

Electric shavers for household use — Methods for measuring the performance

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British Standard

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Contents

	Page
Cooperating organizations	Inside front cover
National foreword	ii
Foreword	2
Text of EN 61254	5
National annex NA (informative) Committees responsible	Inside back cover

National foreword

This British Standard has been prepared under the direction of the Light Electrical Engineering Standards Policy Committee and is the English language version of EN 61254:1994, *Electric shavers for household use — Methods for measuring the performance*, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 1254:1993, first edition, published by the International Electrotechnical Commission (IEC). The text of the International Standard IEC 1254:1993 was approved by CENELEC as a European Standard without any modification.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 40, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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English version

Electric shavers for household use — Methods for measuring the performance

(IEC 1254:1993)

Rasoirs électriques à usage domestique —
Méthodes de mesure de l'aptitude à la fonction
(CEI 1254:1993)

Elektrische Haushalt — Rasierer
Prüfverfahren zur Bestimmung der
Gebrauchseigenschaften
(IEC 1254:1993)

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 59(CO)33, as prepared by IEC Technical Committee 59: Performance of household electrical appliances, was submitted to the IEC-CENELEC parallel vote in July 1993.

The reference document was approved by CENELEC as EN 61254 on 8 March 1994.

NOTE Sweden has no obligation to implement this European Standard.

The following dates were fixed:

- latest date of publication
of an identical national
standard (dop) 1995-03-15
- latest date of withdrawal
of conflicting national
standards (dow) 1995-03-15

For products which have complied with the relevant national standard before 1995-03-15, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2000-03-15.

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given only for information. In this standard, Annex A, Annex B, Annex C and Annex D are normative and Annex E and Annex F are informative.

Contents

	Page
Foreword	2
Introduction	5
1 Scope	5
2 Definitions	5
3 List of measurements	6
4 General conditions for measurements	6
5 Measuring methods for dimensions	6
5.1 Overall dimensions	6
5.2 Mass	6
5.3 Length of the supply cord	6
6 Determination of the operation time per charge	6
6.1 Operation time per battery charge	6
6.2 Operation time per primary battery	6
7 Shaving performance	6
7.1 Composition of the test panels	6
7.2 Test duration and test procedure	7
7.3 Distribution of the shavers	7
7.4 Statistical analysis	8
7.5 Final ranking	8
8 Trimmer performance	8
9 Gravimetric analysis of the difference in closeness of shave	8
9.1 Composition of the test panels	9
9.2 Test procedure and distribution scheme	9
9.3 Conversion from mass into average residual hair-stubble length	10
9.4 Statistical analysis	10
Annex A (normative) Questionnaires	12
Annex B (normative) Instructions to the testers	17
Annex C (normative) Distribution scheme	17
Annex D (normative) Possible variations in the testing scheme	20
Annex E (informative) Application of the method	20
Annex F (informative) Bibliography	39
Figure 1 — Schematic presentation of the test procedure	11
Table 1 — Sources of variation and associated number of degrees of freedom	8
Table C.1	18
Table C.2	18

	Page
Table C.3 — Introduction period and first week of the distribution scheme	19
Table E.1 — Interaction of panels x types	22
Table E.2 — Result analysis of variance of “shaving time”	23
Table E.3 — Result analysis of variance of “final closeness on cheek, chin and under the nose”	24
Table E.4 — Result analysis of variance of “final closeness in the neck”	25
Table E.5 — Result analysis of variance of “skin irritation in the neck”	26
Table E.6 — Result analysis of variance of “total judgment of use and comfort”	27
Table E.7 — Result analysis of variance of “handling shaver”	28
Table E.8 — Result analysis of variance of “shaving on difficult to reach places”	29
Table E.9 — Result analysis of variance of “on/off switch”	30
Table E.10 — Result analysis of variance of “noise”	31
Table E.11 — Result analysis of variance of “vibration”	32
Table E.12 — Result analysis of variance of “retention of hair”	33
Table E.13 — Result analysis of variance of “cleaning method”	34
Table E.14 — Result analysis of variance of “instructions for use”	35
Table E.15 — Result analysis of variance of “storage in the original case”	36
Table E.16 — Possible rating for consumer presentation	37

Introduction

Determination of the performance characteristics of dry shavers is usually based on the subjective analysis of a test panel. The results of such a test programme may be affected by prolonged use of a certain type of shaver prior to test and subsequent use of a particular shaver system during a test. Intrusive advertising campaigns may have an influence as well.

In the test method of this standard such problems are largely overcome by taking the following measures:

- a) Care is taken to ensure that different shaver systems (rotary and vibratory) are represented by equal numbers of shaver users.
- b) To maintain the balance between the shaver systems throughout the entire test period, each tester uses his own shaver prior to using each test shaver.
- c) Conclusions on differences between shavers are based on statistical analysis, taking into account possible user-effects (see point a).

NOTE Whereas the performance data are assessed on a non-comparative basis, the results should be evaluated by comparison.

1 Scope

This International Standard states and defines the principal performance characteristics for men's electric shavers, which are of interest to the user, and describes standard methods for measuring these characteristics.

This standard is not concerned with safety or with performance requirements.

2 Definitions

2.1

mains shaver

shaver which can be operated directly from the mains supply

NOTE The shaver may also be suitable for an additional power source.

2.2

rechargeable shaver

shaver which is supplied by a rechargeable battery belonging to it

NOTE A rechargeable shaver may also be operated directly from the mains supply.

2.3

battery shaver

shaver which is supplied by primary batteries

2.4

car shaver

shaver which is supplied by a car or boat battery

2.5

rotary shaver

shaver with round shaving head(s) and usually rotating cutters

2.6

vibratory shaver

shaver with linear shaving head(s) and usually vibrating cutters

2.7

trimmer

accessory incorporated in the shaver, to groom particular facial hair, e.g., moustache, beard or side whiskers

3 List of measurements

Performance is determined by carrying out the following measurements:

- Overall dimensions (5.1).
- Mass (5.2).
- Length of the supply cord (5.3).
- Operation time per battery charge (6.1).
- Operation time per primary battery (for battery shavers only) (6.2).
- Shaving performance (clause 7).
- Trimmer performance (clause 8).
- Gravimetric analysis of the difference in closeness of shave (clause 9).

4 General conditions for measurements

Unless otherwise specified, the measurements are made under the following conditions:

- Ambient temperature: $20\text{ °C} \pm 5\text{ °C}$.
- Supply voltage: rated voltage.

5 Measuring methods for dimensions

5.1 Overall dimensions

The maximum overall dimensions of the shaver — height, length and width or diameter — are measured and indicated in millimetres. Any fixed projection on the appliance itself is taken into account, including control knobs and the cord guard of any supply cord. Movable parts such as the trimmer are in the closed position.

The overall dimensions of the storage case are also measured.

5.2 Mass

The mass of the shaver in use is measured and indicated in grams to the nearest five grams.

NOTE “Shaver in use” means without protection cap but with batteries or supply cord, as appropriate.

5.3 Length of the supply cord

The distance between the entry points into the shaver and the plug, including any cord guard, is measured. Coiled cords are stretched with a pull of approximately 1 daN, and indicated in metres rounded down to the nearest 0,05 m.

6 Determination of the operation time per charge

6.1 Operation time per battery charge

After being fully charged and discharged, the batteries are fully charged according to the instructions for use. The shaver is operated for periods of 5 min, separated by intervals of 24 h. The test is terminated when the cell voltage drops below 1,05 V with the shaver running in free air. The operation time is expressed in minutes.

NOTE The operation time resulting from this test procedure will be higher than the time resulting from practical use.

6.2 Operation time per primary battery

The shaver is operated as specified in 6.1 using new batteries. The test is terminated when the cell voltage drops to approximately 0,9 V with the shaver running in free air. The operation time is expressed in minutes.

NOTE The operation time resulting from this test procedure will be higher than the time resulting from practical use.

7 Shaving performance

7.1 Composition of the test panels

Each panel is to be composed so that it is reasonably representative of the adult male population of the country in which the test is performed, particular attention being paid to hair density, rate of beard growth, toughness of the beard, sensitivity towards skin irritation, and the time taken to shave.

The members of the test panels should not be influenced by preconceived ideas.

Subpanels of equal size should be formed, each subpanel representing one of the two basic electric shaver systems:

- rotary type shaver users (ROTA panel);
- vibratory type shaver users (VIBRA panel).

For statistical reasons, the number t of testers in each of the above subpanels should be at least 12.

NOTE 1 Whereas some deviation of the test panel composition from the real situation in a country will not have a noticeable influence on the results, it is essential that subpanels have comparable compositions.

NOTE 2 A subpanel composed of testers who use wetshavers (razor blades) may be considered.

7.2 Test duration and test procedure

7.2.1 Test duration

The test period is preceded by a two week introduction period in which the panel testers familiarize themselves with the other shaving system, i.e. rotary type shaver users shave with vibratory type shavers, and vibratory type shaver users shave with rotary type shavers.

The test period for each shaver, which should start within a week of the introduction period, has three shaving days. The first day of each period the tester uses his own shaver (see Annex D).

NOTE 1 If a small number of shaver models are to be tested, the three days period can be extended to six days. On day 7 the testers use their own shaver (see Annex D).

NOTE 2 For panels with a low density of beard hairs or light beards, each test day may be preceded by a non-shaving day (see Annex D).

7.2.2 Test procedure

Day 1

On the first shaving day each panel tester shaves with his own shaver, which is used as a reference. Questionnaire 1 (see Annex A) is to be completed immediately after shaving, but only in the first two test periods.

NOTE Questionnaire 1 is not included in the final analysis. It allows for the test institute to characterize the user-panels, particularly with respect to the average level of judgement scores.

Day 2 and Day 3

On the second and third shaving days the panel tester shaves with one of the test shavers. On both days he records the shaving time with a stopwatch, and immediately after shaving fills in questionnaire 2 (see Annex A) relating to shaving time, closeness of shave, and skin comfort.

NOTE Possible variations in the testing scheme are given in Annex D.

7.2.3 Handling, convenience and storage, etc.

For each test period the handling, convenience and storage, etc. of the test shaver are assessed and questionnaire 3 is completed on the last day of the test period (see Annex A).

The test is continued until each panel tester has tested each shaver once.

The instructions for panel testers is given in Annex B.

7.3 Distribution of the shavers

The shavers are distributed so that each panel tester:

- shaves with each shaver in turn;
- uses each shaver an equal number of times (usually once).

The following should be observed as far as possible:

- For each panel tester, the sequence of distribution of the shavers should be different.

NOTE This procedure avoids possible interaction between shavers.

- The first shaver to be tested shall not be the same as that used in the introduction period.

- If a particular shaving system (vibra or rota) is substantially under-represented, all shavers of that system should be tested sequentially.

NOTE This procedure limits the influence of the over-representation of the other system.

- The number of each model of shaver should be as small as possible.

NOTE Although each shaver is judged individually, the method proposed by Kraitichik (1953) can be used as an efficient tool to produce a distribution scheme. The method is illustrated by the example shown in Annex C.

7.4 Statistical analysis

Using a 10 point scale, as shown in Annex A, the results are analysed by using an analysis of variance. The following sources of variation are included:

- variation due to subpanels p ;
- variation due to users t (within subpanels p);
- variation due to shaver types n ;
- variation due to the interaction $p \times n$;
- variation due to the interaction $t(p) \times n$;
- variation due to experimental error (residual variation).

As an example Table 1 shows the sources of variation and the associated numbers of degrees of freedom (df) for the case $p = 2$, $t(p) = 18$, $n = 9$, k (number of the repetitions) = 2.

Table 1 — Sources of variation and associated number of degrees of freedom

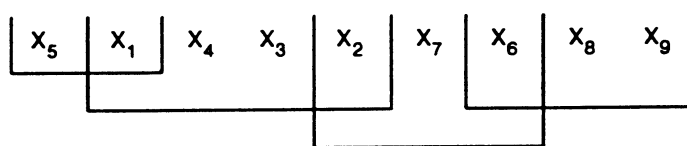
Source of variation	df
Grand mean	1
Subpanels p	1
Users (within panels) $t(p)$	34
Shaver types n	8
Interaction $p \times n$	8
Interaction $t(p) \times n$	272
Residual	324

The homogeneity of the shaver types can be assessed with an F-test. Given a significant difference between types, it is possible to establish clusters of types (see Annex E).

7.5 Final ranking

If the statistical analysis shows a significant interaction between subpanels and shaver types ($p \times n$), results for each subpanel have to be presented separately.

For each result e.g. closeness on cheek, chin, under the nose (see Annex A); the analysis leads to a result which can be shown schematically. An example for nine shavers, X_1 to X_9 is given below:



The horizontal bars below the characters X_5 , X_1 , etc., represent the results of the analysis of variance. Shaver types X_5 and X_1 form the first statistical group, showing that the difference between X_5 and X_1 does not differ significantly from zero. The second statistical group is formed by shavers X_1 , X_4 , X_3 and X_2 , the third by X_2 , X_7 and X_6 and the fourth by X_6 , X_8 and X_9 .

Differences in average scores should only be identified if the relevant shaver types belong to different statistical groups.

8 Trimmer performance

The evaluation of trimmer performance is included in questionnaire 3 (Annex A).

9 Gravimetric analysis of the difference in closeness of shave

In this analysis the relative closeness of shave produced by different shaver types is determined by establishing the total yield of hair and skinflakes, and by applying mathematical treatment and statistical analysis of the data.

The method is of a differential nature, testers shaving one side of their face with a shaver of one particular type and the other side of their face with another. Thus, results always relate to differences in shaving quality rather than to absolute values. The gravimetric analysis has to be performed in a laboratory.

NOTE References to a document giving extensive information related to the development and background of the method are given in Annex F.

9.1 Composition of the test panels

Each panel is to be composed as specified in 7.1. The number of testers t in each subpanel shall be at least six but preferably 12.

9.2 Test procedure and distribution scheme

The method is based on test periods of four days, subdivided into two blocks of two days. On the day preceding the first test day, the testers shave at home as usual (see Figure 1).

During the test period the testers shave until they consider themselves clean shaven.

Day 1

On the first day the testers arrive at the laboratory with a 1 day beard.

They shave the left side of their face with a shaver of type A and the right side of their face with a shaver of type B. The shaving time on each side is recorded separately.

Day 2

24 h $\pm$ 4 h later the testers return to the laboratory, without having shaved. Although the beard has grown, the difference in closeness that resulted from using the shavers A and B on the first test day still manifests itself in a difference in stubble length between the left and the right side of the face.

Each tester shaves the left side of his face with a reference shaver (S). The shaving time is recorded. The amount of hair and skinflakes, M_s , removed by shaving and collected, is determined by weighing the reference shaver before and after shaving.

NOTE 1 Reference shavers can be any type of shaver, provided that the hair-shavings are retained.

NOTE 2 M_s can be determined accurately with an analytical balance.

NOTE 3 The temperature of the shaver at the moment of weighing before and after the test should be similar.

The procedure is repeated on the right side of the face.

NOTE 4 A different reference shaver of an identical type may be used.

The difference in closeness (expressed in mg) after shaving on the first day with shavers A and B, respectively, is the difference in mass between left and right side of the face ($M_{slII} - M_{srII}$).

NOTE 5 Normally, the total yield is of the order of 50 mg, while yield differences are of the order of 1 mg to 10 mg.

NOTE 6 As the shavers may be contaminated by touching them with the fingers, it is necessary for the laboratory assistants and the testers to wear gloves (thin cotton gloves are suitable).

The accuracy of the measurements can be increased by working in a temperature and humidity controlled room.

NOTE 7 An additional advantage is that the skin condition of the testers can be standardized, if they wait in the room for 5 min prior to shaving. This is particular important in summer, because then the testers may suffer from excessive perspiration.

9.2.1 Left-right effects

In order to eliminate possible differences in the number of hairs on each side of the face the procedure is repeated using the shavers in reverse order.

Day 3

Similar to test day 1, this time using shaver B on the left side of the face and shaver A on the right side of the face.

Day 4

Similar to test day 2, this time taking the difference in mass between right and left side of the face ($M_{srIV} - M_{slIV}$).

NOTE There may be an interval between day 2 and day 3 when the tester uses his own shaver.

9.2.2 Testing of more than two shaver types

If more than two shaver types are to be tested, each tester uses a reference shaver with which the shavers are compared. In this case, if n shaver types (n_1 to n_x) are to be assessed, the first tester uses a shaver of type n_1 as reference shaver (n_{1r}) and shaves in the following sequence:

$n_{1r} - n_1, n_{1r} - n_2, n_{1r} - n_3, \dots, n_{1r} - n_x.$

The second tester uses a shaver of type n_2 as reference shaver (n_{2r}) and shaves in the following sequence:

$$n_2r - n_2, n_2r - n_3, n_2r - n_4, \dots, n_2r - n_x, n_2r - n_1.$$

Thus, each tester always starts with a combination of shavers of the same type (i.e. $n_1r - n_1, n_2r - n_2, n_3r - n_3$, etc.). The other combinations are tested in numerical order.

Each type is to be used an equal number of times as reference shaver.

9.3 Conversion from mass into average residual hair-stubble length

The mass of the hair is converted into average residual hair-stubble length. The individual difference in hair mass is divided by the product of total amount of hairs on the face (n), the density of the hairs (p) and the area of a cross section of the average hair (F).

NOTE 1 During the development of this gravimetric method the average npF for a large panel of testers was established. It was found that hair forms about 75 % of the total mass of the shavings collected. The average growth of beard hair in 24 h is approximately 400 μm .

$$\text{Thus: } npF = \frac{0,75}{400} (M_{sl} + M_{sr}) = 1,875 \times 10^{-3} (M_{sl} + M_{sr})$$

For calculation of the average residual hair-stubble length for the entire face, the difference in hair mass between left and right side of the face is multiplied by 2. The average residual hair-stubble length for the entire face is therefore:

$$\frac{2 (M_{sl} - M_{sr})}{1,875 \times 10^{-3} (M_{sl} + M_{sr})} = 1\,067 \frac{(M_{sl} - M_{sr})}{(M_{sl} + M_{sr})}$$

NOTE 2 As an example, if $M_{sl} = 40,4$ mg and $M_{sr} = 38,6$ mg, the average residual hair-stubble length is:

$$1\,067 \frac{(40,4 - 38,6)}{(40,4 + 38,6)} = 24 \mu\text{m}$$

9.4 Statistical analysis

A statistical analysis is performed the basis of all individual $M_{slII} - M_{srII}$ and $M_{srIV} - M_{slIV}$ data or on basis of all individual data:

$$1\,067 \frac{(M_{slII} - M_{srII})}{(M_{slII} + M_{srII})} \quad \text{and} \quad 1\,067 \frac{(M_{srIV} - M_{slIV})}{(M_{srIV} + M_{slIV})}$$

If more than two shaver types are tested, an analysis of variance should be applied, as described in 7.4, with the addition of the following sources of variation:

- variation due to sides s ;
- variation due to the interaction $p \times s$;
- variation due to the interaction $t(p) \times s$;
- variation due to the interaction $n \times s$.

NOTE 1 If only two shavers are to be compared, to estimate whether the average difference in residual hair-stubble length is significantly different from zero, a t -test of significance should be performed on basis of the individual data ("left-right" effects eliminated per tester):

$$1\,067 \frac{(M_{slII} - M_{srII} + M_{srIV} - M_{slIV})}{(M_{slII} + M_{srII} + M_{srIV} + M_{slIV})}$$

NOTE 2 The conversion from mass to average residual hair-stubble length may be omitted, and the statistical analysis is carried out on the basis of the mass values.

The shaver types are to be ranked as described in 7.5.