INTERNATIONAL STANDARD

IEC 60287-3-1

Edition 1.1
1999-05

Edition 1:1995 consolidated with amendment 1:1999

Electric cables – Calculation of the current rating –

Part 3-1: Sections on operating conditions – Reference operating conditions and selection of cable type

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

Reference number
IEC 60287-3-1:1995+A1:1999(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRIC CABLES – CALCULATION OF THE CURRENT RATING –

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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.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
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6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60287-3-1 has been prepared by subcommittee 20A: High-voltage cables, of IEC technical committee 20: Electric cables.

This first edition of 60287-3-1 cancels and replaces annexes A and B of the second edition of IEC 60287 published in 1982 without technical changes.

IEC 60287-1-1 replaces sections one and two of the second edition of IEC 60287, IEC 60287-2-1 replaces section three and annexes C and D of the second edition of IEC 60287; IEC 60287-3-2 replaces the first edition of IEC 61059.

This consolidated version of IEC 60287-3-1 consists of the first edition (1995) [documents 20A(CO)75 and 20A(CO)81] and its amendment 1 (1999) [documents 20A/403/FDIS and 20A/408/RVD].

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 1.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

INTRODUCTION

IEC 60287 has been divided into three parts and sections so that revisions of, and additions to, the document can be carried out more conveniently.

Each part is divided into sections which are published as separate standards.

Part 1: Formulae for ratings (100 % load factor) and power losses

Part 2: Formulae for thermal resistance

Part 3: Sections on operating conditions

This section of IEC 60287-3 contains reference ambient temperatures and thermal resistivities of soil in various countries. Also in this section is an outline of the information required from the purchaser for the selection of the appropriate type of cable.

Quantities related to the operating conditions of cables are liable to vary considerably from one country to another. For instance, with respect to the ambient temperature and soil thermal resistivity, the values are governed in various countries by different considerations. Superficial comparisons between the values used in the various countries may lead to erroneous conclusions if they are not based on common criteria: for example, there may be different expectations for the life of the cables, and in some countries design is based on maximum values of soil thermal resistivity, whereas in others average values are used. Particularly, in the case of soil thermal resistivity, it is well known that this quantity is very sensitive to soil moisture content and may vary significantly with time, depending on the soil type, the topographical and meteorological conditions, and the cable loading.

The following procedure for choosing the values for the various parameters should, therefore, be adopted.

Numerical values should preferably be based on results of suitable measurements. Often such results are already included in national specifications as recommended values, so that the calculation may be based on these values generally used in the country in question; a survey of such values is given in this section.

ELECTRIC CABLES – CALCULATION OF THE CURRENT RATING –

Part 3-1: Sections on operating conditions – Reference operating conditions and selection of cable type

1 Scope

This section of IEC 60287-3 is applicable to the conditions of steady-state operation of cables at all alternating voltages, and direct voltages up to 5 kV, buried directly in the ground, in ducts, troughs or in steel pipes, both with and without partial drying-out of the soil, as well as cables in air. The term "steady state" is intended to mean a continuous constant current (100 % load factor) just sufficient to produce asymptotically the maximum conductor temperature, the surrounding ambient conditions being assumed constant.

This section concerns reference operating conditions and selection of cable type.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this section of IEC 60287-3. At the time of publication, the edition indicated was valid. All normative documents are subject to revision, and parties to agreements based on this section of IEC 60287-3 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60183:1984, *Guide to the selection of high-voltage cables*
Amendment 1 (1990)

3 Reference ambient temperatures and thermal resistivities of soil in various countries

3.1 Standard operating conditions

In order to use the formulae given in the various parts of IEC 60287, numerical values for the physical quantities should be chosen relating to the operating conditions.

It is obviously possible to compare the results of two calculations of current rating only when the assumptions made and the numerical values of the parameters are known.

In particular, the quantities related to the operating conditions of cables are liable to vary considerably from one country to another. An enquiry into this subject has been carried out and a number of countries have replied.

Clause 4 and its subclauses summarize the operating conditions used in various countries. Attention is drawn to the fact that the information in clause 4 is intended only as a guide for cable installation designers when data provided by a user is incomplete. Care must be taken not to draw unjustified conclusions from comparisons of values for different countries. It should be remembered that the values adopted in any particular country are governed by many factors some of which might not be of equal importance in other countries.

Values relating to the operating conditions are given in clause 4 for the following countries:

Australia	Netherlands
Austria	Norway
Canada	Poland
Finland	Sweden
France	Switzerland
Germany	United Kingdom
Italy	United States of America
Japan	

3.2 Procedure when values are not provided in national tables

It is recommended that when there is no value laid down in the national tables for the reference ambient temperature and thermal resistivity of the soil, the following values should be adopted.

3.2.1 Ambient temperatures at sea level

Climate	Ambient air temperature		Ambient ground temperature at a depth of 1 m	
	Min. °C	Max. °C	Min. °C	Max. °C
Tropical	25	55	25	40
Subtropical	10	40	15	30
Temperate	0	25	10	20

It is essential that current ratings should be valid for the maximum temperatures given. The lower values are for winter ratings if required. The values correspond with the temperature limits of winter and summer, alternatively rainy and dry seasons.

When no information about the depth of laying is given, the standard depth is to be taken as 1 m.

3.2.2 Thermal resistivity of soil

Thermal resistivity K.m/W	Soil conditions	Weather conditions
0,7	Very moist	Continuously moist
1,0	Moist	Regular rainfall
2,0	Dry	Seldom rains
3,0	Very dry	Little or no rain

4 Values relating to the operating conditions in various countries

4.1 Australia

1) *Standard conditions*

Soil thermal resistivity	1,2 K.m/W
Soil ambient temperature	25 °C summer
	18 °C winter

2) *Depth of laying*

Measured from the ground surface to the centre of the cable, or to the centre of a trefoil group.

L.V. cables	500 mm under footways
	750 mm under roadways
11 kV cables	800 mm under footways
	800 mm under roadways
33 kV cables and higher voltages	1 000 mm under footways
	1 000 mm under roadways

3) *Air ambient temperature*

Maximum value	40 °C summer
	30 °C winter

4.2 Austria

1) *Thermal characteristics of the soil*

a) *Thermal resistivity:*

up to 30 kV, average value	0,7 K.m/W
30 kV, average value	1,0 K.m/W (max. 1,2; min. 0,7 K.m/W)

b) *Temperature:*

maximum value	20 °C
minimum value	0 °C

2) *Depth of laying for buried cables*

All cables up to 1 kV	700 mm
All cables up to 10 kV	800 mm
Paper-insulated cables 10 kV	1 000 mm
Oil-filled cables up to 220 kV	1 200 mm

3) *Air ambient temperature*

Average value	20 °C (max. 40 °C; min. –20 °C)

4.3 Canada

While there are no recognized Canadian national values of soil thermal resistivity and temperature, and depth of laying, the values shown below are typical.

1) *Thermal characteristics of the soil for cables directly buried or in ducts*

   a) *Thermal resistivity:*

maximum value	1,2 K.m/W
minimum value	0,6 K.m/W
average value	0,9 K.m/W

   b) *Temperature:*

maximum value	20 °C
minimum value	–5 °C
average value	not used as a design basis

Soil thermal resistivity

Where direct measurements are not available, it is usual to assume a thermal resistivity of 0,9 K.m/W. However, in cases where it is foreseen that there may be a progressive deterioration of the thermal characteristics of the environment over a period of years, and in cases where the climatic conditions may give rise to significant seasonal variations, it is recommended that the current-carrying capacity be based on a thermal resistivity of 1,2 K.m/W.

Reference is not made to lower values of resistivity, during winter, as a basis for system design to any significant extent.

2) *Depth of laying*[*]

	Direct burial	In ducts
a) Paper insulated, solid and non-draining cables for voltages up to 69 kV	1 100 mm	1 100 mm
b) Solid insulation (butyl, ethylene propylene rubber, p.v.c., polyethylene, cross-linked polyethylene, etc.) cables for voltages up to 46 kV	900 mm	900 mm
c) Oil-filled cables for voltages up to 345 kV	1 100 mm	1 100 mm
d) Pipe-type (gas or oil pressure) cables for voltages up to 345 kV	1 100 mm	

3) *Air ambient temperature*

Maximum value	40 °C
Minimum value	–40 °C
Average value	not used as a design basis

[*] This is in reality a "minimum cover" requirement and in the case of duct banks corresponds to the duct bank cover.