IEC 61394

Edition 1.0 2011-10

INTERNATIONAL STANDARD

colour inside

Overhead lines – Requirements for greases for aluminium, aluminium alloy and steel bare conductors

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Overhead lines – Requirements for greases for aluminium, aluminium alloy and steel bare conductors

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

OVERHEAD LINES – REQUIREMENTS FOR GREASES FOR ALUMINIUM, ALUMINIUM ALLOY AND STEEL BARE CONDUCTORS

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This first edition of IEC 61394 cancels and replaces the first edition of technical specification IEC/TS 61394 published in 1997. It constitutes a technical revision and now has the status of an International Standard.

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

FDIS	Report on voting
7/609/FDIS	7/613/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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OVERHEAD LINES – REQUIREMENTS FOR GREASES FOR ALUMINIUM, ALUMINIUM ALLOY AND STEEL BARE CONDUCTORS

1 Scope

This International Standard specifies the requirements and tests of greases designed for corrosion protection of bare overhead conductors.

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 60068-2-11:1981, *Basic environmental testing procedures – Part 2-11: Tests – Test Ka: Salt mist*

ISO 2137:2007, *Petroleum products and lubricants – Determination of cone penetration of lubricating greases and petrolatum*

ISO 2176:1995, *Petroleum products – Lubricating grease – Determination of dropping point*

3 Designation system

Greases shall be designated $\theta_1 A \theta_2$ or $\theta_1 B \theta_2$ where *A* and *B* define the type of grease as follows:

– type *A*: products generally applied in the cold state, for example greases: semi-solid or solid products consisting essentially of a stabilized mixture of mineral or synthetic oil and thickeners such as metal soaps or inorganic compounds;

– type *B*: products generally applied in the hot state, for example petrolatum: semi-solid, or solid products made up essentially of microcrystalline waxes associated with small quantities of mineral oil and organic additives;

– θ_1 is the lowest temperature in °C below 0 °C at which the grease will perform the requirement of protection of the conductor from atmospheric corrosion;

– θ_2 is the highest temperature, in °C, at which the grease will perform to this requirement (achieve specified drop point or high temperature stability).

Examples:

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

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

The grease supplier shall provide a unique identifier for its grease, and shall retain details of its composition for future reference. The composition shall include manufacturing tolerance and shall remain unchanged while the grease is marketed under this specific identifier.

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4 Requirements for grease

The grease shall protect overhead bare conductors from atmospheric corrosion in service and in storage. The grease shall remain in the conductor for the specified conditions of operation. The grease shall meet the requirements as described in this standard.

5 Tests

5.1 Classification of tests

5.1.1 Type tests

Type tests are intended to verify the main characteristics of a grease which depend mainly on its composition. They are carried out once for a supplier's specific product and then subsequently repeated when the composition of the grease has changed.

5.1.2 Sample tests

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

Table 1 – Classification of tests

Test	Type tests		Sample tests	
	Type *A*	Type *B*	Type *A*	Type *B*
Drop point	X	X	X	X
High temperature stability	X		X	
Penetrability	X	X	X	X
Low temperature adherence	X	X		
Acidity/alkalinity		X		
Ageing	X	X		
Stability on conductor	[a]	[a]		
Stability on conductor (short-circuit)	[a]	[a]		

[a] If requested by the purchaser.

5.2 Preconditioning of samples

5.2.1 Type *A* products

Type *A* grease delivered with an excess of oil on the surface shall not be acceptable. Excess oil on the surface of the product after storage shall be removed. If necessary, the product shall be mixed prior to carrying out the measurements.

5.2.2 Type *B* products

The product shall be heated between 10 °C to 20 °C above the temperature at which melting occurs, and maintained at this temperature for 30 min. The quantity necessary for carrying out the tests shall be poured into the test containers and allowed to cool at ambient temperature for a period of at least 24 h.

5.2.3 Products taken from a conductor

When the product to be tested is taken from a conductor, no preconditioning is allowed.

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5.3 Drop point

5.3.1 The determination of the drop point shall be made using the method given in ISO 2176.

5.3.2 When tested in accordance with 5.3.1, the minimum value of 5 determinations shall be greater than or equal to θ_2. Type *A* products may not have a well defined drop point, in which case the tests shall be stopped when the temperature reaches (θ_2 + 20) °C.

5.4 High temperature stability (Type *A* products only)

5.4.1 The oil separation shall be determined using the method given in IP 121, after 1 h at a temperature of θ_2.

5.4.2 When tested in accordance with 5.4.1, the maximum quantity of oil separated shall not exceed 0,2 % by mass.

5.5 Penetrability test

5.5.1 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.

5.5.1.1 Type *A* products

When the type *A* product is tested in accordance with 5.5.1, the mean value obtained for a type test shall be greater than or equal to 70 units × 0,1 mm. Results obtained from sample tests shall not vary from the value obtained from the type test by more than ± 20 %.

5.5.1.2 Type *B* products

When the type *B* product is tested in accordance with 5.5.1, the value obtained for a type test shall be between 120 and 180 × 0,1 mm. Results obtained from sample tests shall not vary from the value obtained from the type test by more than ± 20 %.

5.6 Low-temperature adherence

5.6.1 An aluminium coupon measuring 100 mm × 100 mm × (1 ± 0,1) mm shall be coated with a (0,50 ± 0,05) mm thick film of the product on one side and then maintained, along with a 25 mm mandrel, at a temperature less or equal to θ_1 for 1 h.

5.6.2 The coupon with the coated side outside of the mandrel shall then be immediately bent to an angle between 100 ° and 120 ° around the mandrel. The folding time of the coupon is 5 s.

5.6.3 When tested in accordance with 5.6.1 and 5.6.2, the product shall remain adhering to the coupon with no evidence of cracking or flaking when examined by the naked eye or with normal corrective lenses.

5.7 Acidity/alkalinity (type *B* grease only)

5.7.1 The test set-up and method is described in Annex A.

5.7.2 When tested in accordance with 5.7.1, the acidity or alkalinity of the sample before ageing shall be less than or equal to 2,0.

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5.8 Ageing

5.8.1 Preconditioning

5.8.1.1 Type *A* grease

No preconditioning is required for Type *A* grease.

5.8.1.2 Type *B* grease

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.

5.8.2 Sample preparation shall be in accordance with the procedure described in Annex B. After ageing, the metal coupons with grease shall be subjected to the corrosion test. The grease in the cups shall be subjected to the penetrability test as described in 5.5, as well as the acidity/alkalinity as described in 5.7.

5.8.3 When tested in accordance with 5.8.2, the mean penetrability value shall not differ from the type test mean value by more than ± 20 %. The acidity/alkalinity index shall be less than or equal to 2,5.

5.9 Corrosion tests

5.9.1 The coupons shall be prepared in accordance with 5.8. They shall be positioned with an angle of (20 ± 2) ° in a suitable chamber and then be subjected to the following:

– seven 24 h cycles in a sulphurous atmosphere. For the first 8 h of each cycle, the chamber shall have a relative humidity greater than 90 % and shall contain 0,067 % of sulphur dioxide by volume, at a temperature of (40 ± 3) °C. For the remaining 16 h, the chamber door shall be open to the laboratory atmosphere.

– 168 h in a water spray solution with 5 % of NaCl by mass at a temperature of (35 ± 1) °C in accordance with IEC 60068-2-11.

5.9.2 The coupons shall be examined after the grease has been removed using a suitable solvent and the coupons with the lowest and highest degree of corrosion in the evaluation area (see Annex B) shall both be discarded. There shall only be a limited number of pits and a limited spread of corrosion from these pits in the central part of the remaining coupon.

5.9.3 The degree of corrosion on the remaining coupon is assessed by means of a grading index based on the corrosion coupons shown in Figure 1.

5.9.4 When tested in accordance with 5.9.1, the coupon shall have a grading index greater than or equal to 8.

5.10 Stability of grease on conductor at high temperature

5.10.1 This test is performed at the request of the purchaser only.

5.10.2 A sample of conductor, selected by the user, shall be filled with grease in accordance with the appropriate IEC conductor specification. The sample shall be subjected to the test procedure as described in Annex C. The maximum operating temperature, θ_3, shall be defined by the purchaser.

5.10.3 When tested in accordance with 5.10.2, the temperature θ_A, as defined in Annex C, shall be not less than θ_3.

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5.11 Stability of grease on conductor under short-circuit

5.11.1 This test is performed at the request of the purchaser only.

5.11.2 A sample of conductor, selected by the user, shall be filled with grease in accordance with the appropriate IEC conductor specification. The sample shall be subjected to the test procedure as described in Annex D. The withstand temperature, θ_4, shall be defined by the purchaser.

5.11.3 When tested in accordance with 5.11.2, the sample shall meet the acceptance criteria as agreed upon before the test between the supplier and the purchaser.

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Figure 1 – Corrosion coupons

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Annex A
(normative)

Acidity or alkalinity test method for type *B* grease

A.1 General

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

A.2 Reagents

- Toluene, minimum 99,5 % by volume
- Ethanol, 96 % by volume
- Alkaline blue solution – 0,1 g alkaline blue in 100 ml of ethanol 96 % by volume
- Potassium hydroxide 0,1 mol/l (or 5,61 mg/ml) solution in ethanol 96 % by volume
- Hydrochloric acid 0,1 mol/l solution in ethanol 96 % by volume.

A.3 Equipment

- Glass conical flask
- Weighing device
- Glass measuring burette.

A.4 Procedure

a) Prepare approximately 1 g of the grease to be tested
b) Weigh the sample with an accuracy of 0,001 g
c) Place the sample in the conical flask
d) Add 60 ml of toluene
e) Add 40 ml of ethanol
f) Add 1 ml of alkaline blue solution
g) If the grease is alkaline, acidify the solution with 5 ml of hydrochloric acid 0,1 mol/l solution in ethanol
h) Shake the mixture vigorously
i) Using the burette, add the potassium hydroxide solution progressively into the flask, shaking vigorously
j) When the colour indicator changes colour (from blue to pink) note the volume of potassium hydroxide solution used, *n*.

A.5 Calculations

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

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Table A.1 – Acidity or alkalinity index formula

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

where

n is the volume of potassium hydroxide solution used, ml:

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

m is the mass of grease sample, g.

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Annex B
(normative)

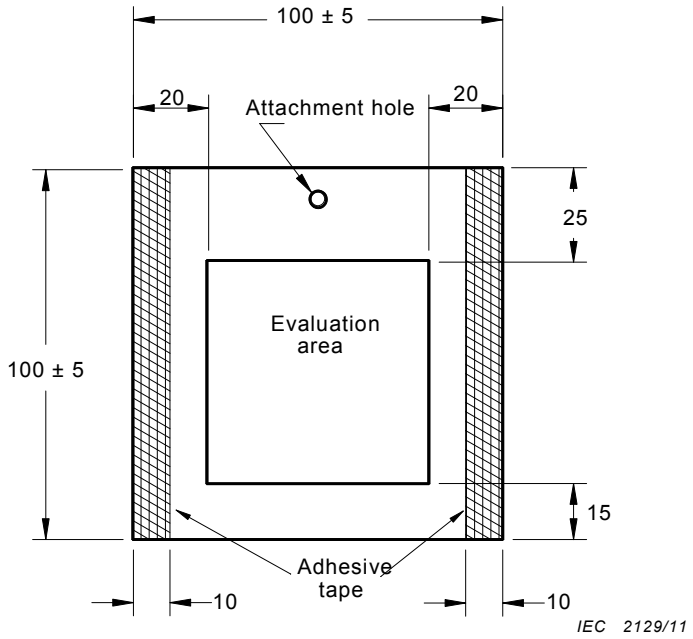
Sample preparation and test procedure for ageing test

B.1 Preparation of metal coupons

Three steel coupons approximately 100 mm × 100 mm × (2 ± 0,1) mm, shall be electro galvanized from a minimum zinc thickness of 2,8 μm to a maximum of 3,75 μm. The face which is not to be used in the test shall be covered with a suitable adhesive coating capable of withstanding the ageing cycles and salt spray of the corrosion test. The quality of the surface of the coupons shall be examined carefully, and any imperfections recorded and taken into account by agreement between the grease purchaser and the grease supplier.

B.2 Type *A* grease

A layer of grease shall be applied to the uncovered surface of each coupon 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 10 mm wide by (100 ± 10) μm thick are applied to two opposite sides of each coupon. A slight excess of grease is applied uniformly over the whole surface, and the excess removed by sliding a straight edge over the strips of tape. 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 the grease supplier.



Dimensions in millimetres

Note

Tolorance ± 1 mm unless otherwise indicated

Figure B.1 – Coupon for type *A* grease

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B.3 Type *B* grease

Metal coupons, as shown in Figure B.2, shall be immersed in a bath of molten grease, suspended from an attachment hole located in its corner. In order to obtain the required uniform thickness of (100 ± 10) μm in the central portion of the coupon, the following parameters should be determined by trials:

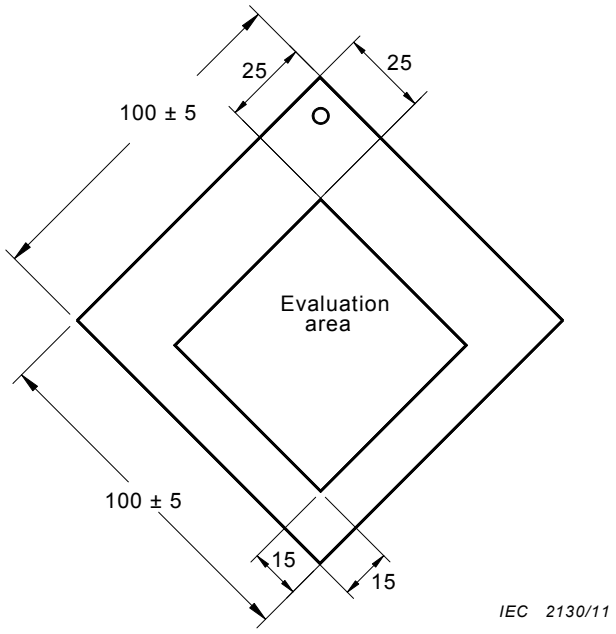
– the temperature of the bath, which may be between 10 °C to 30 °C above θ_m;

– the duration of immersion in the grease;

– the vertical draining time after removal.

The coupon shall be withdrawn uniformly from the bath within approximately 0,5 s and the thickness of grease in the upper portion of the evaluation area confirmed by a thickness measurements on trial coupons.

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.



Dimensions in millimetres

Note

Tolorance ± 1 mm unless otherwise indicated

Figure B.2 – Coupon for type *B* grease

Excess grease shall be removed from the edges of the coupon and the face not under test, and the average thickness calculated to the closest 10 μm by measuring the increase in mass of the coupon, using 0,87 g/cm^3 for the density of the protective product, or the value supplied by the grease supplier.

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B.4 Ageing

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

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

B.5 Tolerance

Tolerance on time shall be 0,1 h. Tolerance on temperature shall be ± 2 °C.

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Annex C
(normative)

Stability of grease on conductor at high temperature

This test is performed at the request of the purchaser only.

The maximum operating temperature, θ_3, shall be defined by the purchaser.

The sample conductor shall be at least 3 m long and be terminated with compression type tension clamps. The filler compound used in the compression type tension clamps shall be compatible with the grease being tested.

The sample shall be maintained at a tension of between 15 % to 20 % of its rated tensile strength, at a slope of between 10 ° and 15 ° to the horizontal and heated by the passage of current through its whole length.

The sample shall be subjected to the following procedure:

– the temperature of the sample shall be raised to the maximum operating temperature θ_3 by increments of 20 °C per 15 min;
– the sample shall be maintained at the maximum operating temperature θ_3 for 1 h;
– the temperature shall be raised by increments of 2 °C per 10 min until the grease flows freely from the conductor, or until the maximum operating temperature $\theta_3$is reached, whichever comes first.

The following temperatures shall be recorded:

– the temperature at which the product fills any space between the wires of the outside layer, θ_A;
– the temperature at which the product drips from the conductor (for information only).

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Annex D
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Stability of grease complete conductor under short-circuit

a) This test is performed at the request of the purchaser only.

b) The withstand temperature, θ_4, shall be defined by the purchaser.

c) The sample conductor shall be at least 3 m long and be terminated with compression type tension clamps. The filler compound used in the compression type tension clamps shall be compatible with the grease being tested.

d) The sample shall be maintained at a tension of between 15 % to 20 % of its rated tensile strength, at a slope of between 10 ° and 15 ° to the horizontal and heated by the passage of current through its whole length.

e) The required short-circuit current shall be applied through the end fittings for between 0,5 s to 1,5 s.

f) The maximum conductor surface temperature shall be recorded.

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Bibliography

This annex contains lists of related systems standards.

IEC 60050-466, *International Electrotechnical Vocabulary – Chapter 466: Overhead lines*

ISO 3310-1, *Test sieves – Technical requirements and testing – Part 1: Test sieves of metal wire cloth*

ISO 3310-2, *Test sieves – Technical requirements and testing – Part 2: Test sieves of perforated metal plate*

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

IP 121/05 [1], *Determination of oil separation from lubrication grease – Pressure filtration method*

_____

[1] IP = *Institute of Petroleum.*

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