

# INTERNATIONAL STANDARD



Electric cables – Calculation of the current rating –  
Part 3-1: ~~Sections on~~ Operating conditions – Site reference ~~operating~~ conditions  
~~and selection of cable type~~

Document Preview

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRIC CABLES –  
CALCULATION OF THE CURRENT RATING –****Part 3-1: ~~Sections on~~ Operating conditions –  
Site reference ~~operating conditions and selection of cable type~~**

## FOREWORD

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International Standard IEC 60287-3-1 has been prepared by IEC technical committee 20: Electric cables.

This second edition cancels and replaces the first edition published in 1995 and Amendment 1:1999. This edition constitutes a technical revision. This edition includes the following significant technical changes with respect to the previous edition:

- a) the updated list of national laying conditions is now covered in Annex A;
- b) Clause 5 about the information required from the purchaser for the selection of the appropriate type of cable has been removed.

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

FDIS	Report on voting
20/1714/FDIS	20/1730/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.

A list of all parts in the IEC 60287 series, published under the general title *Electric cables – Calculation of the current rating*, can be found on the IEC website.

The reader's attention is drawn to the fact that Annex A lists all of the “in-some-country” clauses on differing practices of a less permanent nature relating to the subject of this standard.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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## 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 subdivided into subparts 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 part 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 part of IEC 60287-3.

## ELECTRIC CABLES – CALCULATION OF THE CURRENT RATING –

### Part 3-1: ~~Sections on~~ Operating conditions – Site reference ~~operating conditions and selection of cable type~~

#### 1 Scope

This part 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.~~

This document defines site reference conditions, however the general values are superseded by specific national requirements.

#### 2 Normative references

~~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)~~

There are no normative references in this document.

#### 3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

#### 4 Reference ambient temperatures and thermal resistivities of soil in various countries

##### 4.1 **Standard** Operating conditions – Site reference 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~~ likely to vary considerably from one country to another. An enquiry into this subject has been carried out and a number of countries have replied.



Annex A summarizes the operating conditions used in various countries. Attention is drawn to the fact that the information in Annex A is intended only as a guide for cable installation designers when data provided by a user is incomplete. Care ~~must~~ should 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 Annex A for the following countries:

Australia	Italy	Portugal
Austria	Japan	Spain
Canada	Mexico	South Africa
China	Netherlands	Sweden
Egypt	New Zealand	Switzerland
Finland	Norway	United Kingdom
France	Oman	United States of America
Germany	Poland	

## 4.2 Procedure when values are not provided in national tables

### 4.2.1 General

It is recommended that when there is no value laid down in the national tables for the reference ambient temperature, thermal resistivity of the soil or solar radiation, the values given in 4.2.2, 4.2.3 and 4.2.4 should be adopted.

### 4.2.2 Ambient temperatures at sea level

See Table 1.

**Table 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.

### 4.2.3 Thermal resistivity of soil

See Table 2.

**Table 2 – Thermal resistivity of soil**

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

#### **4.2.4 Solar radiation**

When no information about the intensity of solar radiation a value of 1 000 W/m<sup>2</sup> is adopted.

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## Annex A (informative)

### Values relating to the operating conditions in various countries

#### A.1 Australia

<i>Standard conditions</i> Thermal characteristics of the soil		
Soil Thermal resistivity, nominal	1,2	K·m/W
Soil ambient temperature, summer	25	°C
Soil ambient temperature, winter	18	°C
<b>Depth of laying of cables <sup>a</sup></b>		
<b>Voltage range 1:</b> L.V. cables		
under footways	0,5	m
under roadways	0,75	m
<b>Voltage range 2:</b> 11 kV cables		
under footways and roadways	0,8	m
<b>Voltage range 3:</b> 33 kV cables and higher voltages		
under footways and roadways	1,0	m
<b>Air ambient temperature</b>		
Maximum, summer	+40	°C
Maximum, winter	+30	°C
<sup>a</sup> Measured from the ground surface to the centre of the cable, or to the centre of a trefoil group.		

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## A.2 Austria

<b>Thermal characteristics of the soil</b>		
<i>Thermal resistivity:</i>	0,7 K.m/W	
up to 30 kV, average value	1,0 K.m/W	
30 kV, average value	(max. 1,2; min. 0,7 K.m/W)	
Thermal resistivity, nominal, season 1 (wet)	1,0	K.m/W
Thermal resistivity, dry zone, season 1 (dry)	2,5	K.m/W
<b>Temperature:</b>		
maximum value	20 °C	
minimum value	0 °C	
Temperature, season 1	20	°C
<b>Depth of laying for buried of cables</b>		
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	
Voltage range 1: up to 1 kV	0,7	m
Voltage range 2: > 1 kV up to 30 kV	0,8	m
Voltage range 3: > 30 kV	1,2	m
<b>Air ambient temperature</b>		
Average value	20	°C
Maximum	+40	°C
Minimum	-20	°C

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### A.3 Canada

There are no recognized Canadian national values of soil thermal resistivity and temperature, and depth of laying, however the values shown below are typical. It is recommended that, where feasible, soil tests are performed for cable installations.

<b>Thermal characteristics of the soil <del>for cables directly buried or in ducts</del></b>		
<del>Thermal resistivity:</del>		
<del>maximum value</del>	<del>1,2 K.m/W</del>	
<del>minimum value</del>	<del>0,6 K.m/W</del>	
<del>average value</del>	<del>0,9 K.m/W</del>	
Thermal resistivity, nominal (Critical temperature 50 °C)	0,5 to 3,0	K·m/W
Temperature, season 1 (summer)	20 25	°C
Temperature, season 2 (winter)	-5	°C
<del>average value</del>	<del>not used as a design basis</del>	
<b>Depth of laying of cables (minimum cover)</b>		
Paper insulated, solid and non-draining cables for voltages up to 69 kV	1,1	m
Solid insulation (butyl, ethylene propylene rubber, p.v.c., cross-linked polyethylene, etc.) cables for voltages up to 46 kV	0,9	m
Oil filled cables for voltages up to 345 kV	1,1	m
Pipe-type (gas or oil pressure) cables for voltages up to 345 kV	1,1	m
<b>Air ambient temperature</b>		
Maximum	5 to 40	°C
Minimum	-40 -55 to -20	°C
<b>Cyclic ratings</b>		
Critical temperature	50	°C
Drying out is not considered for cables in concrete duct banks		

Where direct measurements of soil thermal resistivity 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.

### A.4 China

<b>Thermal characteristics of the soil</b>		
Thermal resistivity	1,0 to 1,2	K·m/W
Temperature, summer	30	°C
Temperature, winter	5	°C
<b>Depth of laying of cables</b>		
≤1 kV	0,7	m
>1 kV up to 35 kV	0,7	m
≥110 kV up to 500 kV	1,0	m
<b>Air ambient temperature</b>		
Maximum	40	°C
Minimum	-10	°C
<b>Solar radiation</b>		
Intensity of solar radiation	1 000	W/m <sup>2</sup>

### A.5 Egypt

<b>Thermal characteristics of the soil</b>		
Thermal resistivity	1,2	K·m/W
Temperature, summer	35	°C
Temperature, winter	0	°C
<b>Depth of laying of cables</b>		
≤1 kV	0,4	m
>1 kV up to 35 kV	0,8	m
≥110 kV up to 500 kV <sup>a</sup>	1,2	m
<b>Air ambient temperature</b>		
Maximum	47	°C
Minimum	-5	°C
<b>Solar radiation</b>		
Intensity of solar radiation	≥1 000	W/m <sup>2</sup>
<sup>a</sup> Note at soil temperature 25 °C.		