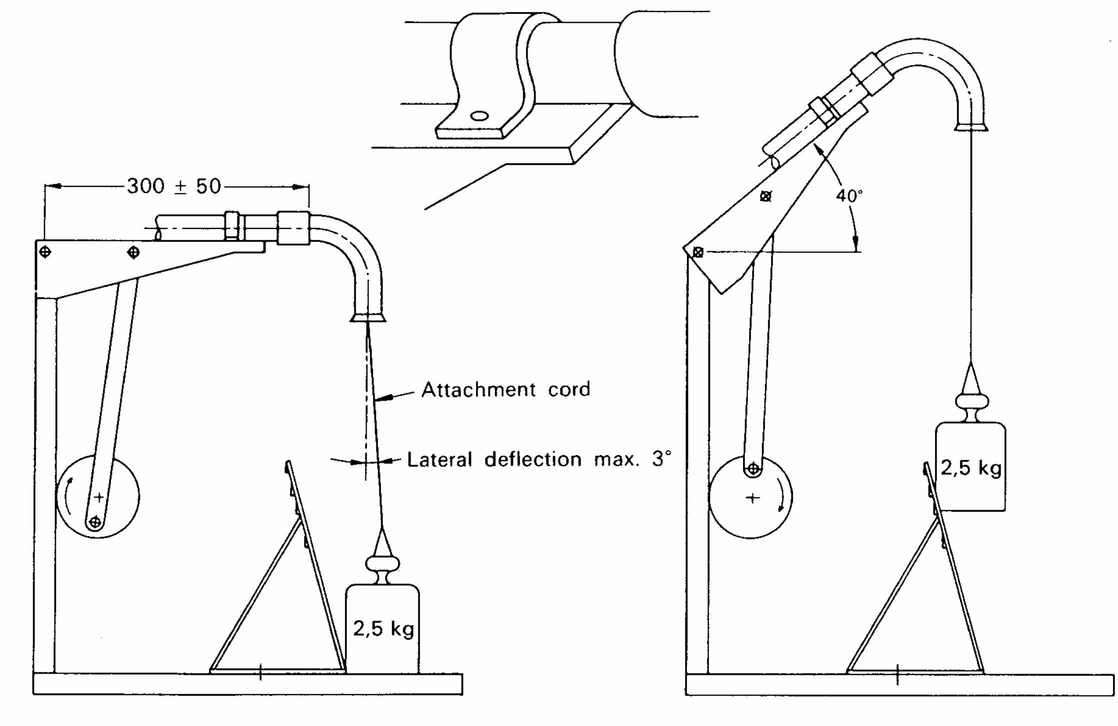
6.8 Repeated bending of the hose

The purpose of this test is to determine the ability of the hose to be repeatedly bent, as in normal use of the vacuum cleaner, before damage causes leakage affecting the performance of the cleaner.

NOTE Standard atmospheric conditions according to 4.1 not required.

6.8.1 Test equipment

The test equipment, in accordance with Figure 10, consists of a pivoting lever with a clamping device for the attachment of the hose connector. The lever is operated by means of an oscillator, for instance the crank mechanism shown, to perform a raising and lowering movement with a frequency of (10 ± 1) periods per minute. The initial position of the lever is its horizontal position from which it is raised to form an angle of (40 ± 1)° with the horizontal plane.



Dimensions in millimetres

Figure 10 – Equipment for repeated bending of hoses

6.8.2 Test method

The hose connector is clamped to the lever so that the distance between the pivot point of the lever and the hose fitting end of the connector is (300 ± 50) mm.

A weight of 2,5 kg is attached to the pendent part of the hose in such a way that, during the oscillation period, it is lifted to a height of (100 ± 10) mm above the mounting plate and, during the remainder of the period, rests on the mounting plate to unload the hose completely. To accomplish this movement, the hose may need to be shortened to a length of about 300 mm.

In order to avoid pendulation of the weight loading the hose, it is given a lateral deflection of maximum 3° by means of an adjustable deflection plate.

The number of oscillations performed until the hose is damaged to the extent that it is deemed unusable is recorded.

NOTE It is recommended that the test is discontinued after 40 000 oscillations.

6.9 Life test

The purpose of this test is to determine the ability of the vacuum cleaner to maintain its air flow performance representative of normal commercial use.

NOTE Standard atmospheric conditions according to 4.1 not required.

Prior to the test, the vacuum cleaner shall have been subjected to air data measurements (see 5.8) in order to determine the maximum air flow of the cleaner with hose fitted, if applicable, and the appropriate setting of a throttle to reduce the air flow to half its maximum value.

With the air flow reduced to half its maximum value, the cleaner is allowed to run intermittently with periods of 14 min 30 s on and 30 s off. If the cleaner is provided with an agitation device, it shall be running but not in contact with the floor.

During the test, the vacuum cleaner shall be equipped with a clean dust receptacle (see 4.5) every 100 h approximately, at which time the maintenance of air flow should be checked and recorded. Filter(s) shall be checked and replaced according to manufacturer's instructions.

If the operation of the machine stops, the time of cessation shall be reported.

NOTE 1 It is recommended that the test is discontinued after 1500 h.

NOTE 2 It is assumed that 250 h equates to 12 months usage.

6.10 Mass

The mass of the vacuum cleaner, attachments and accessories, if any, shall be determined and reported. The mass of the vacuum cleaner includes the contribution of the power supply cord and the accessories placed inside the accessory compartment, if provided, and shall be reported in grams.

NOTE Standard atmospheric conditions according to 4.1 not required.

6.11 Weight in hand

This test method is under development and proposals are requested from National Committees or individual members. It will include twisting and steering force.

6.12 Dimensions

(ADDITIONAL INFORMATION IS REQUIRED BY NATIONAL COMMITTEE FOR WHAT SHOULD BE REPORTED)

Only those dimensions of importance for the storage of the vacuum cleaner shall be reported. All dimensions shall be reported in mm.

6.13 Noise level

See IEC 60704-1 and IEC 60704-2-1.

6.14 Energy consumption

The energy consumption figures for cleaning a carpeted test surface or hard floor surface with diagonal crevices are registered and in each case the equivalent figures for a 10 m^2 area covered by 5 double strokes (cleaned 10 times) are calculated.

The average energy consumption shall be calculated from the measurements for carpet and hard-floor and recorded.

When using an active cleaning head the energy consumption figures are in each case the sum of the values for the vacuum cleaner and the active cleaning head.

6.14.1 Energy consumption when vacuuming of carpets

6.14.1.1 Test requirements

This test is to be carried out with the mechanical test equipment described in 7.2.12.

The test carpet used shall be the Wilton carpet in accordance with 7.1.1.2.1, after pre-treatment to remove loose pile in accordance with 7.1.1.3.

On multi-motor vacuum cleaners all motors should be running during measurements.

The vacuum cleaner is to be fitted with a new dust bag and filter equipment and is to be operated at maximum suction setting.

If a setting mechanism is available on the cleaning head, the operational mode "Carpet" is to be selected (the same as for testing dust removal from carpets).

6.14.1.2 Test procedure

A test surface with length 1 m and the width of the cleaning head is to be traversed with 5 double strokes at the given stroke speed of 0,5 m/s. With this the average effective power intake of the vacuum cleaner including the cleaning head is to be established.

NOTE When it is not possible to run the cleaner head at 0,5 m/s, it is permitted to run it at its self-running speed on condition this is specifically mentioned in the test report.

The areas to accelerate and decelerate the cleaning head are not taken into account. From the average effective power intake and the time taken for 5 double strokes, the average energy consumption for vacuuming of the traversed area is calculated. This figure, which is dependent on the test width (3.14) of the cleaning head, is then used to calculate a figure for a 10 m^2 area.

6.14.1.3 Establishing the average effective power intake

Measurement of the electrical effective power intake is carried out with an accuracy 0,5% related to a measuring range of max. TO BE ESTABLISHED W. The measuring equipment must be controlled such that depending on the movement of the cleaning head at least 10 measurements are taken over each stroke length. The average effective power intake is then calculated as follows:

$$P_{eff} = \frac{1}{10} \times \frac{1}{n} \times \left[\sum_{1}^{10} \left[\sum_{i=1}^{n} P_{eff}(i) \right] \right]$$

where
P_{eff} is the average effective power intake for 5 double strokes in Watt;
$P_{eff}(i)$ is the effective power intake in Watt per measurement;
N is the number of effective power measurements/stroke ($n \geq 10$).

6.14.1.4 Establishing energy consumption

The energy consumption per 10m^2, E(10 m^2) with 5 double stokes, is calculated as follows:

with
$P\ eff$ average power intake
b cleaning head test width
b_{test} on carpets (mm)
b_{trac} on hard floors (mm)
v stroke speed (0,5 m/s)
E energy consumption in Ws

Covered area with the nozzle:

$$A_{tot} = N \times A$$

where

A is the area to clean (10 m^2);

N is number of cleaning processes (5 double strokes);

total track length for cleaning A_{tot};

Stot = Atot/(b × 10^{-3})

Total cleaning time for 10m^2 by 5 double strokes:

$$t_{tot} = s\ tot/v$$

Input power:

$E = P\ eff \times ttot$ $E = P\ eff \times Stot/v$

$E = P_{eff} \times A_{tot}/(b \times 10^{-3}xv)$ $E = Peff \times N \times Al(b \times 10^{-3} \times v)$

And with 10m^2, 5 double strokes (10 strokes) and stroke speed of 0,5 m/s:

$E = Peff \times 10x10/(b \times 10\text{-}^{3} \times 0{,}5)$ $E = P_{eff} \times 2 \times 105/^{btest}$

6.14.2 Energy consumption with vacuuming of hard floors with uneven surfaces

6.14.2.1 Test requirements

This test is to be carried out with the test equipment described in 7.2.12.

The test surface used must be in accordance with 7.2.2. The surface is to be prepared in accordance with 5.2. Each type of surface must be tested and type recorded.

NOTE No dust has to be spread onto the surface.

The vacuum cleaner is to be fitted with a new dust bag and filter equipment and is to be operated at maximum suction setting.

Multi-motor vacuum cleaners should be run with all motors running.

If a setting mechanism is available on the cleaning head, the operational type "Hard floor" is to be selected (the same as for the dust removal test on hard floor).

6.14.2.2 Test procedure

Similar as described in 6.14.1.2.

6.14.2.3 Establishing the average effective power intake

Similar as described in 6.14.1.3.

6.14.2.4 Establishing energy consumption

With P_{eff} measured in accordance with 6.14.1.3 and b = b_{trac}' the energy consumption per 10 m^2, E(10 m^2) with 5 double stokes, is calculated as follows:

$E(10\ m^2) = P_{eff} \times 2 \times 105/_{btrac}$

7 Test material and equipment

This clause contains information on material and on the principal designs of suitable equipment to be used in various tests. It should be noted that only as far as possible the composition of a material (see Annex A) has been specified.

7.1 Material for measurements

7.1.1 Test carpets

7.1.1.1 Quantity and size of carpets

Separate test carpets are to be used for measurements with passive nozzles and with nozzles having rotating brushes, for measurements of fibre removal or dust removal along walls, and for measurement of motion resistance. Each test carpet is duplicated, and preferably procured at the same time; one to be used as the actual test carpet and the other one as a reference carpet.

For measurements of thread removal, fibre removal and dust removal along walls, a suitable size of the test carpet is 1,2 m weft and 2,0 m warp to provide a sufficient test area.

For measurement of dust removal from carpets and motion resistance, a suitable size of the carpet is 0,5 m weft and 2 m warp to provide a sufficient test area.

7.1.1.2 Type and quality of carpets

Whichever carpet is selected for test must be declared in the results along with the reason for using that type.

7.1.1.2.1 International single test carpet (Wilton carpet)

Type	Wilton	
Pile composition	Wool 8,6/2*2	
Method of manufacturing	Wilton fabric	
Colour	Dark, one colour	
Backing	Jute and cotton + latex	
Type	Cut-pile	
Total height	7,5 mm	See tolerances
Pile height	6,4 mm	See tolerances
Total weight/m^2	2100 g/m^2	See tolerances
Pile weight//rn"	1500 g/m^2	See tolerances
Number of knotsrn"	96 000 knots/rn	See tolerances
Reed	320 *rim*	
Shots	300 sch/m	
Standard width	400 cm	
Tolerances	+ 1,5 %	

7.1.1.2.2 Carpet tiles (to be defined)

7.1.1.2.3 Moderately difficult to clean (to be defined)

7.1.1.2.4 Difficult to clean (to be defined)

7.1.1.3 Pre-treatment of carpets for dust removal testing

A new carpet shall be pre-conditioned in the following manner before recordable testing is carried out.

Using a suitable vacuum cleaner, all loose pile and fibre is removed until an amount no greater than 0,1 g is removed during the cleaning process of 5 double strokes on 2 consecutive runs. The weight of the carpet is recorded.

Using a reference cleaner, a dust removal test according to 5.3 is carried out and the result recorded and plotted on a graph. This is repeated until the resulting curve is flat and parallel with the horizontal axis and the difference between the average results of each of two consecutive tests is no greater than 1 percentage point; the carpet is once more weighed and the result should be no more than 2 g higher than the weight recorded after the fibre removal. If so, then further cleaning runs should be made until this weight is within the 2 g tolerance allowed. This weight is the official carpet weight and is to be used between tests to minimize dust build up over the life of the carpet. The maximum allowable deviation from this weight is ${}^{+1}_{-5}$ g.

Separate carpets shall be used for power nozzles and passive nozzles. These separate carpets shall be clearly marked.

7.1.1.4 Verification of replacement carpets

The reference vacuum cleaner shall be used to verify the suitability of replacement carpets when required. If the result is greater than YY percentage points different to the original or first carpet used in the laboratory, then it may not be used.

These figures (YY) are to be determined.

7.1.2 Standard dust type

7.1.2.1 Mineral dust – Type 1

The mineral dust shall consist of dolomite sand with the following grain size distribution and is used in the hard surface, and crevice tests (see also Figure 11):

Particle size range mm	**Parts by weight** %
< 0,020	20
0,020 < 0,040	10
0,040 < 0,075	10
0,075 < 0,125	10
0,125 < 0,25	20
0,25 < 0,5	16
0,5 < 1,0	11
1,0 < 2,0	3

Figure 11 – Grain size diagram for test dust

(Figure 11 needs to be modified to remove references to Mineral dust/wood flour mixture and Wood Flour. The new mineral dusts should be added.)

7.1.2.2 Mineral Dust – Type 2

Measurements of dust removal ability from carpets is carried out with the following test dust.

Test dust: sieved from CEM 1 according to ISO 679, grain size: 0,09 mm I 0,20 mm.

7.1.2.3 Simulated commercial environment dust

Test dust for establishment of the filled dust receptacle condition shall be a homogeneous mixture of

– 70 % by weight mineral dust, in accordance with the grain size distribution as stated in the table below;

– 20 % by weight cellulose dust (Arbocel);

– 10 % by weight cotton linters.

The mineral dust portion of the simulated household dust shall consist of dolomite sand with the following grain size distribution:

Particle size range mm	**Parts by weight** %
< 0,005	9
0,005 < 0,040	5
0,010 < 0,075	8
0,020 < 0,125	11
0,040 < 0,25	10
0,075 < 0,5	7
0,125 < 1,0	0
0,50 < 2,0	24
0,500 < 1,000	6
1,000 < 2,000	0

The cotton linters shall be cut with an upper length of 4 mm in a linters screening mill. Before cutting, the linters shall have been pressed into a bale and stored at a temperature of (20 + 2) °C and a relative humidity of (40+ 5) %. The residual moisture of the cut linters shall not exceed 2,5 %.

The test dust may be obtained ready-mixed or be prepared by adding to a mixing vessel the separate components alternating in the order: mineral dust, cellulose dust, cotton linters. The mixing vessel shall be part of a tumble mixer which can be operated at 28 (tolerance $^{+3}_{-0}$)r/min with a tilting angle of 150°/revolution.

7.1.2.4 Emission test dust

The test dust for measurement of dust emission shall have the following particle size distribution:

Particle size range mm	**Parts by weight** %
< 5	39 ± 2
5 < 10	18 ± 3
10 < 20	16 ± 3
20 < 40	16 ± 3
40 < 80	9 ± 3

7.1.3 Fibre material

For the determination of fibre removal ability, rayon tow according to the following specification is used:

– natural carded viscose flock 1,5 denier;

– dry cut to 19 mm (0,75 in) no finish.

7.1.4 Moulding granules

For the determination of the maximum usable volume of the dust receptacle, injection moulded granules of thermoplastic elastomer (Kraton G7705-Evoprene 961) are used.

7.2 Equipment for measurements

7.2.1 Floor test plate

Tests relating to hard flat floors are carried out on a floor test plate of untreated laminated pine wood or equivalent panel, at least 15 mm thick. Recommended dimensions are 0,5 m × 2,0 m.

7.2.2 Test plates with uneven surfaces

To be defined – two different surface textures are planned.

7.2.3 Carpet-beating machine

A machine suitable for removing all residual dust shall not damage the carpet. One suitable design consists of a horizontal cylinder provided with thongs to beat the backing of the carpet when it is fed back and forth under the rotating cylinder (see Figure 12).

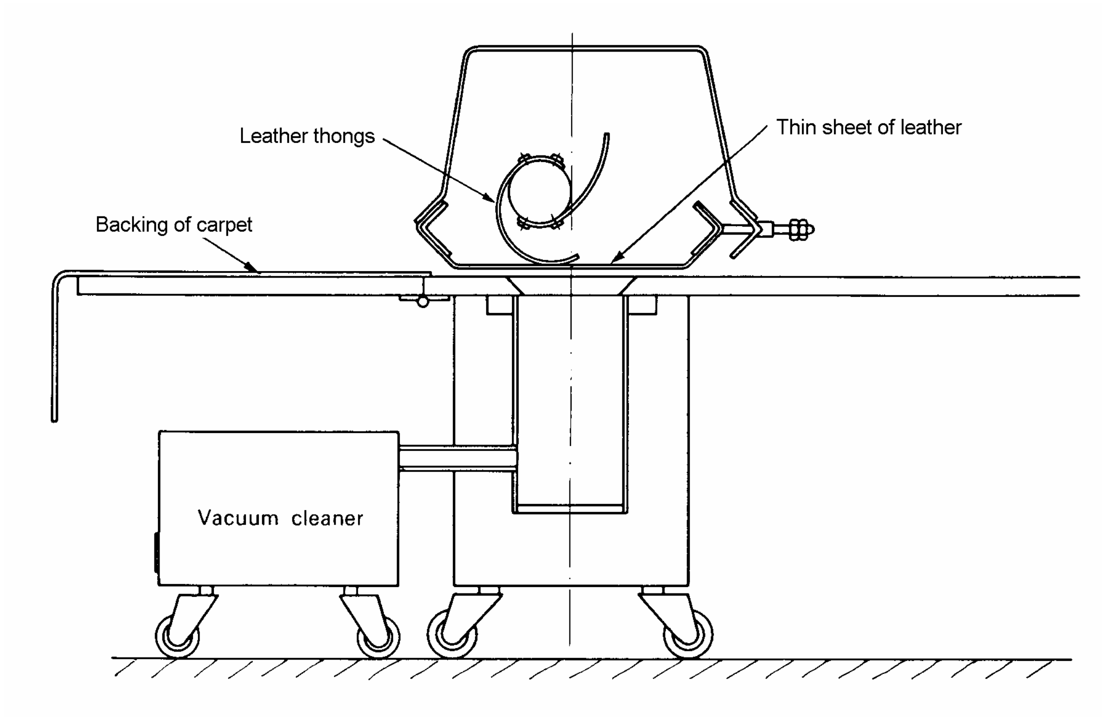


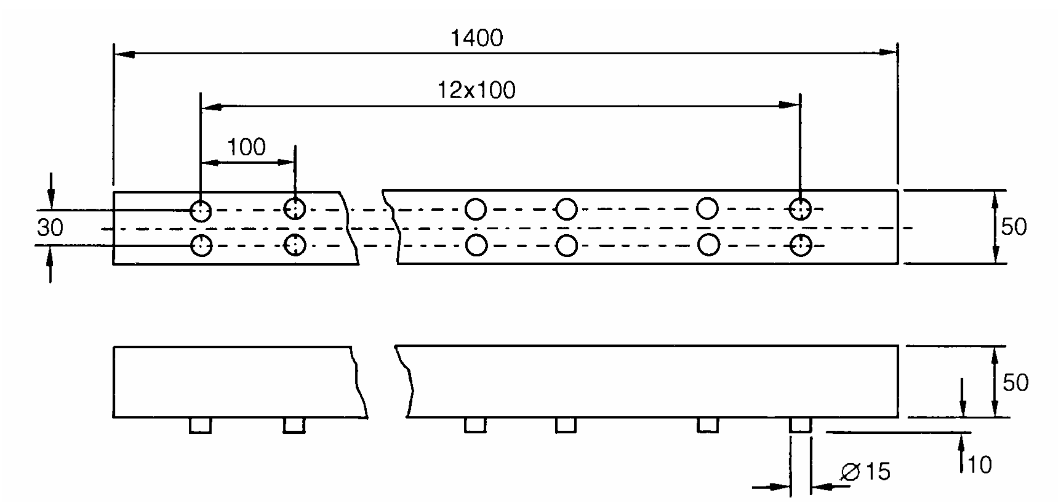
Figure 12 – Carpet-beating machine

7.2.4 Carpet hold-downs and guides

The two carpet hold-downs shall be at least 1,4 m × 0,05 m × 0,05 m in dimension and weigh 10 kg each. They shall be designed in such a way so as not to obstruct the air flow at the sides of the cleaning head (see Figure 13). It is recommended that the edges of the hold-downs adjacent to the cleaning head are treated to reduce friction.

NOTE Low-friction adhesive tape may be used to reduce friction.

The hold-downs should be placed on either side of the test area with a clearance of not more than 5 mm on both sides of the cleaning head.



Dimensions in millimetres

Figure 13 – Carpet hold-downs and guides

7.2.5 Dust spreader

The device consists of a tray extending across the width of the test area and mounted on a trolley, which can be moved along the length of the test area without impinging upon it. When the trolley is moved back and forth over the test area, a vibratory action causes the test dust, which has been placed evenly along the tray, to emerge from a line of suitably sized holes along the base of the tray, equally spaced and sufficient in number to cover the test area uniformly with test dust.

The vibratory action may be brought about by an incorporated vibrator or by the trolley running on spur racks as indicated in Figure 14.

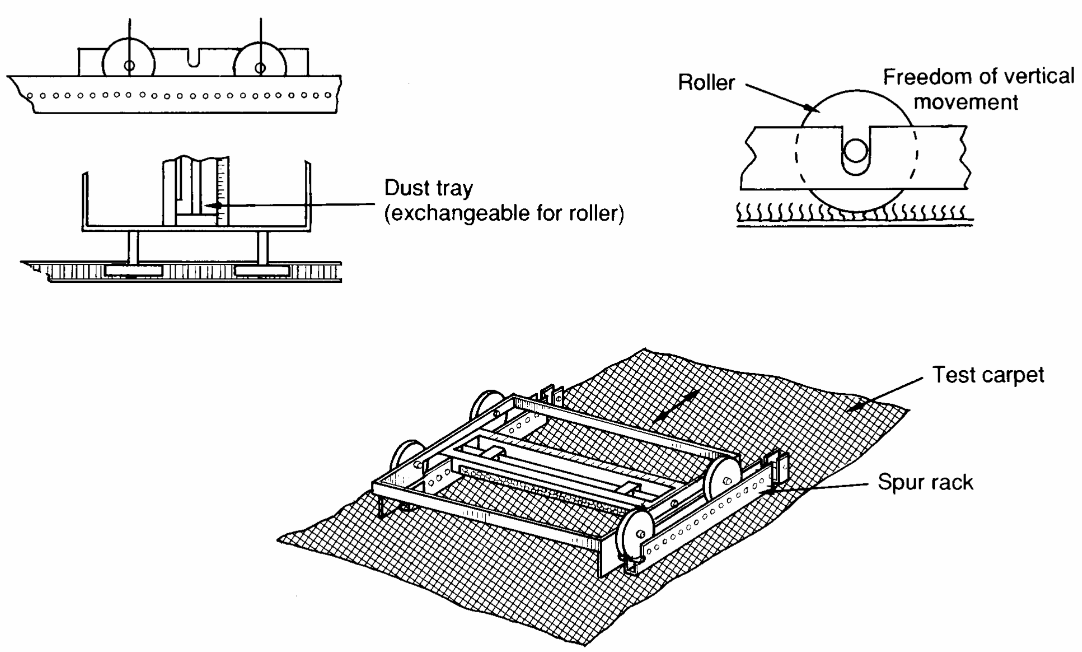


Figure 14 – Dust spreader and roller for embedding dust into carpets

7.2.6 Rollers for embedding

7.2.6.1 Dust embedding roller

The roller shall have a diameter of 50 mm and a length of at least 380 mm such that it is at least 20 mm longer than the test width. The roller is preferably made of steel and polished. It can be provided with a handle for rolling by hand or be driven by a motorized unit.

The mass of the roller, if applicable, shall be 10 kg per metre length. The roller may be incorporated into the dust spreader as indicated in Figure 14.

7.2.6.2 Fibre embedding roller

The roller shall have a diameter of 70 mm and a mass of 30 kg per metre length. The roller is preferably made of solid steel and polished. It can be provided with a handle for rolling by hand or be driven by a motorized unit. A convenient mass for rolling by hand is 15 kg.

7.2.7 Equipment for air data measurement

Two alternatives of equipment are provided, each comprising a wattmeter and a measuring box, to which the vacuum cleaner, a vacuum-meter and means for setting the airflow are connected. The test report shall state which alternative has been used to obtain the air data.

The measuring box shall be made of sheet steel and shall allow the connection of all types of vacuum cleaners. The interior edges of adaptors for the connection of the suction duct, the hose or the connection tube of vacuum cleaners shall be well rounded with a radius of at least 20 mm to prevent interference from contraction and deflection of the air stream.

Measured air data shall be corrected to standard air density conditions if the measurements are carried out at other conditions (see 7.2.8.4). Instruments for measuring temperatures and ambient air pressure should therefore be available.

7.2.7.1 Alternative A

The test set-up and details of the measuring box are shown in Figures 15a and 15b, respectively.

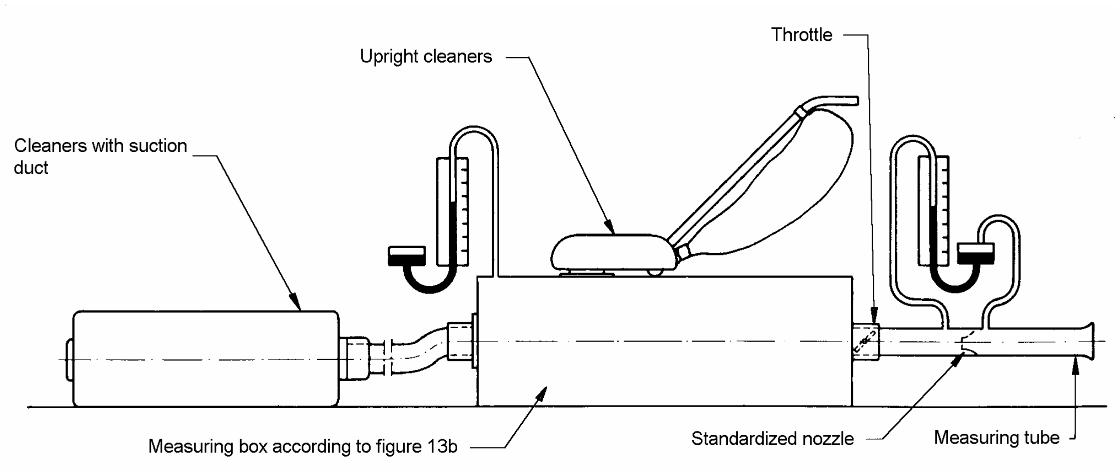


Figure 15a – Alternative A equipment for air data measurements

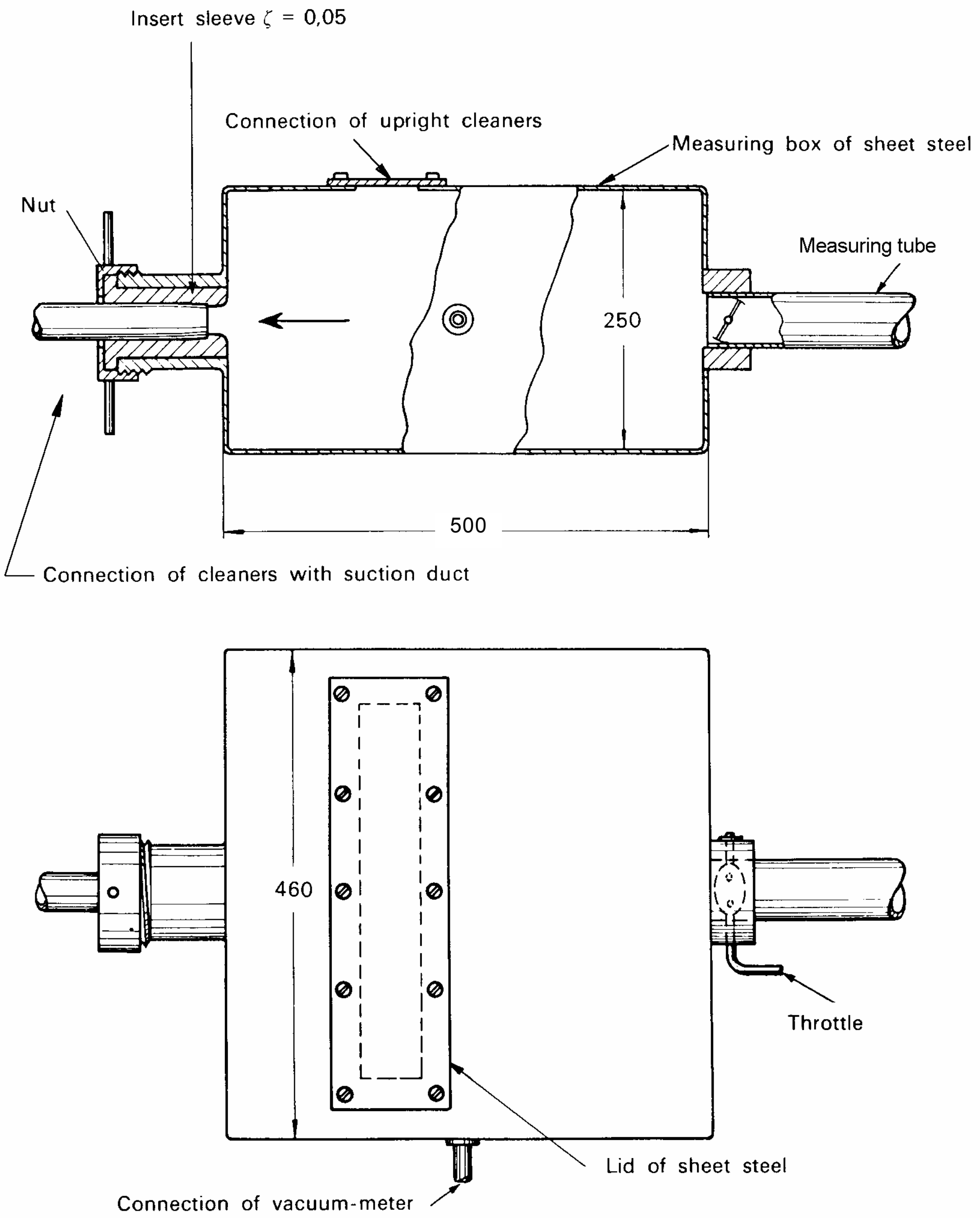


Figure 15b – Measuring box for alternative A

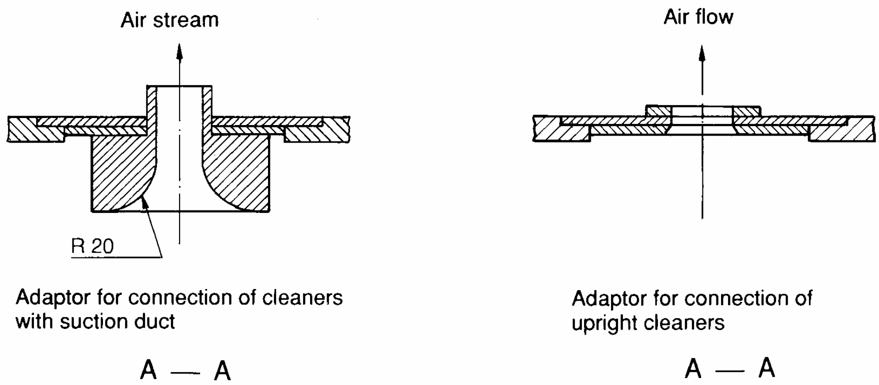
The air flow is established by means of a throttle and a measuring tube with a suitable nozzle or orifice plate in accordance with ISO 5167-1 (see Figure 15a). The accuracy of the measurement shall be ±1 %.

NOTE The measuring tube may be replaced by a tube containing any sort of air flow meter, for instance a gas flow meter, capable of giving the same measuring result as ISO 5167-1.

7.2.7.2 Alternative B

The measuring box (see Figure 15c) shall be 500 mm × 500 mm × 500 mm in internal dimensions with provisions for fastening replaceable orifice plates to establish the air flow.

The outlet for connection of the vacuum-meter shall be located in the vicinity of a corner within 15 mm from adjacent walls.



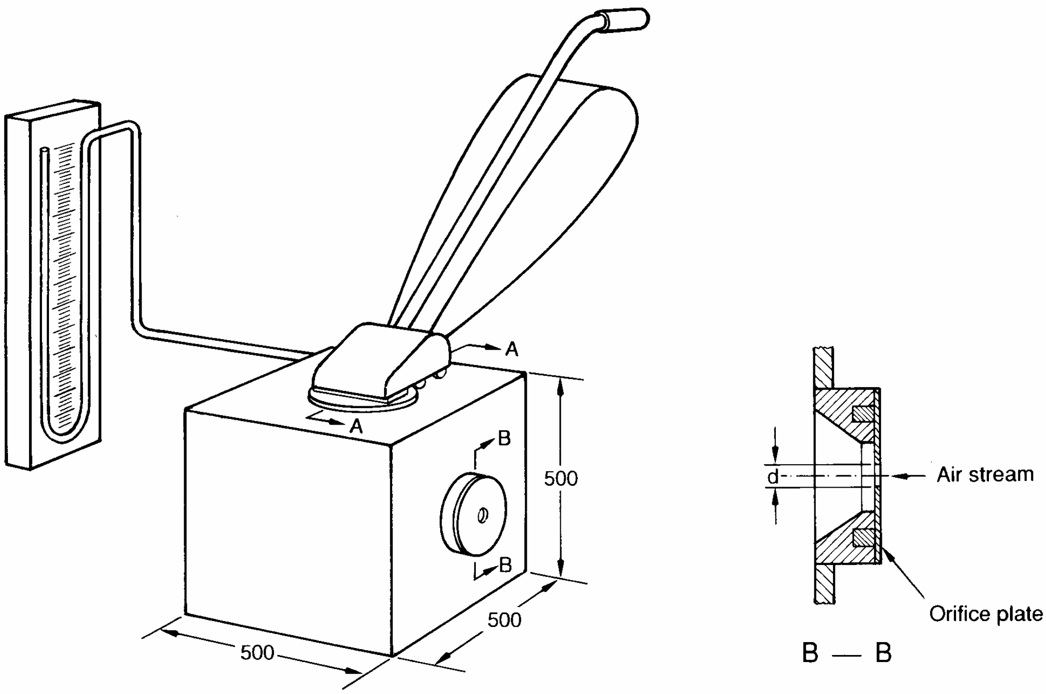


Figure 15c – Alternative B equipment for air data measurements

Figure 15 – Alternative A and B

The air flow is controlled by means of a set of 10 orifice plates with varying orifice sizes and is determined from the observed values of the vacuum. The orifice plates shall be made of sheet steel, (2 ± 0,1) mm in thickness, and have sharp-edged circular openings with nominal diameters D_0 as follows:

Size	0	1	2	3	4	5	6	7	8	9
D_o (mm)	0	6.5	10	13	16	19	23	30	40	50

The orifice plates shall be mounted air-tightly, either in front of an opening in the measuring box or on a protrusion. The flow of air into the box shall be free of disturbance within a hemisphere with a radius of at least 0,5 m, and having passed the orifice, it shall be free of disturbance from built-in parts within a conical region with an angle of 90° relative to the largest orifice diameter.

At standard air conditions, the air flow *q* is given by the following:

$$q = \alpha \times 0{,}032\ d^{2} \sqrt{h} \qquad \mathrm{dm}^3/\mathrm{s}$$

$$\alpha = 0{,}595 + 0{,}0776\ \frac{s}{d} - 0{,}0017\ \mathrm{h}$$

where

α is the orifice coefficient;

d is the orifice diameter, in millimetres;

h is the vacuum, in kilopascals;

s is the thickness of the orifice plate, in millimetres.

Deviations of more than 0,01 mm from the nominal orifice diameter shall be taken into account when calculating the air flow.

7.2.7.3 Instrumentation

The wattmeter for measuring input power shall have an accuracy according to IEC class 0,5.

The vacuum-meter shall have an accuracy of ±0,5 % for alternative A and ±0,01 kPa for alternative B.

The barometer for measuring the ambient air pressure shall not be corrected for sea level and shall have an accuracy of ±0,5 kPa.

The thermometer for measuring ambient air temperature shall have an accuracy of ±0,5 °C.

The thermometer for measuring the exhaust air temperature shall have an accuracy of ±0,5 °C.

7.2.7.4 Correction to standard air density

Series-wound motors, commonly used in vacuum-cleaners, are to a certain extent sensitive to thermodynamic changes in air density as regards motor loading and speed of rotation. To account for the interaction between air density and common characteristics of series-wound motors, measured air data shall be corrected to standard air conditions.

The performance characteristics of vacuum cleaners with series-wound motors have a known relationship to small voltage deviations. To account for this relationship data measured at line voltage V_m outside the rated voltage value range $\frac{V_{rv} - V_m}{V_{rv}}$ $\underline{+}$ 0,25 % must be corrected to the rated voltage value.

The corrected value of the vacuum h is given by

$$h = h_m D_m^{-0,67} \left(\frac{V_{rv}}{V_m} \right)^{+1,33} \quad \text{(kPa)}$$

The corrected value of the input power P_1 is given by

$$P_1 = P_{1m} D_m^{-0,5} \left(\frac{V_{rv}}{V_m} \right)^{+2,00} \quad \text{(W)}$$

The corrected value of the air flow q is given by

$$q = q_m D_m^{+0,17} \left(\frac{V_{rv}}{V_m} \right)^{+0,67} \quad \text{(l/s)}$$

For alternative A, q_m is derived from the pressure difference measured by the measuring tube or from the (not air density corrected) air flow meter readings.

where

$$D_\mathrm{m} = \frac{p_\mathrm{m} + \Delta p_{RH}}{101,3} \times \frac{273}{t_\mathrm{m} + 273}$$

and

$$\Delta p_{RH} = +0.44 - \mathrm{RH} \times \left(2.32 + 0,212 t_m + 0,00028 t_m^3 \right)$$

V_m is the measured real time line voltage, in Volt (V);

V_{rv} is the rated voltage value, in Volt (V);

p_m is the measured ambient air pressure, in kilopascals (kPa);

t_m is the measured ambient temperature, in degrees Celsius (°C);

h_m, q_m , P_{1m} are the values measured at line voltage at ambient air conditions.

h, q ,P_1 are the values corrected to rated voltage and standard air conditions.

RH is the relative humidity, in %.

Δp_{RH} is the ambient pressure correction term, valid for ambient temperature t_m < 35 (°C) and relative humidity RH < 80 %.

NOTE The ambient pressure correction term Δp_{RH} can be neglected when 15°C < t_m < 25°C and 30% < RH < 70 %.

For alternative B, the air flow shall be calculated using the corrected value of the vacuum.

7.2.8 Test equipment for determining the fractional filtration efficiency of the vacuum cleaner

The test equipment is comprised of a test hood, a dust feeder and a particle analysis system including equipment for sampling the aerosol upstream and downstream. All surfaces which may come in contact with the intake or exhaust aerosol are required to have low adhesion for the test dust, being preferably metallic and having a smooth finish.

7.2.8.1 Test hood (informative)

The test hood is shaped as shown in Figure 13. It contains a base plate with edge rails bent upright. For inserting the vacuum cleaner and for connecting the hose and electrical cables, the test hood will have appropriate openings which can be closed airtight when the vacuum cleaner is in operation. The upper end of the test hood tapers to the form of a short pipe of d_i = 100 mm inner diameter which connects to the exhaust chimney.

7.2.8.2 **Dust dispenser** (informative)

The dust dispenser evenly supplies the provided quantity of test dust and disperses the dust into the aerosol channel (see Figure 14) in order to generate the required concentration, c = 0, 1 g / m³, of test dust in the air intake of the vacuum cleaner.

A suitable device consists of a dust reservoir with a portioning and feeding appliance, and a disperser nozzle operating at air flow of 5 m³/h to 20 m³/h according to ISO 5011. The aerosol is blown from the dispenser nozzle into an aerosol channel of d_i = 100 mm, the end of which provides a conical transition to the hose adapter of d_i = 30 mm.

7.2.8.3 **Exhaust channel** (informative)

The entire exhaust air of the vacuum cleaner under the closed test hood has to be conducted through an exhaust channel, as shown in Figure 15.

7.2.8.4 **Particle analyzer system**

The test requires taking aerosol samples, under comparable conditions, of intake air entering, and of exhaust air leaving the vacuum cleaner. Air samples shall be taken isokinetically, i.e. the speeds of air flow in the channel, $v_{channel}$, and at the entry of the sampling system, v_{probe}, are required to satisfy the relation

$$0,8 < v_{probe} / v_{channel} < 1,2$$

The inner diameter of the sampling tube has to conform to the inner diameter of the entry to the analysis system and should be designed as to minimize changes to the sample air.

For flawless particle registration and analysis, it has to be monitored and maintained that the particle concentration at the counter is within its specified range of proper operation and that each individual particle count z_{SAMPLE} is well below the maximum count $z_{COUNTER\_MAX}$, such that

$$z_{SAMPLE} < 0.2\ z_{COUNTER\_MAX}$$

In order to satisfy these conditions, an aerosol dilution system may be employed which reduces the particle concentration in the aerosol sample entering the particle counter, relative to the particle concentration in the aerosol sample being taken from the channel, by a definite and reproducible dilution factor, without altering the population ratios between particle size classes.

The analyzer should be an optical particle counter preferably with a volumetric flow of 28,3 l/min [1cfm] for particle sizes from 0,3 µm to at least 10 µm. These particle sizes are divided into geometrically graded classes, where the size interval q is determined by

$$q = (D_{OK} / D_{UK}) \wedge (1 / k)$$

where

D_{UK} is the minimum recorded particle size;

D_{OK} is the maximum recorded particle size;

k is the number of particle classes.

To reduce the statistical interference, the size interval q should be < 2.

For particle counters with at least 8 configurable size classes, the following graduation is prescribed:

Class (k)	1	2	3	4	5	6	7	8

d_{ui} (µm)	0,3	0,5	0,7	1,1	1,7	2,7	4,2	6,5
d_{ui} (µm)	0,5	0,7	1,1	1,7	2,7	4,2	6,5	10

7.2.9 Device for motion resistance test

The device comprises a wooden plate on which the test carpet is fixed with two hold-downs.

The handle of the vacuum cleaner shall be moved over the test area according to the conditions described for dust removal from test carpets.

For the determination of motion resistance the test plate shall be designed such that the force exerted between cleaning head and carpet in pile direction can be measured in a range from 5 N to at least 100 N.

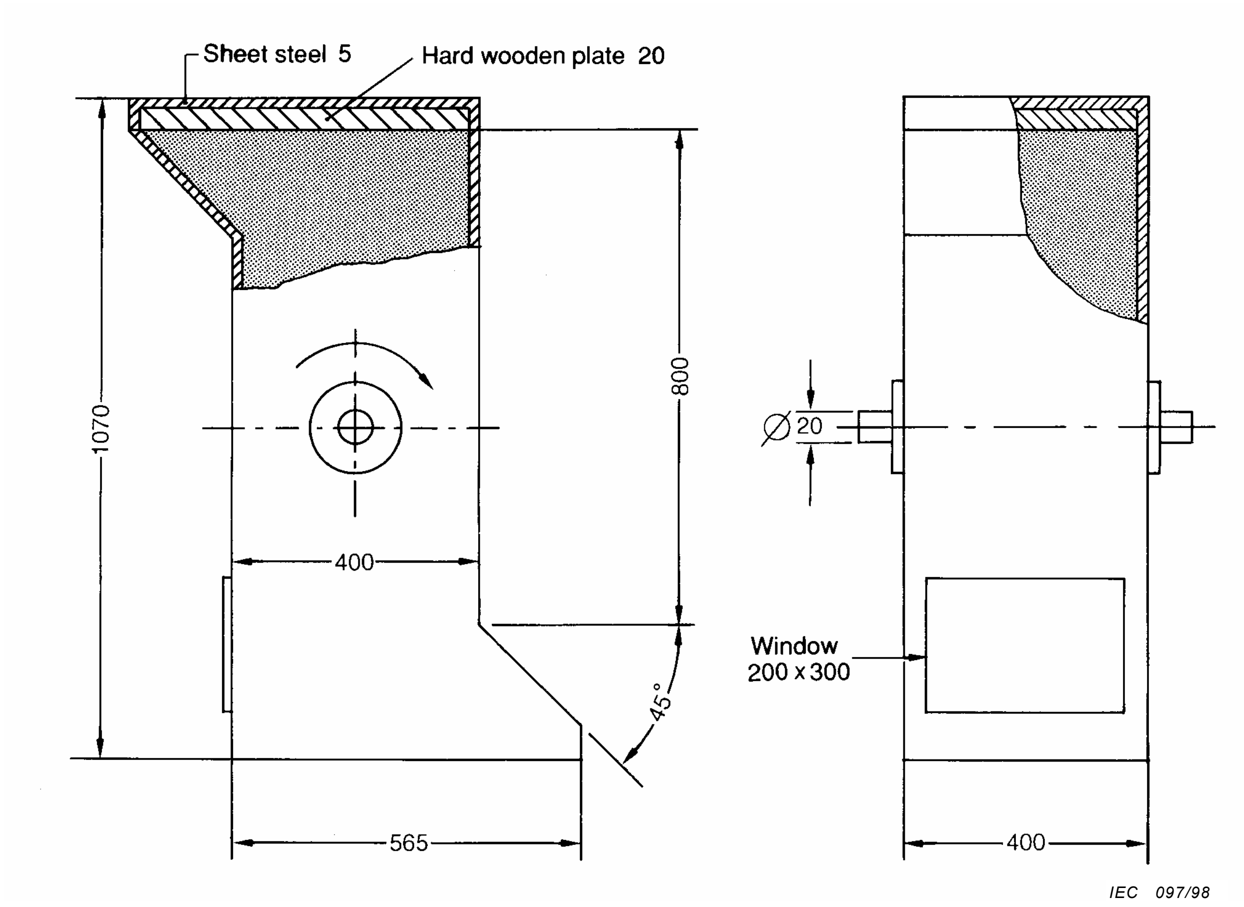
The test set-up shall be constructed in a stiff and low frictional way in order to prevent a distortion of the measurement results. The inherent frequency of the set-up shall be greater than 35 Hz. The measurement values shall be recorded analog or with a time slot pattern smaller or equal to 100 ms.

One realisation comprises a solid base frame, on to which a stiff test plate is arranged connected to the base via flexible elements in pile direction. The exerted force can be deducted from the flexibility of the connecting elements directly or indirectly from the deflection of the test plate.

The described equipment can be incorporated in a mechanical operator as described in Figure 18.

7.2.10 Device for impact test

The device consists of a drum of sheet steel provided with an inspection window and with floors made of sheet steel, 5 mm in thickness, covered with 20 mm thick plates of oak or material of equivalent density and stiffness (see Figure 16).



Dimensions in millimetres

Drive: geared motor and V-belt drive

Speed of rotation: approximately 5 r/min

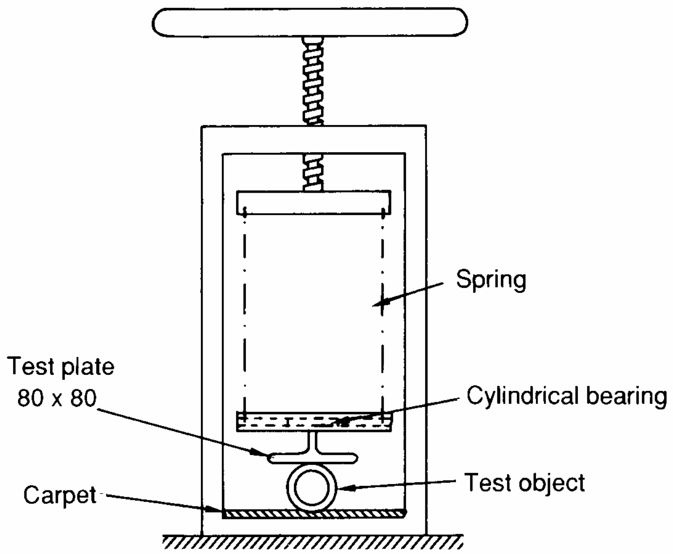
A counter, connected to the shaft of the drum, registers the number of falls to which the nozzle has been subjected.

Figure 16 – Drum for impact test

When the drum is rotated with a speed of about 5 r/min, the test object drops alternately towards one or the other of floors of the drum, the height of fall being 80 cm.

7.2.11 Device for determination of deformation of hoses and connecting tubes

The device, as shown in Figure 17, consists of a screw press with the support covered by a piece of test carpet, in accordance with 7.1.1. The force of the screw press is transmitted by a spring to a test plate of polished steel on a cylindrical bearing, the axis of which is perpendicular to that of the test object.



Dimensions in millimetres

Figure 17 – Device for testing deformation of hoses and connecting tubes

The force applied is indicated on a load indicator and the reduced cross-sectional dimension is measured by a vernier or digital calliper.

7.2.12 Mechanical operator

The principle construction of a mechanical operator is indicated in Figure 18. It consists of a rigid support with a linear drive to carry out double strokes over the test carpet, which has been placed on an incorporated test floor (see 4.2) and is kept in position by hold-downs. As shown in the figure, the equipment may be adapted to measurements of motion resistance by replacing the test floor with the device described in 7.2.9, allowing its wooden plate a sufficient freedom of movement in the direction of the strokes.

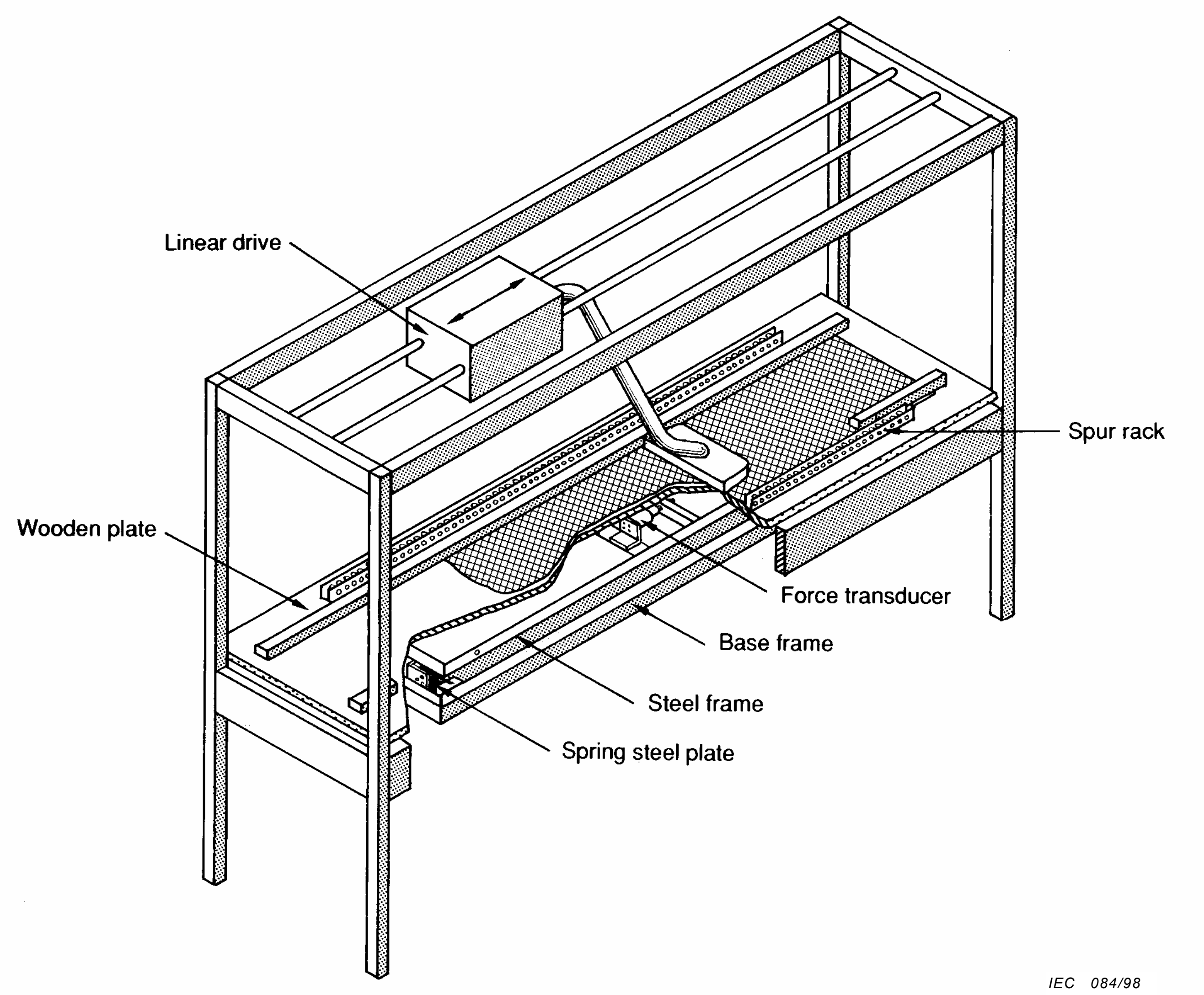


Figure 18 – Mechanical operator for the measurement of dust removal from carpets and of motion resistance

The spur racks, which suggest a way to bring about the vibratory action to the dust spreader depicted in Figure 14, have no function in the motion resistance test.

7.2.13 Weighing machine

The weighing machine used in connection with tests on dust removal ability and for verification of the pre-cleaning of the test carpet shall have an accuracy of 0,01 g.

The weighing machine used in connection with fibre removal tests shall have an accuracy of 0,05 mg.

8 Instructions for use

It shall be checked whether the manufacturer's instructions for use contain information about the use of the appliance and its accessories, if any, and about the cleaning necessary to ensure the proper performance of the appliance.

9 Information at the point of sale

The following information for the consumer shall be provided at the point of sale, if applicable:

a) type of cleaner;
b) voltage/voltage range (V);
c) frequency (Hz);
d) power input (W);
e) cord length (m);
f) weight (g) (the weight of the vacuum cleaner, attachments and accessories);
g) dimensions (dimensions concerning the storage of the vacuum cleaner);
h) noise level;
i) energy consumption (kWh);
j) filtration specification.

Annex A
(informative)

Information on materials

The following information on supplies of test materials and details of test equipment is given for the convenience of users of this PAS and does not constitute an endorsement by IEC of the suppliers named.

A.1 Test carpets according to the specification in 7.1.1 are available from:

7.1.1.2.1 Wilton Wool Carpet

Distributor:

SLG Pruf-und Zertifizierungs GmbH
Burgstadter Strasse 20
D-09232 HARTMANNSDORF
Germany
Fax: +49 3722 7323 99
www.slg.de.com

Manufacturer:

B.I.C. – Carpets
Walle 113
B-8500 Kortrijk
Belgium
Fax: +32 56 23 54 11
www.bic-carpets.be

7.1.1.2.3 Plush and 7.1.1.2.4 Shag Carpet

Distributor:

Textile Innovators
A Division of SDLAtlas
PO Box 8, 101 Forest St.
Windsor, NC 27983 USA
Fax: +01 252.794.9704
E-Mail: info@sdlatlas.com
www.textileinnovators.com

A.2 The mineral dust mentioned in 7.1.2.1 and 7.1.2.4 is available from:

DMT

A.3 The test dust of 7.1.2.2 is available from:

Normensand GmbH
Postfach 1752
Annastrasse 1
D-4720 BECKUM
Germany

A.4 The test dust (SAE J726 Air Cleaner Dust) mentioned in 7.1.2.4 is available from:

Powder Technology Inc.
P.O. Box 1464
BURNSVILLE, Minnesota 5537
USA

A.5 The tow according to the specification in 7.1.3 is available from:

Cellusuede Products, Inc.
500 North Madison Street
ROCKFORD, Illinois 61107
USA

A.6 The moulding granules mentioned in 7.1.4 are available from:

Supplier:

Albis Plastic GmbH
Mühlenhagen 35
D-20539 Hamburg
Germany

Manufacturer:

AlphaGary Ltd.
Beler Way
Melton Mowbray
Leicestershire LE13 ODG
Great Britain

A.7 Details of suitable design of the equipment mentioned in 7.2.12 are available from:

SLG Prüf– und Zertifizierungs GmbH
Burgstädter Strasse 20
D-09232 HARTMANNSDORF
Germany

A.8 Materials for test cushion

The foam, the fleece and the upholstery materials mentioned in 7.1.6 as well as ready-made test cushions are available from:

Foam material (Standard-Polyesterprogramm-Polyaether Type 3545)

Koepp AG
Rheingaustr. 19
D-65375 OESTRICH-WINKEL
Germany

Fleece material (Polyesterwatte "Brilliant 6" 100 g/m^2)

H. Brinkhaus GmbH & Co
Zwischen den Emsbrücken 2
D-48231 WARENDORF
Germany

Upholstery material (Wollvelour Fantasie Dess. 6960/blau, manufacturing width 1 300 mm)

Möbelstoffe GmbH
A. Rogler Sohn
Roglerstr. 2
D-95482 GEFREES
Germany

Test cushion

SLG Prüf- und Zertifizierungs GmbH
Burgstädter Strasse 20
D-09232 Hartmannsdorf
Germany

A.9 Details of the equipment mentioned in 7.6.3 are available from:

SLG Prüf- und Zertifizierungs GmbH
Burgstädter Strasse 20
D-09232 Hartmannsdorf
Germany

A.10 Test carpets according to the specifications in 7.1.1.5 are available from:

Vorwerk & Co Teppichwerke GmbH & Co KG
Kuhlmannstrasse 11
D-31785 Hameln
Germany
Ordering information: "MODENA" FB 82611

A.11 Grease-free pigment (Teppichschmutz I) and sieved carpet dirt (Teppichschmutz II) mentioned in 7.1.2.6 are available from:

WFK
Campus Fichtenhain 11
D-47807 Krefeld
Germany

A.12 An active nozzle (Wessel SEB 215), suitable for working in test soil and removal of loose soiling material as described in 6.2.2.1 and 6.2.2.2,respectively, is available from:

Wessel Werk GmbH
Wildbergerhuette
D-51580 Reichshof
Germany

A.13 Cellulose dust, Arbocel, Egyptian cotton linters, mentioned in 7.1.2.3 as well as ready-mixed dust is available from:

Arbocel 600/30 BE:
J.Rettenmeier & Söhne Fullstoff-Fabriken
D-73494 ELLWANGEN-HOLZMÜHLE
Germany

Egyptian cotton linters:
Powder Technology, Inc.
P.O Box 1464
Burnsville, MN55337
USA

Ready-mixed dust:
Deutsche Montan Technologie GmbH
Am Technologiepark
D-45139 ESSEN
Germany

Annex B
(informative)

Information at the point of sale

The following information for the consumer should be provided at the point of sale, if applicable:

a) type of cleaner
b) voltage/voltage range (V);
c) frequency (Hz);
d) power input (W);
e) cord length (m);
f) weight (g) (the weight of the vacuum cleaner, attachments and accessories);
g) dimensions (dimensions concerning the storage of the vacuum cleaner);
h) noise level;
i) energy consumption (kWh);
j) filtration specification.

Annex C
(informative)

Information on materials

The following information of supplies of test materials and details of test equipment is given for the convenience of users of this PAS and does not constitute an endorsement by IEC of the suppliers named.

C.1 Test carpets according to the specification in 7.1.1 are available from:

C.1.1 Wilton Wool Carpet

Distributor:

SIG Pruf-und Zertifizierungs GmbH
Burgstadter Strasse 20
0-09232 HARTMANNSDORF
Germany
Fax: +49 3722 7323 99
www.slg.de.com
7.1.1.2.2, 7.1.1.2.3 and 7.1.1.2.4
To be advised

Manufacturer:
B.I.C. – Carpets
Walle 113
B-8500 Kortrijk
Belgium
Fax: +32 56 23 54 11
www.bic-carpets.be

C.1.2 The mineral dust mentioned in 7.1.2.1 and 7.1.2.4 is available from:

DMT

C.1.3 The test dust of 7.1.2.2 is available from:

Normensand GmbH
Postfach 1752
An nastrasse 1 0
4720 BECKUM
Germany

C.1.4 The test dust (SAE J726 Air Cleaner Dust) mentioned in 7.1.2.4 is available from:

Powder Technology Inc.
P.O. Box 1464
BURNSVIllE, Minnesota 5537
USA

C.1.5 The tow according to the specification in 7.1.3 is available from:

Cellusuede Products, Inc. 500
North Madison Street
ROCKFORD, Illinois 61107
USA

C.1.6 The moulding granules mentioned in 7.1.4 are available from:

Supplier:

Manufacturer:
Albis Plastic GmbH
MLihlenhagen 35 0-
20539 Hamburg
Germany

Manufacturer
AlphaGary Ltd.
Beier Way
Melton Mowbray
Leicestershire
LE13 ODG
Great Britain

C.1.7 Details of suitable design of the equipment mentioned in 7.2.12 are available from:

SLG PrLif- und Zertifizierungs GmbH
Burgstadter Strasse 20
0-09232 HARTMANNSDORF
Germany

C.1.8 Details of the equipment mentioned in 7.6.3 are available from:

SLG PrLif- und Zertifizierungs GmbH
Burgstadter Strasse 20
0-09232 Hartmannsdorf
Germany

C.1.9 Cellulose dust, Arbocel, Egyptian cotton linters, mentioned in 7.1.2.3 as well as ready mixed dust is available from:

Arbocel 600/30 BE
:
J.Rettenmeier & Sbhne Fullstoff-Fabriken
0-73494 ELLWANGEN-HOLZMOHLE
Germany

C.1.10 Egyptian cotton linters:

Powder Technology, Inc.
P.O Box 1464
Burnsville,
MN55337 USA

C.1.11 Ready-mixed dust:

Deutsche Montan Technologie GmbH Am
Technologiepark
0-45139 ESSEN
Germany

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Amendment 1 ((2004)
Amendment 2 (2006) [1]

IEC 60335-2-2:2002, *Household and similar electrical appliances – Safety – Part 2-2: Particular requirements for vacuum cleaners and water-suction cleaning appliances*
Amendment 1 ((2004)
Amendment 2 (2006) [2]

IEC 60335-2-9:2008, *Household and similar electrical appliances – Safety – Part 2-9: Particular requirements for grills, toasters and similar portable cooking appliances*

ISO 2439, *Flexible cellular polymeric materials – Determination of hardness (indentation technique)*

ISO 3386-1, *Polymeric materials, cellular flexible – Determination of stress-strain characteristics in compression – Part 1: Low-density materials*

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[1] There exists a consolidated edition 4.2 (2006) that includes IEC 60335-1 (2001), its amendment 1 (2004) and amendment 2 (2006).

[2] There exists a consolidated edition 5.2 (2006) that includes IEC 60335-1 (2002), its amendment 1 (2004) and amendment 2 (2006).

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