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Design criteria of overhead transmission lines

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Tel: +41 22 919 02 11
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International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

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DESIGN CRITERIA OF OVERHEAD TRANSMISSION LINES

FOREWORD

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International Standard IEC 60826 has been prepared by IEC technical committee 11: Overhead lines.

This third edition cancels and replaces the second edition which was issued as a technical report in 1999. It constitutes a technical revision and now have the status of an International Standard.

This revision consists mainly of splitting the standard into two sections, normative and informative, in addition to simplifying its contents and improving some specific design requirements in accordance with recent technical advances.

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

FDIS	Report on voting
11/175/FDIS	11/177/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.

The committee has decided that the contents of this publication will remain unchanged until 2008. At this date, the publication will be

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- withdrawn;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

DESIGN CRITERIA OF OVERHEAD TRANSMISSION LINES

1 Scope

This International Standard specifies the loading and strength requirements of overhead lines derived from reliability based design principles. These requirements apply to lines 45 kV and above, but can also be applied to lines with a lower nominal voltage.

This standard also provides a framework for the preparation of national standards dealing with overhead transmission lines, using reliability concepts and employing probabilistic or semi-probabilistic methods. These national standards will need to establish the local climatic data for the use and application of this standard, in addition to other data that are country specific.

Although the design criteria in this standard apply to new lines, many concepts can be used to address the reliability requirements for refurbishment and uprating of existing lines.

This standard does not cover the detailed design of line components such as towers, foundations, conductors or insulators.

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 60652:2002, *Loading tests on overhead line structures*

IEC 61089:1991, *Round wire concentric lay overhead electrical stranded conductors*

IEC 61773:1996, *Overhead lines – Testing of foundations for structures*

IEC 61774:1997, *Overhead lines – Meteorological data for assessing climatic loads*

IEC 61284:1997, *Overhead lines – Requirements and tests for fittings*

3 Terms, definitions, symbols and abbreviations

For the purposes of this document, the following terms, definitions, symbols and abbreviations apply.

3.1 Terms and definitions

3.1.1
characteristic strength
guaranteed strength, minimum strength, minimum failing load
R_c
value guaranteed in appropriate standards

NOTE This value usually corresponds to an exclusion limit, from 2 % to 5 %, with 10 % being an upper practical (and conservative) limit.

3.1.2
coefficient of variation
COV
ratio of the standard deviation to the mean value

NOTE The COV of load and strength are respectively denoted by v_Q and v_R.

3.1.3
components
different parts of a transmission line system having a specified purpose

NOTE Typical components are towers, foundations, conductors and insulator strings.

3.1.4
damage limit (of a component)
serviceability limit state
strength limit of a component corresponding to a defined limit of permanent (or inelastic) deformation of this component which leads to damage to the system if it is exceeded

NOTE This limit is also called the serviceability limit state in building codes based on limit states design.

3.1.5
damage state (of the system)
state where the system needs repairing because one of its components has exceeded its damage limit

NOTE The system needs repairing because it is not capable of fulfilling its task under design loads or because design clearances may be reduced (e.g. conductor to ground).

3.1.6
elements
different parts of a component

NOTE For example, the elements of a steel lattice tower are steel angles, plates and bolts.

3.1.7
exclusion limit
***e* %**
value of a variable taken from its distribution function and corresponding to a probability of *e* % of not being exceeded

3.1.8
failure limit (of a component)
ultimate limit state
strength limit of a component which leads to the failure of the system if this limit is exceeded.

NOTE If this strength limit is exceeded, the system will reach a state called "ultimate limit state" as defined in building codes based on limit states design.

3.1.9
failure state (of the system)
state of a system in which a major component has failed because one of its components has reached its failure limit (such as by rupture, buckling, overturning)

NOTE This state leads to the termination of the ability of the line to transmit power and needs to be repaired.

3.1.10
intact state
state in which a system can accomplish its required function and can sustain limit loads

3.1.11
limit loads
climatic loads corresponding to a return period, *T*, used for design purposes without additional load factors

NOTE Refer to 5.2.1.

3.1.12
load factor
γ
factor to be multiplied by limit loads in order to design line components

3.1.13
operating period
general measure of useful (or economical) life

NOTE Typical operating periods of transmission lines vary from 30 years to 80 years.

3.1.14
reference wind speed
V_R
wind speed at 10 m in height, corresponding to an averaging period of 10 min and having a return period *T*

NOTE When this wind speed is taken in a terrain type B, which is the most common case in the industry, the reference wind speed is identified as V_{RB}.

3.1.15
reliability (structural)
probability that a system performs a given task, under a set of operating conditions, during a specified time

NOTE Reliability is thus a measure of the success of a system in accomplishing its task. The complement to reliability is the probability of failure or unreliability.

3.1.16
return period (of a climatic event)
average occurrence of a climatic event having a defined intensity

NOTE The inverse of the return period is the yearly frequency which corresponds to the probability of exceeding this climatic event in a given year.

3.1.17
safety
ability of a system not to cause human injuries or loss of lives

NOTE In this standard, safety relates mainly to protection of workers during construction and maintenance operations. The safety of the public and of the environment in general is covered by national regulations.

3.1.18
security (structural)
ability of a system to be protected from a major collapse (cascading effect) if a failure is triggered in a given component

NOTE Security is a deterministic concept as opposed to reliability which is a probabilistic concept.

3.1.19
strength factor
Φ
factor applied to the characteristic strength of a component

NOTE This factor takes into account the coordination of strength, the number of components subjected to maximum load, quality and statistical parameters of components.

3.1.20
system
set of components connected together to form the transmission line

3.1.21
task
function of the system (transmission line), i.e. to transmit power between its two ends

3.1.22
unavailability
inability of a system to accomplish its task

NOTE Unavailability of transmission lines results from structural unreliability as well as from failure due to other events such as landslides, impact of objects, sabotage, defects in material, etc.

3.1.23
use factor
ratio of the actual load (as built) to limit load of a component

NOTE For tangent towers, it is virtually equal to the ratio of actual to maximum design spans (wind or weight) and for angle towers; it also includes the ratio of the sines of the half angles of deviation (actual to design angles).

3.2 Symbols and abbreviations

a	Unit action of wind speed on line elements (Pa or N/m^2)
A_c	Wind force on conductors (N)
A_i	Wind force on insulators (N)
A_t	Wind force acting on a tower panel made of steel angles, A_{tc} for cylindrical tower members (N)
B_i	Reduction factor of the reference wind speed for wind and ice combinations

C_x	Drag coefficient (general form)
C_i	Drag coefficient of ice covered conductors (C_{iL} for low probability and C_{iH} for a high probability)
C_{xc}	Drag coefficient of conductors
C_{xi}	Drag coefficient of insulators
C_{xt}	Drag coefficient of supports C_{xt1}, C_{xt2} for each tower face (C_{xtc} on cylindrical tower members)
COV	Coefficient of variation, also identified as v_x (ratio of standard deviation to mean value)
d	Conductor diameter (m)
d_{tc}	Diameter of cylindrical tower members (m)
D	Equivalent diameter of ice covered conductors (D_H for high probability and D_L for low probability) (m)
e	Exclusion limit (%)
e_N	Exclusion limit of *N* components in series (%)
$f_{(x)}$	Probability density function of variable *x*
$F_{(x)}$	Cumulative distribution function of variable *x*
G	Wind factor (general form)
G_c	Combined wind factor of conductors
G_t	Combined wind factor of towers
G_L	Span factor for wind calculations
g	Unit weight of ice (N/m)
$\overline{g}$	Mean value of yearly maximum ice load (N/m)
g_{max}	Maximum weight of ice per unit length observed during a certain number of years (N/m)
g_R	Reference design ice weight (N/m)
g_H	Ice load having a high probability (N/m)
g_L	Ice load having a low probability (N/m)
h	Height of centre of gravity of a panel in a lattice tower (m)
K_R	Terrain roughness factor
K_d	Factor related to the influence of conductor diameter
K_h	Factor to be multiplied by $\overline{g}$ to account for the influence of height above ground
K_n	Factor to be multiplied by $\overline{g}$ to account for the influence of the number of years with icing observations
l_e	Length of a support member (m)
L	Span length or wind span (m)
L_m	Average span (m)
n	Number of years of observation of a climatic event
N	Number of components subjected to maximum loading intensity
P_f	Probability of failure (%)
P_{fi}	Probability of failure of component i (%)
P_s	Probability of survival (%)
P_{si}	Probability of survival of component i (%)