SLOVENSKI STANDARD

SIST EN 61472:2007

januar 2007

Delo pod napetostjo - Najmanjše razdalje za dostop do sistemov z izmenično napetostjo v območju od 72,5 kV do 800 kV - Metoda izračuna (IEC 61472:2004)

(istoveten EN 61472:2004)

Live working - Minimum approach distances for a.c. systems in the voltage range 72,5 kV to 800 kV - A method of calculation (IEC 61472:2004)

ICS 13.260

Referenčna številka
SIST EN 61472:2007(en)

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61472

November 2004

ICS 13.260; 29.240.20; 29.260.99

English version

Live working – Minimum approach distances for a.c. systems in the voltage range 72,5 kV to 800 kV – A method of calculation

(IEC 61472:2004)

Travaux sous tension –
Distances minimales d'approche
pour des réseaux à courant alternatif
de tension comprise entre 72,5 kV
et 800 kV –
Une méthode de calcul
(CEI 61472:2004)

Arbeiten unter Spannung –
Mindest-Arbeitsabstände für
Wechselspannungsnetze im
Spannungsbereich von 72,5 kV
bis 800 kV –
Berechnungsverfahren
(IEC 61472:2004)

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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.

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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 78/582/FDIS, future edition 2 of IEC 61472, prepared by IEC TC 78, Live working, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61472 on 2004-10-01.

This standard has been prepared according to the requirements of EN 61477: Live working – Minimum requirements for the utilization of tools,devices and equipement, where applicable.

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)	2005-07-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2007-10-01

Endorsement notice

The text of the International Standard IEC 61472:2004 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60060-1	NOTE	Harmonized as HD 588.1 S1:1991 (not modified).
IEC 60071-1	NOTE	Harmonized as EN 60071-1:1995 (not modified).
IEC 60071-2	NOTE	Harmonized as EN 60071-2:1997 (not modified).
IEC 60743	NOTE	Harmonized as EN 60743:2001 (not modified).
IEC 61477	NOTE	Harmonized as EN 61477:2002 (not modified).

NORME INTERNATIONALE

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Deuxième édition
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Travaux sous tension –
Distances minimales d'approche pour des réseaux à courant alternatif de tension comprise entre 72,5 kV et 800 kV –
Une méthode de calcul

Live working –
Minimum approach distances for a.c. systems in the voltage range 72,5 kV to 800 kV –
A method of calculation

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For price, see current catalogue

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LIVE WORKING – MINIMUM APPROACH DISTANCES FOR AC SYSTEMS IN THE VOLTAGE RANGE 72,5 kV TO 800 kV – A METHOD OF CALCULATION

FOREWORD

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International Standard IEC 61472 has been prepared by technical committee 78: Live working.

This second edition cancels and replaces the first edition of IEC 61472 published in 1998. This second edition constitutes a technical revision.

This document has been prepared according to the requirements of IEC 61477: *Live working – Minimum requirements for the utilization of tools, devices and equipment*, where applicable.

Significant changes with regard to the first edition are the following: this second edition

– revises the application range of this method of calculation to 72,5 kV and above;
– expands in a detailed manner the calculation of the influence of floating objects;
– refers closely to the relevant brochures of CIGRE and to IEC 60071-2.

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

FDIS	Report on voting
78/582/FDIS	78/586/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 the maintenance result date indicated on the IEC web site 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.

The contents of the corrigenda of May 2005 and November 2006 have been included in this copy.

LIVE WORKING – MINIMUM APPROACH DISTANCES FOR AC SYSTEMS IN THE VOLTAGE RANGE 72,5 kV TO 800 kV – A METHOD OF CALCULATION

1 Scope

This International Standard describes a method for calculating the minimum approach distances for live working, at maximum voltages between 72,5 kV and 800 kV. This standard addresses system overvoltages, and the working air distances between parts and/or workers at different potentials.

The required withstand voltage and minimum approach distances calculated by the method described in this standard are evaluated taking into consideration the following:

- workers are trained for, and skilled in, working in the live working zone;
- the anticipated overvoltages do not exceed the value selected for the determination of the required minimum approach distance;
- transient overvoltages are the determining overvoltages;
- tool insulation has no continuous film of moisture present on the surface;
- no lightning is seen or heard within 10 km of the work site;
- allowance is made for the effect of conducting components of tools;
- the effect of altitude on the electric strength is taken into consideration.

For conditions other than the above, the evaluation of the minimum approach distances may require specific data, derived by other calculation or obtained from additional laboratory investigations on the actual situation.

2 Terms, definitions and symbols

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

2.1 Terms and definitions

2.1.1
highest voltage of a system
U_s
highest value of operating voltage which occurs under normal operating conditions at any time and any point in the system (phase to phase voltage)

NOTE Transient overvoltages due e.g. to switching operations and abnormal temporary variations of voltage are not taken into account.

[IEV 601-01-23, modified]

2.1.2
transient overvoltage
short duration overvoltage of few milliseconds or less, oscillatory or non-oscillatory, usually highly damped

[IEV 604-03-13]

2.1.3
fifty per cent disruptive discharge voltage
U_{50}
peak value of an impulse test voltage having a 50 per cent probability of initiating a disruptive discharge each time the dielectric testing is performed

[IEV 604-03-43]

2.1.4
ninety per cent statistical impulse withstand voltage
U_{90}
peak value of an impulse test voltage at which insulation exhibits, under specified conditions, a 90 % probability of withstand

NOTE This concept is applicable to self-restoring insulation.

[IEV 604-03-42, modified]

2.1.5
two per cent statistical overvoltage
U_2
peak value of a transient overvoltage having a 2 % statistical probability of being exceeded

[IEV 651-01-23, modified]

2.1.6
required insulation level for live working
statistical impulse withstand voltage of the insulation at the work location necessary to reduce the risk of breakdown of this insulation to an acceptably low level

NOTE It is generally considered that an acceptable low level is reached when the value of the statistical withstand voltage is greater or equal to the statistical overvoltage having a probability of being exceeded by no more than 2 %.

[IEV 651-01-17]

2.1.7
per unit value
u
expression of the per unit value of the amplitude of an overvoltage (or of a voltage) referred to $U_s \sqrt{2} / \sqrt{3}$

NOTE This applies to u_{e2} and u_{p2} defined in Clause 4.

2.1.8
minimum approach distance
D_A
minimum distance in air to be maintained between any part of the body of a worker, including any object (except appropriate tools for live working) being directly handled, and any parts at different potentials

NOTE The “appropriate tools” are tools for live working suitable for the maximum nominal voltage of the live parts.

[Definition 2.7.1 of IEC 60743 and IEV 651-01-20, modified]

2.1.9
electrical distance
D_U
distance in air required to prevent a disruptive discharge between energized parts or between energized parts and earthed parts during live working

[Definition 2.7.2 of IEC 60743 and IEV 651-01-21, modified]

2.1.10
ergonomic distance
D_E
distance in air to take into account inadvertent movement and errors in judgement of distances while performing work

[Definition 2.7.3 of IEC 60743 and IEV 651-01-22]

2.1.11
part
any element present in the work location, other than workers, live working tools and system insulation

2.1.12
live part
conductor or conductive part intended to be energized in normal operation, including a neutral conductor, but by convention not a PEN conductor [IEV 195-02-12] or PEM conductor [IEV 195-02-13] or PEL conductor [IEV 195-02-14]

NOTE This concept does not necessarily imply a risk of shock.

[Definition 2.1.2 of IEC 60743 and IEV 651-01-03, modified]

2.1.13
work location
any site, place or area where a work activity is to be, is being, or has been carried out

[IEV 651-01-08]

2.2 Symbols used in the normative part of the document

β ratio of the total length of the floating object(s) to the original air gap length

D length of the remaining air gap phase to earth

D_A minimum approach distance

D_E ergonomic distance

D_U electrical distance necessary to obtain U_{90}

d_1, d_2, d_3, d_4 distances between the worker(s) and parts of the installation at different electric potentials (see Figure 2)

F sum of all dimensions, in the direction of the gap axis, of the floating objects in the air gap (in metres)

K_s statistical safety factor

K_t factor combining different considerations influencing the strength of the gap

k_a atmospheric factor

k_d coefficient characterizing the average state of the damaged units

k_f floating object factor

k_g gap factor

k_i insulator strings factor

k_s standard statistical deviation factor

L_f original air gap length

n_d number of damaged units in a string of n_o units

n_o number of units in an insulator string that are not shunted by arcing horns or grading rings

P length of the remaining gap phase to phase

r distance of a conductive object from the axis of the gap

s_e normalized value of the standard deviation of U_{50} expressed in percent

U_2 two per cent statistical overvoltage

U_{50} fifty per cent disruptive discharge voltage

U_{90} ninety per cent statistical impulse withstand voltage

U_{e2} two per cent statistical overvoltage between phase and earth

U_{e90} ninety per cent statistical impulse withstand voltage phase to earth

U_{p2} two per cent statistical overvoltage between two phases

U_{p90} ninety per cent statistical impulse withstand between two phases

u_{e2} per unit value of the two per cent statistical overvoltage phase to earth

u_{p2} per unit value of the two per cent statistical overvoltage between two phases

U_s highest voltage of a system between two phases

3 Methodology

The methodology of the calculation of the minimum approach distances is based on three considerations:

a) to determine the statistical overvoltage expected in the work location (U_2) and from this, determine the required statistical impulse withstand voltage of the insulation in the work location (U_{90});

b) to calculate the electrical distance D_U required for the impulse withstand voltage U_{90};

c) to add an additional distance to allow for ergonomic factors associated with live working, such as inadvertent movement.

The minimum approach distance D_A is thus determined by:

$$D_A = D_U + D_E \tag{1}$$

where

D_U is the electrical distance necessary to obtain U_{90};

D_E is the required ergonomic distance and is dependent on work procedures, level of training, skill of the workers, type of construction, and such contingencies as inadvertent movement, and errors in appraising distances (see Annex A for details).