BRITISH STANDARD

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Conductors for overhead lines — Characteristics of greases

The European Standard EN 50326:2002 has the status of a British Standard

ICS 29.240.20; 75.100

National foreword

This British Standard is the official English language version of EN 50326:2002.

The UK participation in its preparation was entrusted to Technical Committee GEL/7, Overhead electrical conductors, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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English version

Conductors for overhead lines - Characteristics of greases

Conducteurs pour lignes aériennes - Caractéristiques des produits de protection

Leiter für Freileitungen - Eigenschaften von Fetten

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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

This European Standard was prepared by the Technical Committee CENELEC TC 7, Overhead electrical conductors.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50326 on 2002-03-01.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2003-03-01

- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2005-03-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annexes A, B, C and D are normative and annex E is informative.

Contents

1 Scope

This standard specifies the characteristics of protective products, commonly known as greases, for corrosion protection of bare overhead line conductors made of aluminium, aluminium alloy, steel wires or a combination of these wires.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European standard only when incorporated in it by amendment or revision. For undated references the latest issue of the publication referred to applies.

EN 10152		*Electrolytically zinc coated cold rolled steel flat products – Technical delivery conditions*
EN 50182		*Conductors for overhead lines – Round wire concentric lay stranded conductors*
EN 60068-2-11		*Basic environmental procedures – Part 2 – Test Ka – Salt mist. (endorsing IEC 60068-2-11:1981)*
IEC 60050-466		*International Electrotechnical Vocabulary (IEV) – Chapter 466: Overhead Lines*
ISO 2176	1972	*Petroleum – Lubricating grease – Determination of dropping point*
IP 121		*Determination of oil separation from lubricating grease – Pressure filtration method*
ISO 2137	1985	*Petroleum products – Lubricating greases and petrolatums – Determination of cone penetration*

3 Definitions

For the purpose of this standard, the definitions given in IEC 60050-466 and in EN 50182 apply.

4 Designation system

4.1 Greases shall be designated θ_1Aθ_2 or θ_1Bθ_2 where, A and B define the type of grease as follows:

- type A - grease applied without heating, for example greases consisting essentially of a stabilised mixture of mineral or synthetic oil and thickeners such as metal soaps or inorganic compounds;
- type B - grease applied with heating, for example greases consisting of petrolatum, waxes associated with small quantities of mineral oil and organic additives;
- θ_1 is the lowest temperature in °C below 0 °C at which tests referred to in this standard are required to be carried out;
- θ_2 is the highest temperature in °C at which tests referred to in this standard are required to be carried out.

If required by the user of the conductor the values of θ_1 and θ_2 shall be specified by the grease purchaser.

Examples:

20A150 type A grease with a temperature θ_1 of - 20 °C and a temperature θ_2 of 150 °C.

20B110 type B grease with a temperature θ_1 of - 20 °C and a temperature θ_2 of 110 °C.

4.2 The grease supplier shall provide a unique name or code for the grease, and shall retain details of the grease composition for verification purposes. The composition shall include manufacturing tolerances and shall remain unchanged while the grease is marketed under the specific name or code, unless agreement has been reached with the conductor user.

5 Requirements for grease

5.1 The grease shall meet the following requirements.

5.2 The grease shall protect overhead line conductors from atmospheric corrosion in service and in storage. The test requirements in 6.12 shall be met.

5.3 The grease shall remain in the conductor for the specified conditions of operation and meet the specified requirements for the service life of the conductor. The requirements of the tests in 6.5, 6.6, 6.7, 6.8, 6.10 and 6.11 shall be met to demonstrate this, and in addition the tests given in 6.13 may be specified by the grease purchaser.

5.4 To demonstrate that the grease may be satisfactorily applied to a conductor with good adhesion, the test requirements in 6.7 and 6.9 shall be met.

6 Tests

6.1 General

No test shall be performed at a temperature greater than the maximum safe operating temperature indicated by the grease supplier.

All mandatory tests in this standard shall be performed by the grease supplier; grease tests specified in EN 50182 shall be performed by the conductor manufacturer.

6.2 Classification of tests

6.2.1 Type tests are intended to verify the main characteristics of a grease which depend on its composition. These tests are normally performed only once for a grease supplier's specific name or code, but shall be repeated if the composition of the grease has changed such that any of the test characteristics given in Table 1 may have changed.

6.2.2 Sample tests are intended to guarantee the quality of the grease and compliance with the requirements of this standard.

6.2.3 Type tests and sample tests are listed in Table 1.

Table 1 - Type and sample tests for grease

Requirements subclause	Test		Type test		Sample test	
	Characteristic	Subclause	Type A	Type B	Type A	Type B
5.3	Drop point	6.5	-	X	-	X
5.3	High temperature stability	6.6	X	-	X	-
5.3, 5.4	Penetrability (type A)	6.7	X	-	X	-
5.3	Penetrability (type B)	6.8	-	X	-	X
5.4	Adhesion	6.9	X	X	-	-
5.3	Acidity/alkalinity index	6.10	-	X	-	-
5.3	Ageing	6.11	X	X	-	-
5.2	Corrosion	6.12	X	X	-	-
5.3	Stability under steady state conditions	6.13.1	[a]	[a]	-	-
5.3	Stability under short circuit conditions	6.13.2	[a]	[a]	-	-

[a] By agreement between the grease purchaser and the grease supplier, when the test is required by the user of the conductor.

6.3 Preconditioning of samples

6.3.1 Type B grease delivered in solid form shall be preconditioned in order to homogenize the grease prior to the tests of 6.5, 6.8, 6.9 and 6.10, unless otherwise specified in these subclauses, as follows.

6.3.1.1 The grease shall be heated to between 10 °C and 20 °C above the temperature at which melting occurs, and maintained at this temperature for 0,5 h.

6.3.1.2 The quantity required for the tests shall be poured, in the liquid state, into the test containers and left to cool for a minimum of 24 h.

6.3.2 Excess oil on the surface of type A grease, as delivered, shall be cause for rejection.

6.4 Temperature accuracy

In all tests referred to in this standard, temperatures shall be measured using equipment with an accuracy of at least 1 °C.

6.5 Drop point test for type B grease

Five determinations of the drop point shall be made using the method given in ISO 2176.

The minimum value of the five determinations θ_m shall be greater than or equal to θ_2.

6.6 High temperature stability tests for type A grease

6.6.1 This requirement shall be demonstrated by the following two tests.

6.6.2 Oil separation shall be determined, using the method given in IP 121, after 1 h at a temperature of θ_2. The maximum quantity of oil separated shall be a mass fraction of 0,2 %.

6.6.3 The drop point test shall be performed on five samples using the method given in ISO 2176. Type A grease may not have a well defined drop point. Tests may be discontinued at (θ_2 + 20) °C unless the grease purchaser requires evidence of short circuit temperature capability, in which case the drop point test shall be continued to the required temperature.

6.7 Penetrability test for type A grease

6.7.1 The penetrability test shall be performed on type A grease to

a) verify that deliveries of grease are compatible with the type test sample,

b) establish that the grease is capable of being satisfactorily pumped,

c) verify that the grease properties have not significantly changed after ageing (see 6.11) to represent storage and in-service conditions.

6.7.2 A sample of grease shall be tested, using the method given in ISO 2137, using a full scale cone, at a temperature of 25 °C.

6.7.3 Acceptance criteria shall be as given in Table 2.

Table 2 - Type A grease penetrability test acceptance criteria

Test	Acceptance criterion
Type test	Mean value ≥ 70 $^{1}/_{10}$ mm unless otherwise agreed between grease purchaser and grease supplier
Sample test	The mean value shall not differ from the type test mean value by more than 20 % of the type test mean value

6.8 Penetrability test for type B grease

6.8.1 The penetrability test in 6.8.2 shall be performed on type B grease to

a) verify that deliveries of grease are compatible with the type test sample,

b) verify, together with the acidity/alkalinity test (see 6.10), that the grease properties have not significantly changed after ageing (see 6.11) to represent storage and in-service conditions.

6.8.2 A sample of grease shall be tested, using the method given in ISO 2137, using a full scale cone, at a temperature of 25 °C.

6.8.3 Acceptance criteria shall be as given in Table 3.

Table 3 - Type B grease penetrability test acceptance criteria

Test	Acceptance criterion
Type test	120 – 180 $^{1}/_{10}$ mm
Sample test	The mean value shall not differ from the type test mean value by more than 20 % of the type test mean value

6.9 Low temperature adhesion

6.9.1 An aluminium plate measuring approximately (100 ± 5) mm x (100 ± 5) mm with a thickness of (1,0 ± 0,1) mm, covered with a layer of grease (0,5 ± 0,05) mm thick on one side, shall be cooled, together with a 25 mm diameter mandrel, to a temperature not greater than θ_1 and held for 1 h.

6.9.2 The plate shall be placed on the mandrel with the greased face uppermost and, within 5 s, bent steadily to form an internal angle on the ungreased face of between 100° and 120°.

6.9.3 The acceptance criterion shall be that the grease shall remain adhering to the plate without any cracks or separations being visible to the naked eye with normal or corrected vision, but without magnification.

6.10 Acidity or alkalinity index test for type B grease

6.10.1 The acidity or alkalinity test shall be performed to verify, together with the penetrability test (see 6.8), that the grease properties have not significantly changed after ageing (see 6.11).

6.10.2 The test method shall be as described in Annex A.

6.10.3 The acidity or alkalinity index before ageing shall be less than or equal to 2,0 unless otherwise agreed between the grease purchase and grease supplier.

6.11 Ageing test

6.11.1 Preconditioning of type B grease - In order to simulate the storage of type B grease at high temperatures, a suitable quantity of grease shall be heated to a temperature of 20 °C above the temperature at which melting occurs, and maintained for 168 h.

6.11.2 Sample preparation of three cups and three metal plates, and ageing, shall be as described in Annex B for type A and type B grease.

6.11.3 After ageing, the metal plates with grease shall be subjected to the corrosion test in 6.12.2.

6.11.4 The grease in the cups shall be subjected to the penetrability test at 25 °C (see 6.7.2 for type A grease or 6.8.2 for type B grease). The mean penetrability value shall not differ from the type test mean value by more than 20 % of the type test mean value.

6.11.5 For type B grease the acidity/alkalinity index test (see 6.10) shall be performed. The acidity or alkalinity index shall be less than or equal to 2,5.

6.12 Corrosion tests

6.12.1 General

For type B grease the recommended corrosion test is that given in 6.12.2. However, the conductor user may require the tests in 6.12.3 and/or 6.12.4 for either type A or type B grease by agreement with the grease supplier.

6.12.2 Test on plates

6.12.2.1 Three steel plates, prepared and aged as described in 6.11, shall be positioned vertically in a suitable chamber and subjected to

- seven 24 h cycles in a sulphurous atmosphere while held vertically. During the first 8 h of each cycle the chamber interior shall have a relative humidity greater than 90 % and shall contain a volume fraction of 0,067 % sulphur dioxide at a temperature of (40 ± 3) °C. For the remaining 16 h of the cycle, the chamber door shall be open to the laboratory atmosphere,
- 168 h in a water spray solution with a mass fraction of 5 % NaCl at a temperature of (35 ± 1) °C in accordance with EN 60068-2-11 while held at an angle of (20 ± 2)° to the vertical.

6.12.2.2 The plates shall be examined after the grease has been removed using a suitable solvent.

6.12.2.3 Discount the plate with the highest degree of corrosion in the evaluation zone (see Figure B.1 and Figure B.2) and the plate with the lowest degree of corrosion in the evaluation zone.

6.12.2.4 Assess the degree of corrosion on the remaining plate by means of a grading index based on the corrosion plates shown in Figure 1.

6.12.2.5 Acceptance criteria are

a) the grading index shall be greater than or equal to 8,

b) there shall only be a limited number of pits, and a limited spread of these pits in the evaluation zone. Pitting at the edges of the evaluation zone are less important than pitting towards the centre.

6.12.3 Test on wires

6.12.3.1 Three samples, each consisting of (150 ± 10) mm long by 3,1 mm to 3,2 mm diameter bare steel, galvanized steel and aluminium wires, and one sample of three aluminium alloy wires shall be prepared by being straightened, bound together at each end using pieces of 99,5 % minimum purity aluminium wire. The ends of the wires shall be sealed using a suitable compound such as wax or resin.

6.12.3.2 For type A grease, the test sample shall be uniformly coated with a layer of grease with a thickness of (100 ± 10) μm.

6.12.3.3 For type B grease, the samples shall be dipped in the grease, for the full length of the sample, at (20 ± 2) °C above θ_m , and allowed to drain vertically. Preliminary trials shall identify the parameters necessary to produce a uniform thickness of (100 ± 10) μm. This may be confirmed by the increase in mass of the sample using the value 0,87 g/cm^3 for the grease density or the value supplied by the grease manufacturer.

6.12.3.4 The samples shall be subjected to a water spray solution with a mass fraction of 5 % NaCl at a temperature of (35 ± 1) °C, in accordance with EN 60068-2-11, for (1 000 ± 10) h with the samples suspended vertically.

6.12.3.5 At the end of this period the wires shall be examined. There shall be no signs of corrosion, etching, pitting or discolouration of the wires other than that due to the colour of the grease.

6.12.4 Corrosive substances in grease

6.12.4.1 Three samples, each consisting of 75 mm long by 3,1 mm to 3,2 mm diameter bare steel, galvanized steel and aluminium wires, and one sample of three aluminium alloy wires shall be prepared by being straightened, bound together at each end using pieces of 99,5 % minimum purity aluminium wire. The ends of the wires shall be sealed using a suitable compound such as wax or resin.

6.12.4.2 The samples shall be coated with grease as described in 6.12.3.2 for type A grease, or 6.12.3.3 for type B grease.

6.12.4.3 The samples shall be maintained at a temperature of (90 ± 5) °C for 24 h, in air.

6.12.4.4 At the end of this period the wires shall be examined. There shall be no signs of corrosion, etching, pitting or discolouration of the wires other than that due to the colour of the grease.

6.13 Stability of grease in complete conductor

6.13.1 Stability under steady state conditions

6.13.1.1 A conductor sample, of a representative size chosen by the conductor user and greased according to the conductor user's requirements, shall be tested using the method given in Annex C.

6.13.1.2 The acceptance criterion shall be that θ_a shall be greater than or equal to the minimum withstand temperature θ_3.

6.13.2 Stability under short circuit conditions (this test is normally only applicable to conductors intended for use as earth wires)

6.13.2.1 A conductor sample, of a representative size chosen by the conductor user and greased according to the conductor user's requirements, shall be tested using the method given in Annex D.

6.13.2.2 The acceptance criterion shall be agreed between the conductor user and the conductor manufacturer (e.g. the mass fraction of grease which has been lost from the inside of the conductor).

7 Packaging and marking

7.1 Packaging

The grease shall be suitably protected against damage, deterioration or contamination which could occur in ordinary handling and shipping.

7.2 Marking

Information marked on the outside of the package shall include the following:

a) gross, net and tare mass;

b) grease manufacturer's identifying name or code;

c) lot or batch number;

d) date of manufacture;

e) purchase order number;

f) safety information.

8 Information to be clarified by the grease purchaser and the grease supplier

8.1 The grease supplier shall supply the following information:

- the maximum safe operating temperature of the grease, if held at this temperature for more than 5 min;
- the unique identifying name or code of the grease as described in clause 4;
- an indication of the drop point of the grease where applicable;
- recommendations for storage;
- the maximum temperature at which type B grease may be held for a period of two weeks without deterioration.

8.2 The grease purchaser shall specify the following:

- any requirement for a complete conductor tests (see 6.13) and the minimum withstand temperatures θ_3 and θ_4;
- the short circuit condition ($kA^2 \bullet s$) which the conductor shall withstand without significant loss of grease characteristics;

  NOTE The maximum conductor temperature corresponding to this short circuit condition may be calculated using the method given in EN 60865-1 : Short-circuit currents – Part 1 : Definitions and calculation methods.

- corrosion test requirements.

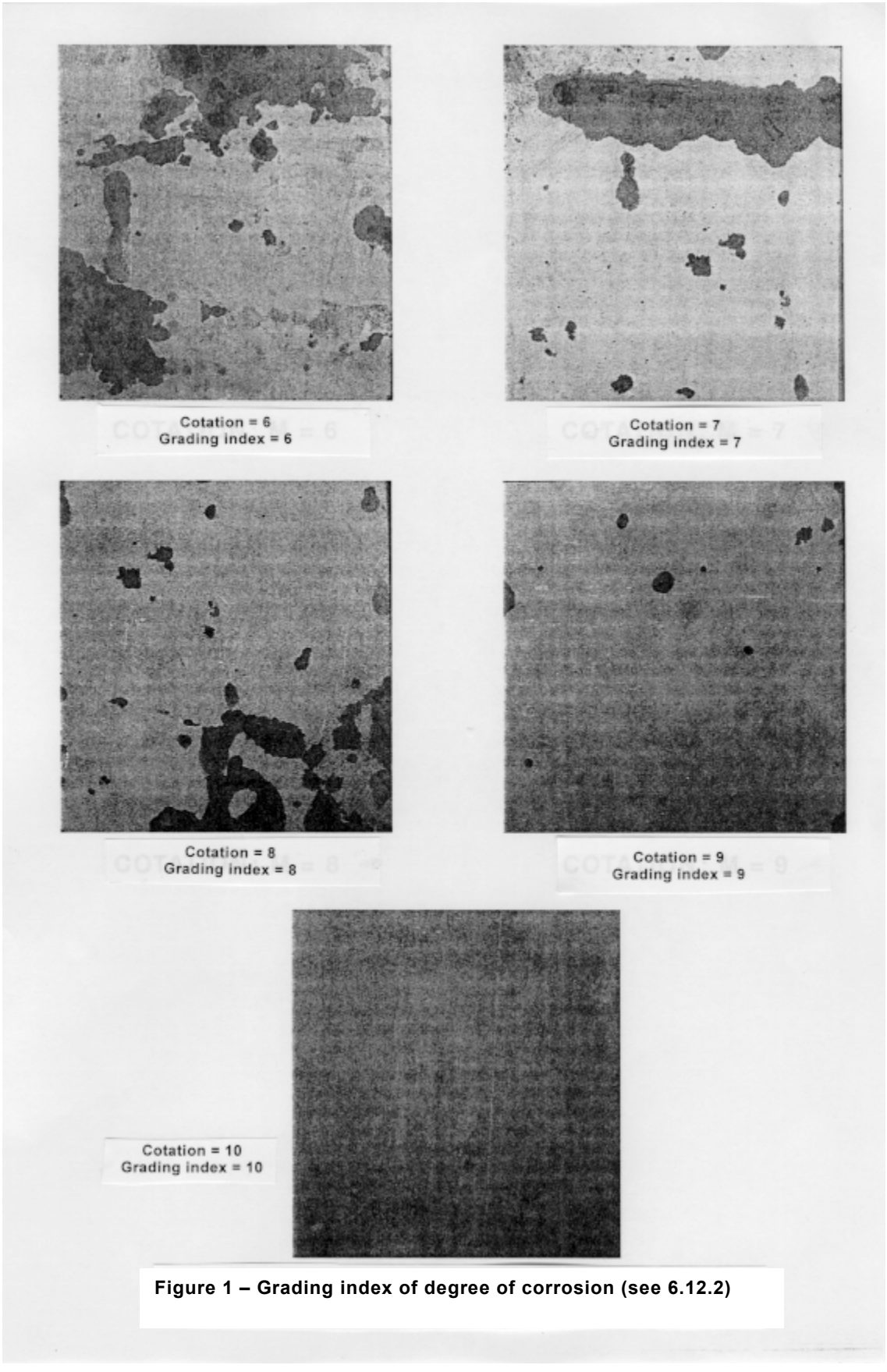

Figure 1 – Grading index of degree of corrosion (see 6.12.2)

Annex A
(normative)

Acidity or alkalinity test method for type B grease

A.1 Basis

The acidity or alkalinity of the grease is measured by comparison with a standard base, and neutrality determined by colour indicator change.

A.2 Reagents

A.2.1 Toluene, minimum 99,5 % volume fraction.

A.2.2 Ethanol, 96 % volume fraction.

A.2.3 Alkaline blue solution - 0,1 g alkaline blue in 100 ml of ethanol 96 % volume fraction.

A.2.4 Potassium hydroxide 0,1 mol/l (or 5,61 mg/ml) solution in ethanol 96 % volume fraction.

A.2.5 Hydrochloric acid 0,1 mol/l solution in ethanol 96 % volume fraction.

A.3 Equipment

A.3.1 Glass conical flask.

A.3.2 Weighing device.

A.3.3 Glass measuring burette.

A.4 Procedure

A.4.1 Prepare approximately 1 g of the grease.

A.4.2 Weigh the sample with an accuracy of 0,001 g.

A.4.3 Place the sample in the conical flask.

A.4.4 Add 60 ml of toluene.

A.4.5 Add 40 ml of ethanol.

A.4.6 Add 1 ml of alkaline blue solution.

A.4.7 If the grease is alkaline, acidify the solution with 5 ml of hydrochloric acid 0,1 mol/l solution in ethanol.

A.4.8 Shake the mixture vigorously.

A.4.9 Using the burette, add the potassium hydroxide solution progressively into the flask, shaking vigorously.

A.4.10 When the colour indicator changes colour (from blue to pink) note the volume of potassium hydroxide solution used, n.

A.4.11 The acidity or alkalinity index is given by the formula in Table A.1 where

n is the volume of potassium hydroxide solution used in millilitres,

5,61 is the concentration of the hydroxide solution (0,1 mol/l),

m is the mass of the grease sample in grams.

Table A.1 - Acidity or alkalinity index formula

	Acidity index	**Alkalinity index**
Acidic grease	$\frac{n \times 5{,}61}{m}$	-
Alkaline grease	-	$\frac{(5-n) \times 5{,}61}{m}$

Annex B
(normative)

Sample preparation and test procedure for ageing test

B.1 Preparation of metal plates

B.1.1 Three steel plates, of dimensions (100 ± 5) mm x (100 ± 5) mm x (2 ± 0,1) mm, shall be electrogalvanized in accordance with EN 10152 to a nominal thickness of zinc of 3,75 μm and a minimum thickness of 2,8 μm. The face which is not to be used in the test shall be covered with a suitable adhesive coating which will withstand the ageing cycles (see B.2) and salt spray of the corrosion test (see 6.12). The quality of the surface of the plates shall be examined carefully, and any imperfections recorded and taken into account by agreement between the grease purchaser and grease supplier.

B.1.2 For type A grease, a layer of grease shall be applied to the uncovered surface of each plate to a uniform thickness of (100 ± 10) μm. A suggested method to achieve this is illustrated in Figure B.1 where strips of adhesive tape of thickness (100 ± 10) μm and 10 mm width are applied to two opposite sides of each plate. A slight excess of grease is applied uniformly over the whole surface, and the excess removed by sliding a straight edge over the tape strips. The aim shall be to produce a smooth, uniform surface without imperfections or air entrapment. This may be achieved by preheating the straight edge. Any remaining imperfections shall be recorded and taken into account by agreement between the grease purchaser and grease supplier.

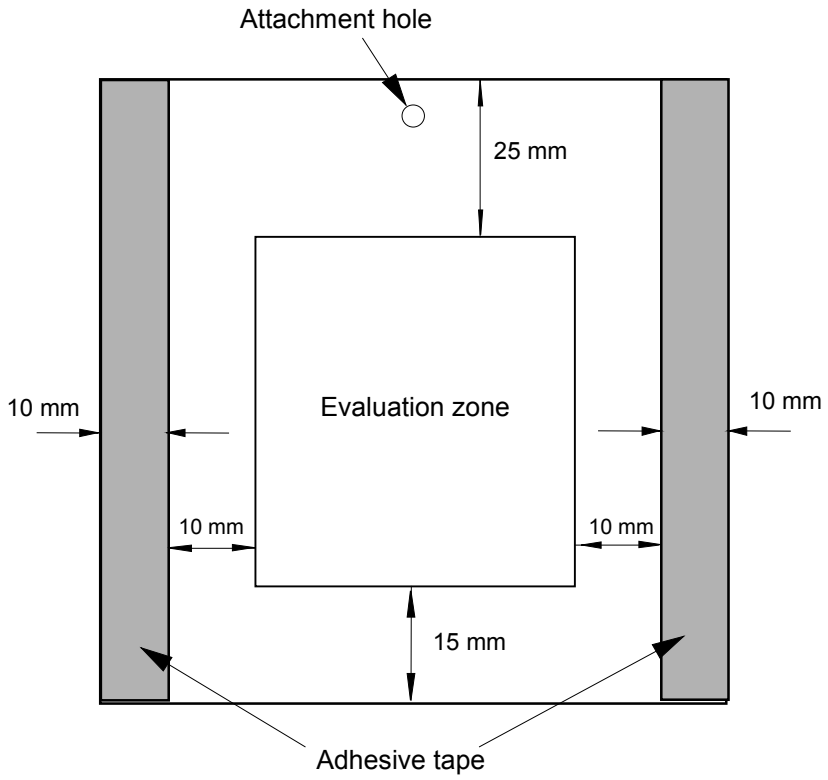

Figure B.1 - Suggested method for coating steel plates with type A grease

B.1.3 For type B grease metal plates, as shown in Figure B.2, shall be immersed in a bath of molten grease, suspended diagonally from the attachment hole. In order to obtain the required uniform thickness of (100 ± 10) μm in the central portion of the plate the following parameters should be examined in trials:

a) the temperature of the bath which may be between 10 °C and 30 °C above θ_m;

b) the duration of immersion in the grease;

c) the vertical draining time after removal.

The plate shall be withdrawn uniformly from the bath within approximately 0,5 s and the thickness of grease at point X (Figure B.2) verified as (100 ± 10) μm by a thickness measurement on a trial plate.

Alternatively, a slight excess of grease may be applied by immersing the plate in a bath of molten grease and, after allowing the grease to cool, removing the excess by sliding a heated straight edge over previously applied tape strips in a similar manner to that described in B.1.2. The aim shall be to produce a smooth, uniform surface without imperfections or air entrapment.

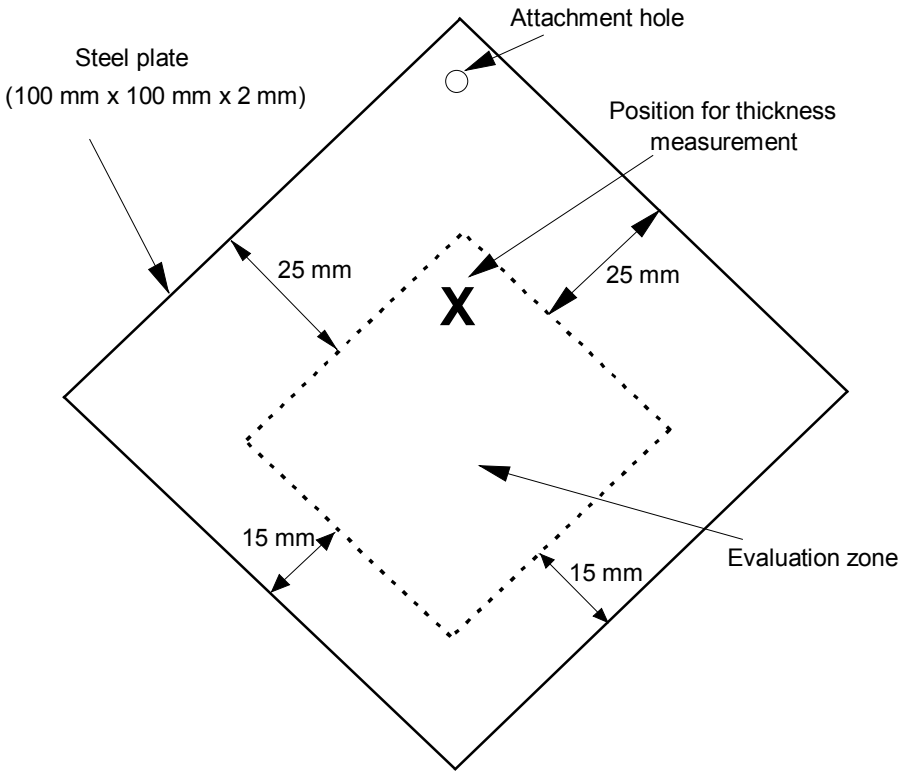

Figure B.2 - Steel plate for type B grease

B.1.4 Excess grease shall be removed from the edges of the plate and the face not under test, and the average thickness calculated by measuring the increase in mass of the plate, using the value 0,87 g/cm^3 for the grease density or the value supplied by the grease supplier. The calculated thickness shall be (100 ± 10) μm.

B.2 Ageing

B.2.1 Three cups shall be filled with grease and, together with the three metal plates held vertically, shall be placed in a test chamber and subjected to three cycles, each consisting of the following sequences:

- 72 h of dry heat (relative humidity less than 30 %) at 70 °C;
- 24 h of wet heat (relative humidity greater than 90 %) at 55 °C;
- three 24 h periods of wet heat and cold comprising
  - 0 h - 9 h humid atmosphere at 55 °C,
  - 9 h - 11 h holding in a cold chamber at - 20 °C,
  - 11 h - 14 h humid atmosphere at 55 °C,
  - 14 h - 16 h holding in a cold chamber at - 20 °C,
  - 16 h - 24 h humid atmosphere at 55 °C.

B.2.2 Temperatures shall be maintained with a tolerance of ± 2 °C.

B.2.3 Tolerances on times shall be ± 0,1 h.

Annex C
(normative)

Test method for stability under steady state conditions

C.1 Test to be performed if required by the conductor user.

C.2 The withstand temperature θ_3 for this test shall be defined by the conductor user.

C.3 A conductor sample of at least 3 m shall be fitted with compression type tension joints containing the same grease as the conductor.

C.4 The sample shall be maintained at a tension of between 15 % and 20 % of the rated tensile strength (RTS) at a slope of between 10° and 15° to the horizontal.

C.5 The conductor temperature shall be controlled, by passing current through it, as follows.

C.5.1 Raised to 70 °C in approximately 1 h.

C.5.2 Raised to (θ_3 - 20) °C in steps of 5 °C every 15 min.

C.5.3 Raised to θ_3 in steps of 2 °C every 15 min.

C.5.4 Maintained at θ_3 for 1 h.

C.5.5 Raised in steps of 2 °C every 10 min until the grease flows freely from the conductor, or until the maximum safe operating temperature of the grease has been reached.

C.6 The temperature of the conductor shall be noted when

- the grease fills any of the spaces between the wires of the outer layer. This temperature shall be recorded as θ_a,
- the grease drips from the conductor, for reference purposes only.

Annex D
(normative)

Test method for stability under short circuit conditions

D.1 Test to be performed if required by the conductor user.

D.2 The withstand temperature θ_4 for this test shall be defined by the conductor user.

D.3 A conductor sample of at least 3 m shall be fitted with compression type tension joints containing the same grease as the conductor.

D.4 The sample shall be maintained at a tension of between 15 % and 20 % of the RTS (Rated Tensile Strength) held horizontally or at a slope of between 10° and 15° to the horizontal.

D.5 The required short circuit current shall be applied, through the end fittings, for between 0,5 s and 1,5 s.

D.6 The maximum conductor surface temperature reached shall be recorded.

Annex E
(informative)

Greases in frequent use in some of the member countries

Table E.1 gives details of greases which are in common use in some of the member countries at the time of publication of this standard.

Table E.1 – Greases in common use in some member countries

Country	Type A grease		Type B grease	
	$\theta 1$	$\theta 2$	$\theta 1$	$\theta 2$
France	-	-	- 20 °C	105 °C
Germany	-	-	- 30 °C	120 °C
Sweden	- 20 °C	225 °C	-	-
United Kingdom	- 20 °C - 20 °C	125 °C 150 °C	- 20 °C	125 °C

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