

Vacuum cleaners for household use — Methods of measuring the performance

ICS 97.080

National foreword

This British Standard is the UK implementation of EN 60312:2008. It is identical to IEC 60312:2007. It supersedes BS EN 60312:1998 which will be withdrawn on 1 February 2011.

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

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CENELEC

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Foreword

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The following subclauses have been updated:

- 2.9 on performance with partly filled receptacle;
- 2.10 on determination of dust emission of the vacuum cleaners;
- 4.14 on energy consumption.

The following dates were fixed:

- | | | |
|--|-------|------------|
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Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60312:2007 was approved by CENELEC as a European Standard without any modification.

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VACUUM CLEANERS FOR HOUSEHOLD USE – METHODS OF MEASURING THE PERFORMANCE

Section 1: General

1.1 Scope

This International Standard is applicable to vacuum cleaners for household use in or under conditions similar to those in households.

The purpose of this standard 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, reference is made to IEC 60335-1 and IEC 60335-2-2.

1.2 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 60704-1:1982, *Test code for the determination of airborne acoustical noise emitted by household and similar electrical appliances – Part 1: General requirements*

IEC 60704-2-1:1984, *Test code for the determination of airborne acoustical noise emitted by household and similar electrical appliances – Part 2-1: Particular requirements for vacuum cleaners*

ISO 554:1976, *Standard atmospheres for conditioning and/or testing – Specifications*

ISO 679:1989, *Methods of testing cements – Determination of strength*

ISO 2439:1997, *Flexible cellular polymeric materials – Determination of hardness (indentation technique)*

ISO 3386-1:1986, *Polymeric materials, cellular flexible – Determination of stress-strain characteristics in compression – Part 1: Low-density materials*

ISO 5167:2003 (all parts), *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full*

CIE 15.2:1986, *Colorimetry*

1.3 Definitions

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

1.3.1

cleaning head

that part of a vacuum cleaner which is applied to a surface to be cleaned

NOTE The cleaning head may be a plain nozzle or a brush attached to a connecting tube, a power nozzle, or form part of the cleaner housing.

1.3.2

power nozzle

cleaning head provided with an agitation device to assist dirt removal

NOTE 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).

1.3.3

self-propelled cleaning head

cleaning head provided with propulsion mechanism

1.3.4

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

1.3.5

double stroke

one forward and one backward movement of the cleaning head between two parallel lines perpendicular to the direction of the forward movement

1.3.6

forward stroke

forward movement of a double stroke

NOTE On test carpets if not otherwise specified, forward strokes are carried out in the direction of the carpet pile (direction of manufacture).

1.3.7

return stroke

backward movement of a double stroke

1.3.8

stroke length

distance between the two parallel lines defining the limits of a double stroke

1.3.9

stroke pattern

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

1.3.10

parallel pattern

stroke pattern where the forward and the return strokes coincide

1.3.11

zig-zag pattern

stroke pattern where the return stroke is directed slantwise towards the starting point of the next forward stroke (see figure 1)

1.3.12**test width**

outside width of the cleaning head less 20 mm

1.3.13**track width**

width of the visible track left in the dust-covered area of a given surface after a forward stroke with the vacuum cleaner in operation, the cleaning head being in full contact with the surface and adjusted in accordance with the manufacturer's instructions

1.3.14**stroke width**

track width less 20 mm

1.3.15**active depth of 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

1.3.16**stroke speed**

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

1.3.17**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

1.3.18**specific cleaning time**

time required for one cleaning cycle of an unobstructed area of 1 m²

1.3.19**dust removal ability**

ratio, in per cent, of the quantity of dust removed during a specified number of cleaning cycles to the quantity of dust distributed on a test area

1.3.20**thread removal ability**

ratio, in per cent, of the number of threads removed during one cleaning cycle to the number of threads distributed on a test carpet

1.3.21**fibre removal ability**

time, in seconds, required to remove a quantity of fibres from a test surface

1.4 General conditions for testing**1.4.1 Atmospheric conditions**

Unless otherwise specified, the measurements shall be carried out under the following conditions (in accordance with ISO 554):

Standard atmosphere 23/50

Temperature: $(23 \pm 2) ^\circ\text{C}$
 Relative humidity: $(50 \pm 5) \%$
 Air pressure: 86 kPa to 106 kPa

NOTE 1 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.

NOTE 2 Reference for laboratories for setting the correct values:

Wet-bulb temperature: $16,3 ^\circ\text{C}$
 Vapour pressure: 1,41 kPa
 Water content: 8,8 g/kg dry air

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

1.4.2 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 24 h at standard atmospheric conditions according to 1.4.1.

1.4.3 Voltage and frequency

Measurements shall be carried out at rated voltage with a tolerance of $\pm 1 \%$ 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.

NOTE 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 must be reported.

1.4.4 Running-in of vacuum cleaner and attachments

Prior to the initial test, the vacuum cleaner and its 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.

1.4.5 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 % of its original weight. Brushing or washing of textile receptacles is not allowed; however, plastic receptacles may be washed and dried thoroughly.

NOTE If the vacuum cleaner has additional filter(s) and the manufacturer's instructions recommend periodic cleaning or replacement of the filter(s), the above requirements also apply, unless it is evident that reusing such filters will not significantly affect the test result.

1.4.6 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.

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.

During measurements where the agitation device of an upright cleaner or a power nozzles is not used as in normal operation, it shall be running but not in contact with the floor.

1.4.7 Conditioning prior to tests

Prior to each test, the vacuum cleaner with its accessories, attachments, disposable dust receptacles and additional filters to be used during a test shall be kept for at least 24 h at standard atmospheric conditions according to 1.4.1.

The vacuum cleaner and attachments to be used shall then be kept running for at least 10 min under the provisions given in 1.4.4 to allow them to stabilize.

1.4.8 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.

1.4.9 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 5.2.13. 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.

1.4.10 Number of samples

Measurements of performance, for instance for comparative testing, shall be carried out on a single 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.

1.4.11 Reference cleaner system

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 recommended that an in-house reference cleaner system be used to regularly check the carpet conditions as a verification of the test results obtained.

Section 2: Dry vacuum cleaning tests

2.1 Dust removal from hard flat floors

2.1.1 Test equipment

A floor test plate in accordance with 5.2.1 shall be used.

2.1.2 Test area and stroke length

The length and the width of the test area (dust-covered part of the floor test plate) shall be 0,7 m and 1,0 m, respectively.

The stroke length shall be 0,7 m plus twice the active depth of the cleaning head by adding to each end of the test area a length equal to the active depth (see figure 2).

2.1.3 Distribution of test dust

35,0 g of mineral dust, in accordance with 5.1.2.1, shall be distributed as uniformly as possible over the test area.

For uniform distribution of the test dust, a distribution device (see figure 4), handled by a skilled test operator, or any equivalent method, may be used. It is recommended to use a 0,7 m × 1,0 m frame to ensure that all test dust is distributed within the test area.

2.1.4 Determination of track width and stroke width

Mineral dust shall be distributed over the test area in accordance with 2.1.3.

Under normal operating conditions the cleaning head is passed over the test area with one forward stroke at a stroke speed of $(0,50 \pm 0,02)$ m/s.

The track width, in millimetres, is determined as the mean value of five measurements of the width of the visible track along the stroke, at points approximately equally spaced.

NOTE To determine the track width left by a cleaning head on a carpet, the test dust is distributed over a similar area of a test carpet but not embedded into it.

The stroke width of the cleaning head is derived from the track width in accordance with 1.3.14.

2.1.5 Test method

The stroke width is marked on two scales, situated parallel to the upper and lower border lines of the test area at a distance equal to the active depth of the cleaning head, the marked scales being used as guides for the correct positioning of the strokes during the cleaning (see figure 1).

The cleaning head is moved over the test area in a zig-zag pattern, until the entire test area has been covered. In order to obtain an approximately symmetrical distribution of the forward and backward strokes over the test area, the first (blind) forward stroke shall be carried out immediately outside the test area starting at the lower left corner. The last strip to be cleaned is usually narrower than the stroke width. This constitutes one cleaning cycle.

The cleaning is carried out at a stroke speed of $(0,50 \pm 0,02)$ m/s, taking care that the cleaning head is in full contact with the test floor and no additional force exerted on it.

To check the average speed of the cleaning head, it is recommended to use a metronome or similar device.

2.1.6 Determination of dust removal ability

Three separate measurements are carried out, each comprising one cleaning cycle.

After each measurement, the surface of the test plate is wiped with a dry cotton cloth having good dust adherence, which is weighed before and after the wiping to determine the amount of dust remaining after the cleaning. Any dust pushed out of the test area shall be included.

The dust removal ability in per cent, often higher than 98 %, is calculated as the mean value from the three measurements; the result of one measurement being given by:

$$k_{hf} = \frac{m_d - m_r}{m_d} \times 100$$

where

k_{hf} is the dust removal ability for one cycle, in per cent;

m_d is the dust quantity distributed on the test floor, in grammes (35 g);

m_r is the amount of dust wiped off with the cloth, in grammes.

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 $0,3 \times (100 \% - \text{mean value})$, 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.

2.2 Dust removal from hard floors with crevices

2.2.1 Test equipment

The equipment, in accordance with 5.2.2, consists of a test plate incorporating a removable insert with a crevice, the angle between the crevice and the direction of strokes being 45°.

To assist in keeping the cleaning head to the centre of the test plate during measurements, the equipment is provided with a guide strip, along which the connecting tube of a cleaner with suction hose or the cleaner housing of an upright cleaner is run and which should be kept as low as possible for accuracy.

NOTE The angle of 45°, chosen to obtain a better accuracy of measurements, is accounted for in the formula for determining the dust removal ability.

2.2.2 Distribution of test dust

The insert is weighed and its crevice thereafter filled with mineral dust, in accordance with 5.1.2.1. After levelling the surface of the dust with a rubber scraper, the insert is again weighed and carefully replaced in the test plate, avoiding shaking.

2.2.3 Determination of dust removal ability

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

The dust removal ability, in per cent, is calculated according to the following formula as the ratio of the quantity of dust removed to the quantity of dust in that part of the crevice which is determined by the track width (see 2.1.4) and accounting for the oblique angle of 45°:

$$k_{cr} = \frac{m_L - m_r}{m_L} \frac{L}{B} \cos 45^\circ \times 100$$

where

k_{cr} is the dust removal ability, in per cent;

m_L is the dust quantity in the crevice before cleaning, in grammes;

m_r is the dust quantity remaining in the crevice after cleaning, in grammes;

L is the length of the crevice, in millimetres;

B is the track width, in millimetres.

Two separate measurements shall be carried out to establish a mean value of the dust removal ability for one double stroke, k_{cr1} , and for five double strokes, k_{cr5} , to be reported separately.

2.3 Dust removal from carpets

2.3.1 Test carpet

A test carpet, in accordance with 5.1.1, shall be used. 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 24 h before the test is due to commence. During measurements the carpet is kept in position on the test floor by the use of carpet hold-downs (see 5.2.4).

2.3.2 Test area and stroke length

The length of the test area (dust-covered part of the carpet) shall be 0,7 m in the direction of the carpet pile (see figure 7b). The width of the test area shall be equal to the test width (see 1.3.12).

The stroke length shall be 1,2 m by adding 0,2 m before and 0,3 m after the test area. These additional lengths are required for acceleration and deceleration of the cleaning head in order to achieve a uniform speed over the test area.

2.3.3 Cleaning cycle

The cleaning head is positioned with its front edge at the beginning of the acceleration area (see figure 7b) and centred so that it overlaps the test area by 10 mm at either side.

The cleaning head is moved forward over the test area at a stroke speed of $(0,50 \pm 0,02)$ m/s and stopped when its front edge is at the end of the deceleration area. The cleaning head is then pulled backwards over the test area at a stroke speed of $(0,50 \pm 0,02)$ m/s until its front edge is once more at the start of the forward stroke. This constitutes one complete cleaning cycle.

It is important that the cleaning head be kept moving at uniform speed over the test area and that it follows a straight line by using the carpet hold-downs as guides. It is recommended that a mechanical operator (see 1.4.9) be used to simulate the operation of the cleaning head as described.

NOTE 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 operated over the test area.

2.3.4 Conditioning of test carpet

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

2.3.4.1 Removal of remaining dust

For cleaning of the test carpet, it is recommended to use a suitable carpet-beating machine such as described in 5.2.3.

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 plain nozzles should only be cleaned with a plain nozzle on the face (although an agitator cleaner or a power nozzle may be used on the back).

2.3.4.2 Verification and preconditioning

After cleaning of the test carpet, the vacuum cleaner under test shall be equipped with a clean dust receptacle (see 1.4.5) 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 1.4.11).

2.3.5 Distribution of test dust

Test dust, in accordance with 5.1.2.2, 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 5.2.5 be used. The adjustment of the device is checked by visual examination of the test dust on the carpet.

2.3.6 Embedding of dust into carpet

The dust shall be embedded into the test carpet by carrying out 10 double strokes over the carpet in the direction of the warp with a roller, in accordance with 5.2.6.1. The speed of the roller shall be 0,5 m/s. 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.

2.3.7 Preconditioning of dust receptacle

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

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

NOTE Since 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 stabilized before weighing.

2.3.8 Determination of dust removal ability

Three separate measurements, each comprising five cleaning cycles, shall be carried out. Prior to each measurement, the sequence of preparations outlined in 2.3.4 to 2.3.7 shall be performed in total. After the fifth cleaning cycle, lift the cleaning head between 20 mm and 100 mm clear of the carpet, switch the cleaner off and wait until the motor has stopped completely.

After each measurement, the amount of dust removed is determined by removing and weighing the dust receptacle, then subtracting the weight of the empty dust receptacle recorded after the preconditioning described in 2.3.7.

The dust removal ability, in per cent, is calculated as the mean value from the three measurements according to the following formulae:

$$D_r = W_f - W_i$$

$$K_{ct} = D_r / D_d \times 100$$

$$K_m(3) = (K_{ct1} + K_{ct2} + K_{ct3}) / 3$$

where

W_i is the weight of the initially empty dust receptacle, in grammes;

W_f is the weight of the dust receptacle after five cleaning cycles, in grammes;

D_r is the amount of dust removed from the carpet, in grammes;

D_d is the amount of dust distributed on the carpet, in grammes;

K_{ct} is the dust removal ability for one measurement, in per cent;

$K_m(3)$ is mean dust removal from three measurements, in per cent.

If the range of results is greater than three percentage units, two extra measurements shall be made and the mean dust removal ability be calculated from the five measurements, i.e.:

$$K_m(5) = (K_{ct1} + K_{ct2} + K_{ct3} + K_{ct4} + K_{ct5}) / 5$$

Example: 45 %, 47 % and 49 % give a range of four percentage units and two extra measurements shall be carried out.

2.4 Dust removal along walls

2.4.1 Test equipment and materials

A right-angled T in accordance with figure 8, 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.

For measurements on carpets, a test carpet in accordance with 5.1.1 shall be used. For measurements on hard flat floors, a floor test plate in accordance with 5.2.1 shall be used.

2.4.2 Distribution of test dust

A sufficient amount of mineral dust, in accordance with 5.1.2.1, shall be distributed over an area of the test surface corresponding to the extremities of the T to ensure good visible coverage.

2.4.3 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 8).

One double stroke is carried out at a speed of $(0,25 \pm 0,05)$ 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.

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

2.5 Fibre removal from carpets and upholstery

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

2.5.1 Fibre removal from carpets

2.5.1.1 Test carpet

A test carpet, in accordance with 5.1.1, shall be used. Test carpets designated for fibre removal tests shall not be used for other tests.

NOTE It is recommended to use a dark-coloured unpatterned test carpet.

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

2.5.1.2 Distribution of fibres

For the distribution of fibres, a stencil, in accordance with figure 10a, shall be used. The stencil shall be 3 mm in thickness, have 95 holes, 30 mm in diameter, and be free from burrs. The stencil shall be placed on the test carpet with its 1 000 mm long sides parallel to the warp.

(150 ± 5) mg of fibre material, in accordance with 5.1.3, shall be plucked by hand into 95 approximately equal portions, which are then pressed by the thumb, without rubbing, in the centres of the holes of the stencil.

After removing the stencil, the fibres are embedded into the carpet by carrying out five double strokes with a roller, in accordance with 5.2.6.2. The direction of the strokes shall be at right angles to the warp of the carpet, and the stroke speed shall be about 0,5 m/s. If the roller is less than 1 m in length, the rolling schedule is repeated until the entire test area has been covered.

2.5.1.3 Determination of fibre removal ability from carpets

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

The cleaning head is passed once over the fibre-covered area in a zig-zag pattern with the forward strokes at right angles to the warp. Remaining fibres may then be removed by carrying out strokes in the direction of the pile not following a specific pattern. The stroke speed shall be (0,5 ± 0,02) m/s and care shall be taken that the cleaning head is in full contact with the test carpet during the cleaning.

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

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

2.5.2 Fibre removal from upholstery

2.5.2.1 Test cushion

A test cushion, in accordance with 5.1.6, shall be used. Prior to each measurement, the surface of the test cushion shall be cleaned thoroughly until the cushion surface is visually free of remaining fibres.

The test cushion shall be placed in a wooden frame, in accordance with figure 10b, to give a working height of about 480 mm above the floor. The frame shall be provided with an adjustable stop strip, which shall rest on the test cushion and be immovable during the measurements.

2.5.2.2 Distribution of fibres

For the distribution of fibres, a stencil, in accordance with figure 10c, shall be used. The stencil shall be 2 mm in thickness, have 23 holes, 30 mm in diameter, and be free from burrs.

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

(45 ± 1) mg of fibre material, in accordance with 5.1.3, shall be plucked by hand into 23 approximately equal portions, which are then pressed by the thumb, without rubbing, in the centres of the holes of the stencil.

2.5.2.3 Determination of fibre removal ability from upholstery

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

After removing the stencil, the cleaning head is passed once over the fibre-covered area in a zig-zag pattern with the forward strokes at right angles to the stop strip. Remaining fibres may then be removed by carrying out strokes parallel to the stop strip not following a specific pattern. Fibres, which have been pushed against the stop strip, may be removed by strokes along the strip. The stroke speed shall be ($0,5 \pm 0,02$) m/s and care should be taken that the cleaning head is in full contact with the test cushion during the cleaning.

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

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

2.6 Thread removal from carpets

2.6.1 Test carpet

A test carpet in accordance with 5.1.1 shall be used.

2.6.2 Distribution of threads

Forty pieces of threads, in accordance with 5.1.4, shall be arranged on the test carpet in four rows parallel with the pile direction according to the pattern shown in figure 9. Each row shall have a length of 0,7 m and the distance between rows is adapted to the width of the cleaning head.

The threads are embedded into the carpet by carrying out five double strokes with a roller, in accordance with 5.2.6.2, over each row and at a stroke speed of ($0,50 \pm 0,02$) m/s.

2.6.3 Determination of thread removal ability

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

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

During a measurement, each row of threads is cleaned with one double stroke at a stroke speed of ($0,50 \pm 0,02$) m/s, unless the cleaning head is self-propelled, the stroke length being in accordance with 2.1.2 (see figure 2). The ratio of the number of threads removed from the carpet to the number of distributed threads is calculated and recorded.

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

NOTE Threads sticking to the cleaning head are considered to be removed from the carpet. It is recommended that a suitable observation be made in the test report.

2.7 Maximum usable volume of the dust receptacle

2.7.1 Conditions for measurement

The vacuum cleaner shall be equipped with a clean dust receptacle (see 1.4.5) and placed in its normal position of operation. 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 5.1.5, shall be used for the test.

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

2.7.2 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 For upright cleaners without provision for optional use of a hose, the granules are fed through a nozzle adaptor (see figure 11) with the handle of the cleaner in normal position of use. For other cleaners, the granules are fed through the hose provided.

2.7.3 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.

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

2.8 Air data

The purpose of this test is to determine such air data, which form the basis for other tests or might be required in various contexts, for example for declaration of power consumption. The following quantities, referred to standard air density $\rho = 1,20 \text{ kg/m}^3$ (at 20 °C, 101,3 kPa and 50 % relative humidity), are considered:

q is the air flow, in cubic decimetres per second (dm^3/s);

h is the vacuum, in kilopascals;

P_1 is the input power, in watts;

P_2 is the suction power, in watts;

η is the efficiency, in per cent.

NOTE 1 Standard atmospheric conditions according to 1.4.1 not required.

NOTE 2 Measured air data should be corrected to standard air density (see 5.2.8.4)

2.8.1 Conditions for measurement

Vacuum cleaners, which in normal operation are equipped with hose and/or connecting tube, shall have such components attached but without nozzle or brush. For upright cleaners with option to be operated with or without a hose, air data shall be obtained for both options and be reported separately.

2.8.2 Test equipment

Either of the alternative test equipment described in 5.2.8 may be used. The test report shall state which of the alternative test equipment has been used to obtain the air data.

2.8.3 Determination of air data

Air flow, vacuum and input power are determined for a number of throttlings sufficient for plotting curves of vacuum and input power against the air flow (see figure 12).

Prior to the sequence of measurements, the vacuum cleaner shall be operated unthrottled in accordance with 1.4.7 to establish a reference value of the exhaust air temperature for further measuring points.

For each measuring point, the air flow, vacuum and input power are recorded 1 min after the throttling. The cleaner is then again operated unthrottled to attain the reference conditions, which is checked by measuring the exhaust air temperature. This procedure is continued until all the entire curves have been plotted with the measuring point for maximum vacuum being the last one.

For each measuring point, the suction power P_2 is obtained as the product of the air flow q and the vacuum h . The efficiency η is calculated as the ratio of corresponding values of the suction power and input power. Curves of suction power and of efficiency are also plotted against the air flow (see figure 12).

2.9 Performance with loaded dust receptacle

2.9.1 General

The intention of this procedure is to provide means to measure the performance of a vacuum cleaner having a loaded dust receptacle. For this purpose the vacuum cleaner is submitted to cleaning ability tests with the air flow restricted to simulate the condition of a loaded dust receptacle.

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

The reduced air flow, that represents the loaded receptacle condition, shall be determined in accordance with 2.9.1.

With the vacuum cleaner prepared according to 2.9.3 to simulate the reduced air flow, the cleaner may be submitted to cleaning ability tests mentioned in 2.9.4 in order to estimate the alternations in performance of the vacuum cleaner.

For uprights with integral hose, the cleaner shall have a connecting tube attached to the hose.

NOTE The method described is not suitable for vacuum cleaners where the soil passes through the fan before entering the receptacle.

2.9.2 Suction with loaded dust receptacle

2.9.2.1 Test equipment

The connecting tube of the vacuum cleaner is modified to include two openings, in accordance with figure 23a. The opening nearest the cleaning head is used to insert a pressure tapping and, thereby, attachment of a vacuum meter. The other opening is used for introduction of the test dust and is fitted with a valve.

NOTE It should be ensured that the openings or any attachments thereto create no disturbance to the airflow in the connecting tube.