

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Electric cables – Calculation of the current rating –
Part 3-1: Operating conditions – Site reference conditions**
(standards.iteh.ai)

**Câbles électriques – Calcul du courant admissible –
Partie 3-1: Conditions de fonctionnement – Conditions du site de référence**

IEC 60287-3-1:2017
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IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRIC CABLES –
CALCULATION OF THE CURRENT RATING –****Part 3-1: Operating conditions –
Site reference conditions**

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- withdrawn,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 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: Operating conditions

This part of IEC 60287-3 contains reference ambient temperatures and thermal resistivities of soil in various countries.

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: Operating conditions – Site reference conditions

1 Scope

This part of IEC 60287-3 is applicable to the conditions of steady-state operation of cables at all voltages, 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 document defines site reference conditions, however the general values are superseded by specific national requirements.

2 Normative references

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 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 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 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
Austria

Italy
Japan

Portugal
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

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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

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

4.2.4 Solar radiation

When no information about the intensity of solar radiation a value of 1 000 W/m² is adopted.

Annex A (informative)

Values relating to the operating conditions in various countries

A.1 Australia

Thermal characteristics of the soil		
Thermal resistivity, nominal	1,2	K·m/W
Soil ambient temperature, summer	25	°C
Soil ambient temperature, winter	18	°C
Depth of laying of cables ^a		
Voltage range 1: L.V. cables		
under footways	0,5	m
under roadways	0,75	m
Voltage range 2: 11 kV cables		
under footways and roadways	0,8	m
Voltage range 3: 33 kV cables and higher voltages		
under footways and roadways	1,0	m
Air ambient temperature		
Maximum, summer	+40	°C
Maximum, winter	+30	°C
^a 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

Thermal characteristics of the soil		
Thermal resistivity, nominal, season 1 (wet)	1,0	K·m/W
Thermal resistivity, dry zone, season 1 (dry)	2,5	K·m/W
Temperature, season 1	20	°C
Depth of laying of cables		
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
Air ambient temperature		
Average value	20	°C
Maximum	+40	°C
Minimum	-20	°C

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.

Thermal characteristics of the soil		
Thermal resistivity, nominal (Critical temperature 50 °C)	0,5 to 3,0	K·m/W
Temperature, season 1 (summer)	25	°C
Temperature, season 2 (winter)	-5	°C
Depth of laying of cables (minimum cover)		
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
Air ambient temperature		
Maximum	5 to 40	°C
Minimum	-55 to -20	°C
Cyclic ratings		
Critical temperature	50	°C
Drying out is not considered for cables in concrete duct banks		

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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

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

A.5 Egypt

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

A.6 Finland

Thermal characteristics of the soil		
Thermal resistivity		
Average value to be used for rating calculations.	1,0	K·m/W
For submarine cables where the soil is completely saturated with water	0,4	K·m/W
Temperature		
Maximum value	15	°C
Minimum value	0	°C
(average value 5 °C to 10 °C, exceptional maximum 20 °C)		
Depth of laying of cables		
All cables up to 36 kV	0,7	m
All cables up to 52 kV	1,0	m
All cables up to 123 kV	1,3	m
All cables up to 245 kV	1,5	m
The actual depth depends on local conditions		
Air ambient temperature		
Reference value for rating calculations	25	°C
Maximum value	35	°C
Minimum value	-20	°C

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A.7 France

Thermal characteristics of the soil		
Thermal resistivity, nominal, summer	1,20	K·m/W
Thermal resistivity, nominal, winter	0,85	K·m/W
Thermal resistivity, dry zone ^a , summer	2,5	K·m/W
Thermal resistivity, dry zone ^a , winter	2,5	K·m/W
Temperature, summer		
20 kV cables	20	°C
63 kV, 90 kV, 225 kV, 400 kV cables		
hot area	25	°C
intermediate area	22	°C
cold area	20	°C
Temperature, winter		
20 kV cables	10	°C
63 kV, 90 kV, 225 kV and 400 kV cables		
hot region	17	°C
intermediate region	15	°C
cold region	13	°C
Depth of laying of cables		
20 kV cables		
in Paris	1,0 to 1,2	m
outside Paris city	0,8	m
63 kV, 90 kV, 225 kV and 400 kV cables		
	1,3	m
Air ambient temperature		
Maximum	30	°C
Minimum	20	°C
Cyclic ratings		
Critical temperature, summer	55	°C
Critical temperature, winter	60	°C
Solar radiation		
Intensity of solar radiation	1 000	W/m ²
^a Drying out of the soil is only considered for high voltage systems.		

A.8 Germany

The indicated values are taken as a basis as standard values for current rating calculations unless there are any requirements specified for the thermal resistivity of the soil, the temperature and the depth of laying.

Thermal characteristics of the soil		
Thermal resistivity, average value	1,0	K·m/W
Thermal resistivity, for calculations considering a dry zone near the cable – for the dry zone	2,5	K·m/W
Temperature, maximum value	20	°C
Temperature, minimum value	0	°C
Temperature, average value	10	°C
Depth of laying of cables		
For cables ≥ 60 kV	1,2	m
For cables < 60 kV	0,7 ^a	m
Air ambient temperature		
Maximum	30	°C
Minimum	-20	°C
Average value	10	°C
^a In spite of being calculated for 0,7 m, often cables at 20 kV to 30 kV are laid at 0,9 m to 1,0 m depth.		

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