SLOVENSKI STANDARD

SIST EN 50151:2004

oct 2004

Železniške naprave – Stabilne naprave električne vleke – Posebne zahteve za kompozitne izolatorje

Railway applications – Fixed installations – Electric traction – Special requirements for composite insulators

ICS 29.080.10; 29.280

Referenčna številka
SIST EN 50151:2004(en)

EUROPEAN STANDARD **EN 50151**

NORME EUROPÉENNE

EUROPÄISCHE NORM November 2003

ICS 29.080.10; 29.280

English version

Railway applications – Fixed installations – Electric traction – Special requirements for composite insulators

Applications ferroviaires – Installations fixes – Traction électrique – Prescriptions particulières pour les isolateurs en matière composite

Bahnanwendungen – Ortsfeste Anlagen – Zugförderung – Besondere Anforderungen an Verbundisolatoren

This European Standard was approved by CENELEC on 2003-10-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Lithuania, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, 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

Ref. No. EN 50151:2003 E

Foreword

This European Standard was prepared by SC 9XC, Electric supply and earthing systems for public transport equipment and ancillary apparatus (fixed installations), of Technical Committee CENELEC TC 9X, Electrical and electronic applications for railways.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50151 on 2003-10-01.

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) 2004-10-01

- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2006-10-01

Annexes designated "informative" are given for information only.
In this standard, Annexes A, B and C are informative.

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and supports the Public Procurement Directive 93/38/EEC.

Contents

Introduction

This standard specifies requirements for the design and testing of composite insulators used on railway electrification overhead contact systems. The insulators, which are installed at relatively low heights in the harsh environment of the railway infrastructure, require special consideration during design to reduce the effects of vandalism and environmental pollution from railway operations, especially when combined with a lack of natural washing. Insulators may be included in arrangements in tunnels and over bridges or be in contact with traction unit pantographs where mechanical combined loading (tension, bending and torsion) may require special consideration.

The standard is intended to allow the user to comply with local working practices, to ensure compatibility with existing electrification systems, and provide an insulator which will give reliable service over its target life span with minimum maintenance.

Insulators in overhead lines are predominately designed to resist tension and/or bending loads and are not designed to resist torsional loads. Mitigating measures to reduce torsional loading are generally introduced by the contact systems design engineer. Some combined loading (tension, compression and torsion) can be experienced and this is represented in the testing procedure specified in this document.

The testing procedures given for railway applications in this standard are predominately referenced from IEC 61109 and EN 61952.

1 Scope

This European Standard specifies characteristics for composite insulators for use in electric traction overhead contact lines for railways and tramways, as defined in EN 50119. Specific applications where high torsional loads can occur are outside the scope of this standard and particular tests should be agreed between the supplier and purchaser, to represent the critical loading arrangements.

The provisions contained in this European Standard are for the new construction of electric traction overhead contact lines using insulators or when complete refurbishment of existing lines takes place.

This standard provides the purchaser and manufacturer with a range of tests which are used to evaluate the suitability of an insulator product for a given railway environment. Additional tests may be specified by the client to measure the compliance of the insulator under particular operating conditions.

The standard establishes the product characteristics, the test methods and acceptance criteria.

The object of this European Standard is to stipulate the provisions for the design and provision of the service indicated by the manufacturer to the purchaser or informed buyer for application on the railway infrastructure.

2 Normative references

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).

EN 50119	*Railway applications - Fixed installatios - Electric traction overhead contact lines*
EN 50124 series	*Railway applications - Insulation coordination*
EN 50163	*Railway applications - Supply voltages of traction systems*
EN 60707	*Flammability of solid non-metallic materials when exposed to flame sources - List of test methods (IEC 60707)*
EN 61952	*Insulators for overhead lines - Composite line post insulators for alternative current with a nominal voltage > 1 000 V (IEC 61952)*
HD 405 series	*Test on electric cables under fire conditions (IEC 60332 series)*
HD 602	*Test on gases evolved during combustion of materials from cables - Determination of degree of acidity (corrosivity) of gases by measuring pH and conductivity (IEC 60754, mod.)*
HD 606 series	*Measurement of smoke density of electric cables burning under defined conditions (IEC 61034 series, mod.)*
IEC 61109	*Composite insulators for a.c. overhead lines with a nominal voltage greater than 1 000 V - Definitions, test methods and acceptance criteria*
IEC 61467	*Insulators for overhead lines with a nominal voltage above 1 000 V - AC power arc tests on insulator sets*

3 Definitions

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

3.1
composite insulator
unit based on a core which usually consists of glass fibres positioned in a resin matrix protected with an polymer housing and equipped with end fittings for attachment within the overhead contact line system

3.2
failing load
maximum load that is reached when testing under the prescribed conditions, when major cracking or parting of the core occurs

3.3
specified mechanical load (SML)
short term load which can be withstood by the insulator when tested under the prescribed conditions

NOTE 1 The term SML can be prefixed by the loading type (tension, bending or torsion).

NOTE 2 A typical load–time withstand curve diagram is given in Annex A.

3.4
maximum design load (MDL)
load above which irreversible damage to the core begins to occur

NOTE 1 The MDL should not be exceeded in service.

NOTE 2 The term MDL can be prefixed by the loading type, for example tension, bending or torsion.

3.5
nominal design load
load corresponding to the normal every day permanent and dynamic loads in the overhead line equipment

4 Characteristics of insulators

4.1 General

Composite materials and modern elastomers permit the manufacture of insulators for use on outdoor overhead contact line systems. The insulators consist of a insulating core, bearing the mechanical load protected by a polymeric housing, the load being transmitted to the core by end fittings. These materials allow new and specialist applications in overhead contact line (including in-running section insulation and flexible supports) and are also used for their advantages of lightness, resistance to vandalism and pollution performance. Despite the common features of design, the materials used and the construction details employed by different manufacturers may be quite different and may lead to different performance parameters.

Overhead contact lines have several characteristics not associated with power lines. They are of low height and run through urban areas, making them targets for vandalism. They are incorporated in bridges and tunnels, built for rolling stock only, and fit into small spaces. They suffer close proximity to railway generated pollution and, in tunnels and bridges are not washed by natural rainfall. They suffer movement and snatch loads due to normal pantograph contact with the wires. When used as in-line section insulators, they suffer mechanical forces and abrasion by the pantograph at high speed.

Some tests have been grouped together in this standard as “design tests”, to be performed only once on insulators which satisfy the same design conditions. As far as practical, the influence of time on electrical and mechanical properties of the components (core material, housing, interfaces etc.) and of the complete composite insulators has been considered in specifying the design tests so that a satisfactory life-time may be expected under normally known stress conditions of overhead contact lines.

The high number of insulators installed in a restricted environment of an operational railway with limited access for maintenance requires a high level of reliability at the appropriate electrical insulation level for the system voltage, including temporary and transient overvoltages. The insulators are required to operate within harsh environmental conditions with a high level of mechanical integrity.

4.2 Target life

A nominal target life of 40 years in a normal railway environment is expected for insulators. However, extreme conditions, evolution of the environment and other external factors can influence this expected target life. This shall be borne in mind when designing the insulators and drafting maintenance instructions for determining life cycle costs.

4.3 Purchaser requirements

The purchaser shall provide information on the railway electrification system and operating requirements which may affect the design of insulators. This shall include, as appropriate, but not be limited to the following:

- electrical system - service parameters (see 4.5);
- outline spatial and dimensional parameters and inclination used in service;
- ambient temperature range (maximum and minimum) of the electrification system;
- system deflection and movement constraints;
- angular movement limitations;
- nominal working loads;
- pollution and environmental considerations;
- end fittings connection requirements;
- any additional requirement for special tests;
- any special delivery, packaging or marking requirements;
- identification of inspection and tests to be witnessed by the purchaser;
- maintenance, cleaning or handling constraints;
- weight or dynamic constraints;
- vandalism frequency and impact levels;
- pantograph strip material and strip width;
- number of pantograph passes;
- pantograph speed.

4.4 In-running contact insulators

In railway applications it is essential to divide the overhead lines into discrete electrical sections. This requires breaks or insulators in the contact wire, on which the traction pantograph runs. Polymeric insulators can provide versatile section insulators with a small mass to minimise pantograph impacts and damage.

Insulators in the overhead contact line which are designed to work in contact with the traction pantograph unit require additional creepage distances depending upon the pantograph width, system voltage and operating speed. The requirements for insulation length exceed the values in this standard and shall be agreed separately between the supplier and purchaser .

If the insulator surface wears, it may not accumulate pollution and testing for pollution deposits may not be required. Alternatively if the surface does not wear, pollution can build up from the pantograph strips, which could lead to flashover or surface degradation. This shall be borne in mind when designing the insulators and drafting maintenance instructions for determining life cycle costs.

Testing shall be in accordance with the requirements defined in 6.1.

4.5 Electrical requirements

4.5.1 System voltages

Values of standard system voltages (phase to ground) are shown in Table 1.

Table 1 - System voltages

Nominal voltages [a] U_n kV	Highest permanent voltage [a] kV	Minimum value of rated insulation voltage [b] U_{Nm} kV	Rated impulse voltage [b] kV	Wet power frequency withstand voltage [b] kV
0,6	0,72	0,72	8	4,3
0,75	0,9	0,9	12	6,5
1,5	1,8	1,8	18	10
3	3,6	3,6	25	12
15	17,25	36 [c]	170	70
25	27,5	52 [c]	200	95
25	36	52 [c]	250	95

a In accordance with EN 50163.

b In accordance with EN 50124.

c See EN 50124-1, Table D.1, Note.

The purchaser shall specify the dry lightning impulse voltage, taking into account the rated impulse voltage and short duration power frequency and wet power frequency withstand voltage.

The dry lightning impulse withstand voltage shall be at least equal to the rated impulse voltage defined in EN 50124.

The wet power frequency withstand voltage shall be at least equal to the short duration power frequency test level defined in EN 50124.

4.5.2 Creepage

The dry arcing distance, creepage distance and geometrical shed form electrically define an insulator. Creepage distances shall be dimensioned according to the highest permanent voltage of the system. Consideration shall also be given to the insulation material and its behaviour in polluted conditions. The manufacturer may recommend greater than the minimum creepage to give adequate life for that material.

The overall shape and size of the insulator is defined by the purchaser's spatial requirements, mechanical and electrical performance requirements and its compatibility with existing equipment. The manufacturer can decide on shed numbers, spacing and size.

Additional railway environmental pollution may be generated by traction braking systems, diesel and steam trains which run under electrified lines. The exhaust from steam trains is very hot (> 200 °C) and should not be allowed to play on insulators. This can be prevented by careful positioning of insulators in the line or by a restriction on train movements and stopping positions. The exhaust from diesel trains is less severe, but contains oil and carbonaceous deposits, which can contaminate insulators. Experience shows that no additional creepage is required for diesel train operation.

Insulators positioned under bridges and tunnels are not washed by natural rainfall and pollution accumulates. In these harsh environmental conditions and in order to minimise the degradation of the housing material, the creepage length and the design need to cover the specific application. This will also be particularly applicable to insulators which are used in contact with the pantograph collector unit (see 4.4).

Specific creepage distance given in IEC 60815 and EN 50124-1 are only suitable for ceramic and glass insulators in a.c. system. Specific creepage distance shall be agreed between the purchaser and manufacturer in taking into account highest permanent voltage (U_{max1}) given in prEN 50163.

Operating conditions are specified in EN 50124-1 (macro-environmental conditions) and/or EN 50119 (pollution level) and/or the special requirements of purchaser.

For d.c. system voltages, higher values may be required.

Insulators used in line and with pantograph contact may require increased creepage length to allow for the width of the pantograph.

For the purpose of this standard, the definitions of environmental conditions for the choice of insulation creepage distances are defined as

1) normal operating condition

- a low population density
- low industrial pollution
- no thermal engine exhaust

2) unfavourable operating condition

- a high population density
- high industrial pollution
- mixed railway operation
- adjacent road traffic pollution and frequent fog

3) extreme unfavourable operating condition

- heavy industrial pollution
- close proximity to the sea with frequent fog or sea spray

4.5.3 Arc protection

In-running insulator arrangements regularly receive power arcs and the full insulating assembly shall be power arc tested according to IEC 61467.

NOTE 1 It is not considered necessary to specify power arc testing for support insulators.

NOTE 2 In the design of end fittings, the heating effect of power arcs should be considered. Properly designed arc-protection devices should prevent any damage to the end fitting which may occur due to the magnitude and duration of the short circuit current.

NOTE 3 Arcing horns are generally only used on insulators which are in contact with the pantograph collector strip and are predominately required to divert arcs away from the insulator to reduce the potential of damage.

4.6 Mechanical requirements

The permanent nominal design load of the overhead contact line system, as defined by the customer, shall not exceed 40 % of the MDL of the insulator. Alternatively if a statistical approach is used, a return period of the overhead line equipment load equal to the MDL shall be at least equal to the required life expected of the insulator.