SLOVENSKI STANDARD
SIST EN 60071-2:2001

01-februar-2001

Insulation co-ordination - Part 2: Application guide

Insulation co-ordination -- Part 2: Application guide

Isolationskoordination -- Teil 2: Anwendungsrichtlinie

Coordination de l'isolement -- Partie 2: Guide d'application

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Ta slovenski standard je istoveten z: **EN 60071-2:1997**

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ICS:

29.080.01	Električna izolacija na splošno	Electrical insulation in general

SIST EN 60071-2:2001 **en**

2003-01.Slovenski inštitut za standardizacijo. Razmnoževanje celote ali delov tega standarda ni dovoljeno.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60071-2

January 1997

ICS 29.080.00

Supersedes HD 450.2 S1:1991 and partly supersedes HD 540.3 S1:1991

Descriptors: Insulation co-ordination, a.c. high-voltage network, voltage stress, insulation withstand, protective device, co-ordination between stresses and withstand

English version

Insulation co-ordination
Part 2: Application guide
(IEC 71-2:1996)

Coordination de l'isolement
Partie 2: Guide d'application
(CEI 71-2:1996)

Isolationskoordination
Teil 2: Anwendungsrichtlinie
(IEC 71-2:1996)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

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Foreword

The text of document 28/115/FDIS, future edition 3 of IEC 71-2, prepared by IEC TC 28, Insulation co-ordination, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60071-2 on 1996-10-01.

This European Standard supersedes HD 540.2 S1:1991 and, together with EN 60071-1:1995, supersedes HD 540.3 S1:1991.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1997-09-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1997-09-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annexes A and ZA are normative and annexes B to J are informative.
Annex ZA has been added by CENELEC.

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Endorsement notice

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The text of the International Standard IEC 71-2:1996 was approved by CENELEC as a European Standard without any modification.

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Annex ZA (normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE: When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 56 (mod)	1987	High-voltage alternating-current circuit-breakers	HD 348 S6[1)]	1995
IEC 60-1	1989	High-voltage test techniques Part 1: General definitions and test requirements	HD 588.1 S1	1991
IEC 71-1	1993	Insulation co-ordination Part 1: Definitions, principles and rules	EN 60071-1	1995
IEC 99-1	1991	Surge arresters Part 1: Non-linear resistor type gapped surge arresters for a.c. systems	EN 60099-1	1994
IEC 99-4	1991	Part 4: Metal-oxide surge arresters without gaps for a.c. systems	EN 60099-4	1993
IEC 99-5 (mod)	1996	Part 5: Selection and application recommendations	EN 60099-5	1996
IEC 505	1975	Guide for the evaluation and identification of insulation systems of electrical equipment	-	-
IEC 507	1991	Artificial pollution tests on high-voltage insulators to be used on a.c. systems	EN 60507	1993
IEC 721-2-3	1987	Classification of environmental conditions Part 2: Environmental conditions appearing in nature - Air pressure	HD 478.2.3 S1	1990
IEC 815	1986	Guide for the selection of insulators in respect of polluted conditions	-	-

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1) HD 348 S6 includes A1:1992 + A2:1995 to IEC 56.

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Coordination de l'isolement –

Partie 2:
Guide d'application

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INSULATION CO-ORDINATION –

Part 2: Application guide

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object to the IEC is to promote international cooperation 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.

3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.

4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.

5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

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.

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International Standard IEC 71-2, has been prepared by IEC technical committee 28: Insulation co-ordination.

This third edition cancels and replaces the second edition published in 1976 and constitutes a technical revision.

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

FDIS	Report on voting
28/115/FDIS	28/117/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.

Annex A forms an integral part of this standard.

Annexes B to J are for information only.

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INSULATION CO-ORDINATION –

Part 2: Application guide

1 General

1.1 *Scope*

This part of IEC 71 constitutes an application guide and deals with the selection of insulation levels of equipment or installations for three-phase electrical systems. Its aim is to give guidance for the determination of the rated withstand voltages for ranges I and II of IEC 71-1 and to justify the association of these rated values with the standardized highest voltages for equipment.

This association is for insulation co-ordination purposes only. The requirements for human safety are not covered by this application guide.

It covers three-phase systems with nominal voltages above 1 kV. The values derived or proposed herein are generally applicable only to such systems. However, the concepts presented are also valid for two-phase or single-phase systems.

It covers phase-to-earth, phase-to-phase and longitudinal insulation.

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This application guide is not intended to deal with routine tests. These are to be specified by the relevant product committees.

The content of this guide strictly follows the flow chart of the insulation co-ordination process presented in figure 1 of IEC 71-1. Clauses 2 to 5 correspond to the squares in this flow chart and give detailed information on the concepts governing the insulation co-ordination process which leads to the establishment of the required withstand levels.

The guide emphasizes the necessity of considering, at the very beginning, all origins, all classes and all types of voltage stresses in service irrespective of the range of highest voltage for equipment. Only at the end of the process, when the selection of the standard withstand voltages takes place, does the principle of covering a particular service voltage stress by a standard withstand voltage apply. Also, at this final step, the guide refers to the correlation made in IEC 71-1 between the standard insulation levels and the highest voltage for equipment.

The annexes contain examples and detailed information which explain or support the concepts described in the main text, and the basic analytical techniques used.

1.2 *Normative references*

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 71. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 71 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.

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IEC 56: 1987, *High-voltage alternating-current circuit-breakers*

IEC 60-1: 1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 71-1: 1993, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 99-1: 1991, *Surge arresters – Part 1: Non-linear resistor type gapped surge arresters for a.c. systems*

IEC 99-4: 1991, *Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems*

IEC 99-5: 1996, *Surge arresters – Part 5: Selection and application recommendations – Section 1: General*

IEC 505: 1975, *Guide for the evaluation and identification of insulation systems of electrical equipment*

IEC 507: 1991, *Artificial pollution test on high-voltage insulators to be used on a.c. systems*

IEC 721-2-3: 1987, *Classification of environmental conditions – Part 2: Environmental conditions appearing in nature – Air pressure*

IEC 815: 1986, *Guide for the selection of insulators in respect of polluted conditions*

1.3 *List of symbols and definitions*

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For the purpose of this part of IEC 71, the following symbols and definitions apply. The symbol is followed by the unit to be normally considered, dimensionless quantities being indicated by (-).

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Some quantities are expressed in p.u. A per unit quantity is the ratio of the actual value of an electrical parameter (voltage, current, frequency, power, impedance, etc.) to a given reference value of the same parameter.

A	(kV)	parameter characterizing the influence of the lightning severity for the equipment depending on the type of overhead line connected to it.
a_1	(m)	length of the lead connecting the surge arrester to the line.
a_2	(m)	length of the lead connecting the surge arrester to earth.
a_3	(m)	length of the phase conductor between the surge arrester and the protected equipment.
a_4	(m)	length of the active part of the surge arrester.
B	(-)	factor used when describing the phase-to-phase discharge characteristic.
C_e	(nF)	capacitance to earth of transformer primary windings.
C_s	(nF)	series capacitance of transformer primary windings.
C_2	(nF)	phase-to-earth capacitance of the transformer secondary winding.
C_{12}	(nF)	capacitance between primary and secondary windings of transformers.
C_{1in}	(nF)	equivalent input capacitance of the terminals of three-phase transformers.
C_{2in}	(nF)	equivalent input capacitance of the terminals of three-phase transformers.
C_{3in}	(nF)	equivalent input capacitance of the terminals of three-phase transformers.
c	(m/µs)	velocity of light.

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c_f	(p.u.)	coupling factor of voltages between earth wire and phase conductor of overhead lines.
E_0	(kV/m)	soil ionization gradient.
F		function describing the cumulative distribution of overvoltage amplitudes, where $F(U) = 1 - P(U)$. See annex C.3.
f		function describing the probability density of overvoltage amplitudes.
g	(-)	ratio of capacitively transferred surges.
H	(m)	altitude above sea-level.
h	(-)	power-frequency voltage factor for transferred surges in transformers.
Ht	(m)	height above ground.
I	(kA)	lightning current amplitude.
I_g	(kA)	limit lightning current in tower footing resistance calculation.
J	(-)	winding factor for inductively transferred surges in transformers.
K	(-)	gap factor taking into account the influence of the gap configuration on the strength.
K_a	(-)	atmospheric correction factor. [3.28 of IEC 71-1]
K_c	(-)	co-ordination factor. [3.25 of IEC 71-1]
K_s	(-)	safety factor. [3.29 of IEC 71-1]
K_{cd}	(-)	deterministic co-ordination factor.
K_{co}	(μs/(kVm))	corona damping constant.
K_{cs}	(-)	statistical co-ordination factor.
$K_{f\,f}^{+}$	(-)	gap factor for fast-front impulses of positive polarity.
$K_{f\,f}^{-}$	(-)	gap factor for fast-front impulses of negative polarity.
k	(-)	earth-fault factor. [3.15 of IEC 71-1]
L	(m)	separation distance between surge arrester and protected equipment.
L_a	(m)	overhead line length yielding to an outage rate equal to the acceptable one (related to R_a).
L_t	(m)	overhead line length for which the lightning outage rate is equal to the adopted return rate (related to R_t).
L_{sp}	(m)	span length.
M	(-)	number of insulations in parallel considered to be simultaneously stressed by an overvoltage.
m	(-)	exponent in the atmospheric correction factor formula for external insulation withstand.
N	(-)	number of conventional deviations between U_{50} and U_0 of a self-restoring insulation.
n	(-)	number of overhead lines considered connected to a station in the evaluation of the impinging surge amplitude.
P	(%)	probability of discharge of a self-restoring insulation.
P_w	(%)	probability of withstand of self-restoring insulation.
q	(-)	response factor of transformer windings for inductively transferred surges.
R	(-)	risk of failure (failures per event).
R_a	(1/a)	acceptable failure rate for apparatus. For transmission lines, this parameter is normally expressed in terms of (1/a)/100 km.

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R_{hc} (Ω) high current value of the tower footing resistance.

R_{km} (1/(m.a)) overhead line outage rate per year for a design corresponding to the first kilometre in front of the station.

R_{lc} (Ω) low current value of the tower footing resistance.

R_p (1/a) shielding penetration rate of overhead lines.

R_{sf} (1/a) shielding failure flashover rate of overhead lines.

R_t (1/a) adopted overvoltage return rate (reference value).

R_u (kV) radius of a circle in the U^+/U^- plane describing the phase-phase-earth slow-front overvoltages.

R_0 (Ω) zero sequence resistance.

R_1 (Ω) positive sequence resistance.

R_2 (Ω) negative sequence resistance.

S (kV/μs) steepness of a lightning surge impinging on a substation.

S_e (kV) conventional deviation of phase-to-earth overvoltage distribution.

S_p (kV) conventional deviation of phase-to-phase overvoltage distribution.

S_{rp} (kV/μs) representative steepness of a lightning impinging surge.

s_e (-) normalized value of the conventional deviation S_e (S_e referred to U_{e50}).

s_p (-) normalized value of the conventional deviation S_p (S_p referred to U_{p50}).

T (μs) travel time of a lightning surge.

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U (kV) amplitude of an overvoltage (or of a voltage).

U^+ (kV) positive switching impulse component in a phase-to-phase insulation test.

U^- (kV) negative switching impulse component in a phase-to-phase insulation test.

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U_0 (kV) truncation value of the discharge probability function $P(U)$ of a self-restoring insulation: $P\ (U \leq U_0) = 0$.

U_0^+ (kV) equivalent positive phase-to-earth component used to represent the most critical phase-to-phase overvoltage.

U_{1e} (kV) temporary overvoltage to earth at the neutral of the primary winding of a transformer.

U_{2e} (kV) temporary overvoltage to earth at the neutral of the secondary winding of a transformer.

U_{2N} (kV) rated voltage of the secondary winding of a transformer.

U_{10} (kV) value of the 10 % discharge voltage of self-restoring insulation. This value is the statistical withstand voltage of the insulation defined in 3.23 b) of IEC 71-1.

U_{16} (kV) value of the 16 % discharge voltage of self-restoring insulation.

U_{50} (kV) value of the 50 % discharge voltage of self-restoring insulation.

U_{50M} (kV) value of the 50 % discharge voltage of M parallel self-restoring insulations.

U_{50RP} (kV) value of the 50 % discharge voltage of a rod-plane gap.

U_c^+ (kV) positive component defining the centre of a circle which describes the phase-phase-earth slow-front overvoltages.

U_c^- (kV) negative component defining the centre of a circle which describes the phase-phase-earth slow-front overvoltages.