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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Insulation coordination –
Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment

Applications ferroviaires – Coordination de l'isolement –
Partie 1: Exigences fondamentales – Distances d'isolement dans l'air et lignes de fuite pour tout matériel électrique et électronique

IEC 62497-1:2010

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FOREWORD

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International Standard IEC 62497-1 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This standard is based on EN 50124-1.

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

FDIS	Report on voting
9/1335/FDIS	9/1358/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 of IEC 62497, under the general title *Railway applications – Insulation coordination*, can be found of the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability 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- withdrawn,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.

INTRODUCTION

Special conditions occurring in railway applications and the fact that the equipment here concerned falls into the scope of both IEC 60071 (prepared by IEC technical committee 28) and IEC 60664-1 (prepared by IEC technical committee 109), led to the decision to draw from these documents and from IEC 60077-1 (prepared by IEC technical committee 9), a single document of reference for all standards applicable to the whole railway field.

IEC 62497 consists of two parts:

– IEC 62497-1: Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment;

– IEC 62497-2: Part 2: Overvoltages and related protection.

This Part 1 allows, in conjunction with IEC 62497-2, to take into account advantages resulting from the presence of overvoltage protection when dimensioning clearances.

RAILWAY APPLICATIONS – INSULATION COORDINATION –

Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment

1 Scope

This part of IEC 62497 deals with insulation coordination in railways. It applies to equipment for use in signalling, rolling stock and fixed installations up to 2 000 m above sea level.

Insulation coordination is concerned with the selection, dimensioning and correlation of insulation both within and between items of equipment. In dimensioning insulation, electrical stresses and environmental conditions are taken into account. For the same conditions and stresses these dimensions are the same.

An objective of insulation coordination is to avoid unnecessary overdimensioning of insulation.

This standard specifies:

– requirements for clearances and creepage distances for equipment;
– general requirements for tests pertaining to insulation coordination.

The term equipment relates to a section as defined in 3.3; it may apply to a system, a sub-system, an apparatus, a part of an apparatus, or a physical realisation of an equipotential line.

This standard does not deal with :

– distances through solid or liquid insulation;
– distances through gases other than air;
– distances through air not at atmospheric pressure;
– equipment used under extreme conditions.

Product standards have to align with this generic standard.

However, they may require, with justification, different requirements due to safety and/or reliability reasons, e.g. for signalling, and/or particular operating conditions of the equipment itself, e. g. overhead lines which have to comply to established standards or regulations such as EN 50119.

This standard also gives provisions for dielectric tests (type tests or routine tests) on equipment (see Annex B).

NOTE For safety critical systems, specific requirements are needed. These requirements are given in the product specific signalling standard IEC 62425.

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 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60071-1, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60507, *Artificial pollution tests on high-voltage insulators to be used on a.c. systems*

IEC 60587, *Electrical insulating materials used under severe ambient conditions – Test methods for evaluating resistance to tracking and erosion*

IEC 60850, *Railway applications – Supply voltages of traction systems*

IEC 61245, *Artificial pollution tests on high-voltage insulators to be used on d.c. systems*

IEC 61992-1:2006, *Railway applications – Fixed installations – DC switchgear – Part 1: General*

IEC 62236 (all parts), *Railway applications – Electromagnetic compatibility*

EN 50119, *Railway applications – Fixed installations – Electric traction overhead contact lines*

3 Terms and definitions

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

NOTE For the purpose of this standard the following definitions apply according to the following priority order:

– the definition given here-under;

– the definition given in IEC 60664-1;

– the definition given in the documents mentioned in Clause 2 other than IEC 60664-1.

3.1
clearance
the shortest distance in air between two conductive parts

3.2
creepage distance
the shortest distance along the surface of the insulating material between two conductive parts

3.3
sections

3.3.1
section
part of an electrical circuit having its own voltage ratings for insulation coordination

Sections fall into two categories:

3.3.2
earthed section
a section connected to earth or to the car body through a circuit for which interruption is not expected

3.3.3
floating section
a section isolated from earth or from the car body

NOTE 1 A section may be under electrical influence of adjacent sections.

NOTE 2 A particular point of a circuit may be considered as a section.

3.4
voltages

3.4.1
nominal voltage (U_n)
a suitable approximate voltage value used to designate or identify a given supply system

3.4.2
working voltage
the highest r.m.s value of the a.c or d.c voltage which can occur between two points across any insulation, each circuit likely to influence the said r.m.s. value being supplied at its maximum permanent voltage

NOTE Permanent means that the voltage lasts more than 5 min, as U_{max1} in IEC 60850.

3.4.3
rated voltage
the value of voltage assigned by the manufacturer to a component, device or equipment and to which operation and performance characteristics are referred

NOTE Equipment may have more than one rated voltage value or may have a rated voltage range.

3.4.4
rated insulation voltage (U_{Nm})
an r.m.s. withstand voltage value assigned by the manufacturer to the equipment or a part of it, characterising the specified permanent (over 5 min) withstand capability of its insulation

NOTE 1 U_{Nm} is a voltage between a live part of equipment and earth or another live part. For rolling stock, earth refers to the car body.

NOTE 2 For circuits, systems and sub-systems in railway applications this definition is preferred to "highest voltage for equipment" which is widely used in international standards.

NOTE 3 U_{Nm} is higher than or equal to the working voltage. As a consequence, for circuits directly connected to the contact line, U_{Nm} is equal to or higher than U_{max1} as specified in IEC 60850.

NOTE 4 U_{Nm} is not necessarily equal to the rated voltage which is primarily related to functional performance.

3.4.5
working peak voltage
the highest value of voltage which can occur in service across any particular insulation

3.4.6
recurring peak voltage
the maximum peak value of periodic excursions of the voltage waveform resulting from distortions of an a.c. voltage or from a.c. components superimposed on a d.c. voltage

NOTE Random overvoltages, for example due to occasional switching, are not considered to be recurring peak voltages.

3.4.7
rated impulse voltage (U_{Ni})
an impulse voltage value assigned by the manufacturer to the equipment or a part of it, characterising the specified withstand capability of its insulation against transient overvoltages

NOTE U_{Ni} is higher than or equal to the working peak voltage.

3.5
overvoltages
any voltage having a peak value exceeding the corresponding peak value of maximum steady-state voltage at normal operating conditions

3.5.1
temporary overvoltage
an overvoltage of relatively long duration due to voltage variations

NOTE A temporary overvoltage is independent of the network load. It is characterised by a voltage/time curve.

3.5.2
transient overvoltage
a short duration overvoltage of a few milliseconds or less due to current transfers

NOTE A transient overvoltage depends on the network load. It cannot be characterised by a voltage/time curve. Basically, a transient overvoltage is the result of a current transfer from a source to the load (network).

Two particular transient overvoltages are defined:

3.5.3
switching overvoltage
the transient overvoltage at any point of the system due to specific switching operation or fault

3.5.4
lightning overvoltage
the transient overvoltage at any point of the system due to a specific lightning discharge.

NOTE The definitions of 3.5 are similar to those of IEC 60664-1 and IEC 60850.

However, the prevalence of the nature of the cause (voltage variations or current transfer) upon time, for segregating transient overvoltages from temporary ones, is clearly stated here (whereas the nature of the cause is not considered in IEC 60664-1).

Long-term (typically 20 ms to typically 1 s) overvoltages defined in IEC 60850, dedicated to contact line networks, are equivalent to temporary overvoltages.

3.6
insulations

3.6.1
functional insulation
the insulation between conductive parts which is necessary only for the proper functioning

3.6.2
basic insulation
the insulation applied to live parts to provide basic protection against electric shock

3.6.3
supplementary insulation
an independent insulation applied in addition to basic insulation, in order to provide protection against electric shock in the event of failure of basic insulation

3.6.4
double insulation
an insulation comprising both basic insulation and supplementary insulation

3.6.5
reinforced insulation
a single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation

NOTE The term "a single insulation system" does not imply that the insulation involves one homogeneous piece. It may involve several layers which cannot be tested singly as basic and supplementary insulation.

4 Basis for insulation coordination

4.1 Basic principles

4.1.1 General

Insulation coordination implies the selection of the electric insulation characteristic of the equipment with regard to its application and in relation to its surroundings.

Insulation coordination can only be achieved if the design of the equipment is based on the stresses to which it is likely to be subjected during its anticipated lifetime.

4.1.2 Insulation coordination with regard to voltage

4.1.2.1 General

Consideration shall be given to:

– the voltages which can appear in the system;
– the voltages generated by the equipment (which could adversely affect other equipment in the system);
– the degree of the expected availability of the equipment;
– the safety of persons and property, so that the probability of undesired incidents due to voltage stresses do not lead to an unacceptable risk of harm;
– the safety of functions for control and protection systems;
– voltages induced in track-side cables;
– the shape of insulating surfaces;
– the orientation and the location of creepage distances;
– if necessary: the altitude that applies.

4.1.2.2 Insulation coordination with regard to permanent a.c. or d.c. voltages

Insulation coordination with regard to permanent voltages is based on:

– rated voltage;
– rated insulation voltage;
– working voltage.

Unless otherwise specified in product standards, permanent voltages last more than five minutes.

4.1.2.3 Insulation coordination with regard to transient overvoltage

Insulation coordination with regard to transient overvoltage is based on controlled overvoltage conditions. There are two kinds of control:

– inherent control: the condition within an electrical system wherein the characteristics of the system can be expected to limit the prospective transient overvoltages to a defined level;
– protective control: the condition within an electrical system wherein specific overvoltage attenuating means can be expected to limit the prospective transient overvoltages to a defined level.

NOTE 1 Overvoltages in large and complex systems such as overhead lines subjected to multiple and variable influences can only be assessed on a statistical basis. This is particularly true for overvoltages of atmospheric origin and applies whether the controlled condition is achieved as a consequence of inherent control or by means of protective control.

NOTE 2 A probabilistic analysis is recommended to assess whether inherent control exists or whether protective control is needed.

NOTE 3 The specific overvoltage attenuating means may be a device having means for storage or dissipation of energy and, under defined conditions, capable of harmlessly dissipating the energy of overvoltages expected at the location.

EXAMPLE of inherent control: Control ensured by flash-over across insulators or spark gap horns on overhead lines.

EXAMPLE of protective control: Control ensured by the filter of a locomotive on the downstream circuit, provided that no switching overvoltage source is likely to perturb the said circuit.

Insulation coordination uses a preferred series of values of rated impulse voltage: it consists of the values listed in the first column of the Table A.3.

4.1.2.4 Insulation coordination with regard to recurring peak voltage

Consideration shall be given to the extent partial discharges can occur in solid insulation or along surfaces of insulation.

4.1.3 Insulation coordination with regard to environmental conditions

The micro-environmental conditions for the insulation shall be taken into account as classified by the pollution degree.

The micro-environmental conditions depend primarily on the macro-environmental conditions in which the equipment is located and in many cases the environments are identical. However, the micro-environment can be better or worse than the macro-environment where, for example, enclosures, heating, ventilation or dust influence the micro-environment.

NOTE Protection by enclosures provided according to classes specified in IEC 60529 does not necessarily improve the micro-environment with regard to pollution.

4.2 Voltages and voltage ratings

4.2.1 General

For determining the working voltage of a floating section, it is considered that a connection is made to earth or to another section, so as to produce the worst case.

It is recommended to avoid floating sections in high voltage systems.

The voltages in this subclause 4.2 are "required voltages" that would be specified for a particular application. These are different from rated voltages that are stated by a manufacturer for a product.

Rated voltages are defined for each section of a circuit.

4.2.2 Rated insulation voltage (U_{Nm})

The rated insulation voltage required as a minimum for a section is equal to the highest working voltage appearing within the section, or produced by adjacent sections.

Stresses shorter than 5 min (e.g U_{max2} as defined in IEC 60850) may be taken into account case by case, considering in particular the interval between such stresses.

4.2.3 Rated impulse voltage (U_{Ni})

4.2.3.1 General

The rated impulse voltage required as a minimum for a section is determined either by method 1 or by method 2.

In inherent control, method 1 should be used.

In protective control, method 1 and method 2 may be used.

4.2.3.2 Method 1

Method 1 is based on rated insulation voltages and overvoltage categories.

The relation between rated insulation voltages and nominal voltages commonly used in railway applications is given in Table D.1 of Annex D.

Method 1 uses four overvoltage categories to characterise the exposure of the equipment to overvoltages.

– OV1: Circuits which are protected against external and internal overvoltages and in which only very low overvoltages can occur because:
  – they are not directly connected to the contact line;
  – they are being operated indoor;
  – they are within an equipment or device;
– OV2: The same as OV1, but with harsher overvoltage conditions and/or higher requirements concerning safety and reliability;
– OV3: The same as OV4, but with less harsh overvoltage conditions and/or lower requirements concerning safety and reliability;
– OV4: Circuits which are not protected against external or internal overvoltages (e.g. directly connected to the contact or outside lines) and which may be endangered by lightning or switching overvoltages.

Further details for specific applications are given in Clause 8.

In method 1, the rated impulse voltage required as a minimum for a section is determined as follows:

– For low voltage circuits not powered directly by the contact line, the rated impulse voltage is given by Table A.1;
– For circuits powered by the contact line and for traction power circuits in thermo-electric driven vehicles the rated impulse voltage is given by Table A.2.

When a specific protection against overvoltages is involved, the choice of the overvoltage category is linked to this protective device.

4.2.3.3 Method 2

In method 2, the rated impulse voltage required as a minimum for a section is equal to the working peak voltage appearing within the section, or produced by adjacent sections.

4.2.3.4 Contingency

No contingency is to be applied to the rated impulse voltage, whatever the method.