

TECHNICAL REPORT

IEC TR 61394

First edition
1997-11

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**OVERHEAD LINES –
CHARACTERISTICS OF GREASES FOR ALUMINIUM,
ALUMINIUM ALLOY AND STEEL BARE CONDUCTORS**

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but no immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

Technical reports of types 1 and 2 are subject to review within three years of publication to decide whether they can be transformed into International Standards. Technical reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

IEC 61394, which is a technical report of type 2, has been prepared by IEC technical committee 7: Overhead electrical conductors.

The text of this technical report is based on the following documents:

Committee draft	Report on voting
7/487/CDV	7/499/RVC

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

This document is issued in the Technical Report (type 2) series of publications (according to G.3.2.2 of part 1 of the IEC/ISO Directives) as a “prospective standard for provisional application” in the field of overhead conductors because there is an urgent requirement for guidance on how standards in this field should be used to meet an identified need.

This document is not to be regarded as an “International Standard”. It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the IEC Central Office.

A review of this Technical Report (type 2) will be carried out not later than three years after its publication, with the options of either extension for a further three years or conversion into to an International Standard or withdrawal.

Annexes A and B are for information only.

Figure 3, which is in colour, is to be found inserted in the inside of the back cover.

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

1 General

1.1 Scope

This technical report applies to products designed for corrosion protection of bare electrical overhead conductors in any combination of

- wires of aluminium and aluminium alloy;
- wires of steel coated with zinc (galvanized) and zinc alloy with aluminium;
- wires of steel coated with aluminium.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this technical report. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this technical report are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60068-2-11:1981, *Environmental testing – Part 2: Tests – Test Ka: Salt mist*

ISO 2137:1985, *Petroleum products – Lubricating grease and petrolatum – Determination of cone penetration*

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

ISO 3310-1:1990, *Test sieves – Technical requirements and testing – Part 1: Test sieves of metal wire cloth*

ISO 3310-2:1990, *Test sieves – Technical requirements and testing – Part 2: Test sieves of perforated metal plate*

ISO 5725-2:1994, *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*

2 General requirements and classification

2.1 General requirements

- a) The product or any constituent element thereof shall neither be damaged, nor flow or exude from the conductor in the course of storage, transport, installation, placing in position or use at the maximum operating temperature or under normal short-circuit conditions (test under consideration).
- b) The product shall have good adherence to the wire. The adherence test (see 3.2.1) is intended to check this requirement.
- c) The product shall not be damaged by the conductor manufacturing process. The stability and ageing test (see 3.2.2) and the oil separation test (see 3.2.4) are intended to check this requirement.

- d) The product shall retain its properties throughout the likely operating temperature range. The tests are the same as for requirement c).
- e) The product shall protect the conductors against corrosion and shall neither corrode, nor affect the properties of the galvanized steel, aluminium-coated steel, aluminium or aluminium alloy wires or any combinations of those wires. The corrosion test (see 3.2.3) is intended to check this requirement.
- f) The product shall not cause an increase in corona noise (test under consideration).
- g) The product shall not present any risks to health and shall comply with all the usual health and safety standards.

2.2 Classification of the product

The products covered by this technical report may be one of two types:

- type I: 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;

The manufacturer of the product shall advise if it is thixotropic or pseudo-plastic, in which case tests appropriate to that type of product shall be agreed upon by the supplier, the conductor manufacturer and the conductor user.

- type II: 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.

3 Approval and quality control

To obtain approval of a product, the tests described in 3.2 shall be carried out. Where appropriate, acceptable values shall be agreed between the product manufacturer, the conductor manufacturer and the conductor user.

If agreed between the product manufacturer, the conductor manufacturer and the conductor user, a type test on a complete conductor may be carried out, as described in annex A.

In addition, the product manufacturer and the conductor manufacturer shall agree on the routine tests that are necessary to ensure quality control of the product. Having been decided upon, these tests shall be carried out as part of the approval procedures and, thereafter shall be carried out on the conductor, where possible, or on samples taken from the point of application during manufacture. The product manufacturer and the conductor manufacturer shall agree on the degree to which a value may deviate from that obtained during the initial approval test. Suitable test methods are described in 3.3.

The frequency of sampling shall be agreed between the conductor manufacturer and user.

3.1 Preconditioning of the samples

3.1.1 Products in the as-delivered condition

Prior to all tests, it is essential to precondition the products so that they are homogenised.

For type I products, after storage, excess oil may appear on the surface of the product. If so, this excess oil shall be removed. If necessary, the product shall be mixed prior to carrying out the measurements. The quantities required for tests are taken and the measurements shall not be carried out until after a rest period of at least 24 h.

For type II products, the product is remelted at a temperature of 10 °C to 20 °C greater than the dropping point indicated by the manufacturer. The quantity necessary for carrying out the tests shall be poured in the liquid state and allowed to cool at ambient temperature for a period of at least 24 h.

In order to achieve reproducibility for the two products, it is recommended to prepare samples directly in the cups or vessels used for measurements.

3.1.2 Products taken from a conductor

When the test is carried out on products taken from a conductor, no preconditioning is permitted.

3.2 Approval and quality test methods

3.2.1 Adherence test

An aluminium panel measuring 100 mm × 100 mm and having a thickness of $(1,0 \pm 0,1)$ mm shall be coated with a $(0,50 \pm 0,05)$ mm thick film of the product on one side and then maintained at -20 °C for 1 h.

The panel shall then be immediately bent to 120° around a 25 mm diameter mandrel which has been cooled at -20 °C.

The product shall remain adhering to the plate with no evidence of cracking or flaking when examined by the naked eye or with normal corrective lenses.

3.2.2 Stability and ageing test

In order to determine the penetrability, acidity or alkalinity of the grease, samples are placed in the vessels specified in ISO 2137 and, in order to check the corrosion, on assemblies comprising plates coated with the product. After this test, the plates undergo the corrosion test.

Three electrogalvanized steel plates, 100 mm × 100 mm × 2 mm, with 3,75 µm thickness of zinc and a minimum of 2,8 µm, shall be covered on one face with a protective coating which will withstand the ageing and saltspray tests.

For type I products, the metal plate is covered on each side with an adhesive tape of thickness (100 ± 10) µm. Slight excess of grease is spread uniformly over the whole surface and then the excess is removed by sliding a perfectly flat and sharp metal rule over the two adhesive strips. Figure 1 illustrates the procedure.

For type II products, the metal plate suspended diagonally is immersed in a bath of grease. To obtain the thickness of (100 ± 10) µm, the influence of parameters involved are determined beforehand – these are duration of immersion, temperature of the bath, rate of removal from the bath, vertical dropping time, taking into account the following conditions.

The temperature of the bath shall be between $(\theta_p + 10)$ °C and $(\theta_p + 30)$ °C, where θ_p is the dropping point measured in 3.3.1. The rate of removal from the bath shall be such that the plate is withdrawn in approximately 0,5 s. The vertical dropping time is the time during which the plate is kept vertical by the hole after removal from the bath. The excess material shall be removed from the edges and the unused surface.

The thickness is checked by the increase in mass of the plate.

$$E = \frac{\Delta P \cdot 10^4}{S \cdot \rho}$$

where

E is the thickness in micrometres;

ΔP is the increase of mass in grams;

S is the area of the surface covered in square centimetres;

ρ is the specific gravity of the product in grams per cubic centimetre at 20 °C.

Then the cups and metal plates shall be subjected to three weekly cycles comprising the following sequences of tests:

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

The temperatures shall be maintained with a tolerance of ± 2 °C.

After this treatment, the grease in the cups shall be subjected without remelting, to the penetrability tests at 60 °C (see 3.3.2) and the acidity index or the alkalinity index (see 3.3.3) is determined.

The metal plates are then subjected to the corrosion test.

3.2.3 Corrosion test

The test is carried out on the metal plates which have undergone the stability and the ageing test specified in 3.2.2. It consists of the following sequences:

- seven cycles of 24 h in a sulphurous atmosphere saturated with moisture in the following conditions: during the first 8 h, the metal plates are kept in a chamber saturated with moisture and containing 0,067 % by volume of sulphur dioxide. The temperature is brought to (40 ± 3) °C and kept at that level. During the last 16 h, the chamber door is opened to the laboratory atmosphere;
- 168 h of exposure to salt mist (5 %) at a temperature of (35 ± 1) °C according to IEC 60068-2-11.

At the end of the test, the grease shall be removed by means of a suitable solvent and the plates shall be examined visually.

The plate with the highest degree of corrosion and the one with the lowest degree of corrosion in the central part (see figure 2) shall be discounted.

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 plate.