SLOVENSKI STANDARD
oSIST prEN 50443:2009

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Učinki elektromagnetne interferece na cevovode, ki jih povzročajo visokonapetostni izmenični železniški sistemi in/ali visokonapetostni izmenični močnostni napajalni sistemi

Effects of electromagnetic interference on pipelines caused by high voltage a.c. railway systems and/or high voltage a.c. power supply systems

Auswirkungen elektromagnetischer Beeinflussungen von Hochspannungswechselstrombahnen und/oder Hochspannungsanlagen auf Rohrleitungen

Effets des perturbations électromagnétiques sur les canalisations causées par les lignes ferroviaires en courant alternatif et/ou par les lignes électriques H.T. en courant alternatif

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This draft European Standard is submitted to CENELEC members for CENELEC enquiry.
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It has been drawn up by CLC/SC 9XC.

If this draft becomes a European Standard, 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.

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CENELEC

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Foreword

This draft European Standard was prepared by a JWG between 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 and the Technical Committee CENELEC TC 210, Electromagnetic compatibility (EMC). It is submitted to a second CENELEC enquiry.

This European Standard gives limits relevant to the electromagnetic interference produced by high voltage a.c. railway and power supply systems on metallic pipelines.
Limits are relevant to the interference which can be tolerated on the metallic pipeline, by the equipment connected to it and by people working on them or in contact with them.

This European Standard indicates the electromagnetic interference situations to which the limits must be related.

Suggestions concerning the interference situations to be examined are given in Annex A. Suggestions concerning the appropriate calculation methods are given in Annex B. Suggestions concerning the appropriate measurement methods are given in Annex C. Suggestions about the use of mitigation measures are given in Annex D. Suggestions for management of interference are given in Annex E.

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1 Scope

The presence of ac power supply systems or of ac railway systems, in the following also indicated as ac power systems, may cause voltages to build up in pipeline systems, in the following indicated as interfered systems, running in the close vicinities of the systems above, due to one or more of the following mechanisms, i.e. to

- inductive coupling,
- conductive coupling,
- capacitive coupling.

Such voltages may cause danger to the people, damage to the pipeline or to the connected equipment, disturbance to the electric/electronic equipment connected to the pipeline.

This European Standard deals with the situations where this effect may arise and with the maximum tolerable limits of the interference effects, taking into account the behaviour of the ac power systems both: in normal operating condition and/or during the faults.

This European Standard applies to all metallic pipelines irrespective of the conveyed fluid, e.g. liquid or gas, liable to be influenced by high voltage a.c. railway and high voltage a.c. power supply systems.

The objective of this standard is to define the types of coupling which must be considered for operating conditions of the high voltage a.c. railway systems and high voltage a.c. power supply systems. It also defines the configurations to be considered for both

- the metallic pipeline,
- the high voltage a.c. railway systems or high voltage a.c. power systems

and the limits to the voltage resulting from the coupling.

This European Standard is applicable to all new metallic pipelines and all new high voltage a.c. railway systems and high voltage a.c. power supply systems and all major modifications that may change significantly the interference effect.

This European Standard only relates to phenomena at the fundamental power frequency (e.g. 50 Hz or 16,7 Hz).

This European Standard does not apply to

- all aspects of corrosion,
- the coupling from a.c. railway and power supply systems with nominal voltages less or equal 1 kV,
- interference effects on the equipment through parts or apparatus not connected to the pipeline.

This European Standard does not deal with costs and cost-sharing of investigations and mitigation measures.

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.

EN 50110-1:2004, *Operation of electrical installations*

EN 50122-1 [1], *Railway applications – Fixed installations – Electrical safety, earthing and bonding – Part 1: Protective provisions against electric shock*

HD 384.6.61 S2:2003, *Electrical installations of buildings -- Part 6-61: Verification - Initial verification* (IEC 60364-6-61:1986 + A1:1993 + A2:1997, mod.)

1) At draft stage.

IEC 60050-161:1990 + A1:1997 + A2:1998, *International Electrotechnical Vocabulary - Chapter 161: Electromagnetic Compatibility*

ITU-T Directives:1989, *Directives concerning the protection of telecommunication lines against harmful effects from electric power and electrified railway lines - Volumes 1, 2, 3, 4, 5, 7, 8, 9*

ITU-T K.68:2008, *Management of electromagnetic interference on telecommunication systems due to power systems and operators' responsibilities*

3 Definitions

For the purposes of this document, the following terms and definitions apply. Unless defined in this European Standard, the definitions given in the IEV shall be applicable.

3.1
a.c. railway system (a.c. electric traction system according to EN 50122-1)
a.c. railway electrical distribution network used to provide energy for rolling stock

NOTE The system may comprise

- contact line systems,
- return circuit of electric railway systems,
- running rails of non-electric railway systems, which are in the vicinity of, and conductively connected to the running rails of an electric railway system.

3.2
a.c power supply system
a.c. electrical system devoted to electrical energy transmission and including overhead lines, cables, substations and all apparatus associated with them

NOTE This includes the HV transmission lines with 16,7 Hz

3.3
interfering system
general expression encompassing an interfering high voltage a.c. railway system and/or high voltage a.c. power supply system

3.4
interfered system
system on which the interference effects appear: In this standard pipeline system

3.5
pipeline system
system of metallic pipework with all associated equipment and stations up to and including the point of delivery

NOTE The associated equipment is the equipment electrically connected to the pipeline.

3.6
earth
the conductive mass of the earth, whose electric potential at any point is conventionally taken as equal to zero [IEC 50 826-04-01]

3.7
operating condition

operation of any system where transients coming from faults are not to be considered as an operating condition but a fault condition

3.8
fault condition

non intended condition caused by short-circuit. The time duration is terminated by the correct function of the protection devices and switches

NOTE 1 For the relevant fault duration the correct operation of protection devices and switches is taken into account

NOTE 2 The short circuit is an unintentional connection of an energized conductor to earth or to any metallic parts in contact with earth.

3.9
conductive coupling

conductive coupling or resistive coupling occurs when part of the current belonging to the interfering system returns to the system earth via the interfered system.

The results of galvanic coupling are conductive voltages and currents

3.10
inductive coupling

the phenomenon whereby the magnetic field produced by a current carrying conductor influences another conductor; the coupling being quantified by the mutual inductive impedance of the two conductors.

The results of inductive coupling are induced voltages and hence currents. These voltages and currents depend for example on the distances, length, inducing current, conductor arrangement and frequency

3.11
capacitive coupling

the phenomenon whereby the electric field produced by an energized conductor influences another conductor; the coupling being quantified by the capacitive impedance between the conductors and the capacitive impedances between each conductor and earth.

The results of capacitive coupling are influenced voltages into conductive parts or conductors insulated from earth. The influenced voltages depend for example on the voltage of the influencing system and distance

3.12
interference

phenomenon resulting from conductive, capacitive, inductive coupling between systems, and which can cause malfunction, disturbance danger, damage, etc

3.13
disturbance

malfunction of an equipment loosing its capability of working properly for the duration of the interference.

When the interference disappears, the interfered system starts again working properly without any external intervention

3.14
damage

permanent reduction in the quality of service which can be offered by the interfered system

3.15
danger

effect which is able to produce a threat to human life

3.16
interference situation

a situation in which an interference may appear (permanently or intermittently) between an a.c. power system and a metallic pipeline system. A given interference situation is defined by the geometrical and electrical data of the a.c. power system and of the metallic pipeline system as well as by the data describing the medium between the two systems

3.17
interference distance

maximum distance between the pipeline and a.c. power system for which an interference shall be considered

3.18
interference voltage

voltage caused on the interfered system by the electromagnetic coupling with the nearby interfering system between a given point and the earth or across insulating element

3.19
prospective touch voltage

voltage between simultaneously accessible conductive parts when those conductive parts are not being touched by a person or an animal

3.20
immunity

ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance
[IEC 60050-161]

3.21
environmental reduction factor

factor which represents the mitigation of interference voltage associated with the presence of extraneous metallic structures

3.22
rural area

area which has a low density of local metal structures in direct electrical contact with the soil

3.23
urban area

area which contains a high density of local metallic structures in direct electrical contact with the soil such as water pipes, cables with bare metal sheaths, railway tracks, earthing structures of buildings, masts and foundations

4 Procedure

In order to evaluate the acceptability of an interference produced by an a.c. power system on a metallic pipeline, the following design steps apply:

a) define the interference distance to be considered, according to Clause 5;
b) define the interference situations to be examined (worst case interference), according to Clause 6;
c) select the involved coupling type(s) to be considered, according to Clause 7;
d) select the involved interference effect(s) to be considered, according to Clause 8;
e) assess the interference result(s) for each effect selected in the previous step, according to Clause 9;
f) select the acceptable limit for each of the results assessed in the previous step, according to Clause 10;

g) select the most restrictive limit, in case more than one effect is to be taken into account;

h) evaluate the interference results on the metallic pipeline by calculation or measurement, according to Clause 11;

i) compare the interference results with the relevant limits. If the comparison shows that the interference situation is unacceptable, mitigation measures shall be applied, according to Clause 12.

The procedure shall be carried out twice, i.e. considering short term interference (due to a.c. power system in fault conditions) and long term interference (due to a.c. power system in operating conditions).

All design steps have to be agreed by the involved parties.

5 Interference distance

5.1 Interference distance for normal operating conditions

5.1.1 In rural areas, for soil resistivity below 3 000 Ωm, an interference distance of 1 000 m between the interfering system and the metallic pipeline has to be considered. In case of soil resistivity value greater than 3 000 Ωm, the interference distance value, in m, is equal to the soil resistivity value, in Ωm, divided by 3.

5.1.2 In urban areas, the previous interference distance may be decreased, taking into account the environmental reducing factor of the metallic structures existing in these areas. In no case shall the interference distance be assumed to be less than 300 m.

NOTE Typical values for the environmental reducing factor are 0,1 to 0,7 (see ITU-T K68, Appendix II).

5.2 Interference distance for fault condition

5.2.1 In rural areas, for soil resistivity below 3 000 Ωm, an interference distance of 3 000 m between the interfering system and the metallic pipeline has to be considered. In case of soil resistivity value greater than 3 000 Ωm, the interference distance value, in m, is equal to the soil resistivity value in Ωm.

5.2.2 In urban areas, for soil resistivity below 3 000 Ωm, the interference distance is not less than 300 m. For soil resistivity greater than 3 000 Ωm the interference distance, in m, is equal to the soil resistivity value, in Ωm, divided by 10.

NOTE 1 For fault condition and for a.c. power supply systems, the above distances apply in the case of neutral solidly earthed or earthed through small impedance. For a.c. power supply systems with compensated neutral or neutral ungrounded, interference effects are negligible.

NOTE 2 The soil resistivity to be taken into account in defining the value of the interference distance is the one of the deep layers of soil (as deep as needed for interference calculations).

National rules determining other interference distances may be applied.

Table 1 summarises the above statements.

Table 1 - Interference distances

Areas	ρ Ω m	Interference distance [a] m	
		Normal operation	Fault condition
Rural	> 3 000	ρ/3	ρ
	≤ 3 000	1 000	3 000
Urban	> 3 000	≥ 300	ρ/10
	≤ 3 000		≥ 300

[a] For underground power supply systems as well as for underground a.c. railway systems the interference distance is 50 m.

6 Parameters of the interference situations

When dealing with a metallic pipeline system coupled with an a.c. power system, only acceptable interferences are allowed.

It means that, in general, interference situations within the interference distance shall be investigated, in order to be sure that all the possible unacceptable interferences, if any, are turned into acceptable ones, by adopting suitable mitigation measures.

In Annex A suggestions are given on how to select the set of interference situations to be investigated and examples of worst case interference.

7 Coupling types

Table 2 defines the coupling types requiring calculation and/or measurement for evaluating the acceptability of the interference situation and maximum distances to be considered for the calculations. Distances do not correspond in any case to worst cases but result from a compromise between the opportunity to avoid useless calculations and the feedback experience of the operation.

Table 2 - Coupling types and distances to be considered

Metallic pipeline					
Above ground				**Underground**	
Not electrically connected to earth		**Electrically connected to earth**			
Normal operation	**Fault condition**	**Normal operation**	**Fault condition**	**Normal operation**	**Fault condition**
Inductive Capacitive [a b] ---	Inductive ---	Inductive --- Conductive [c d]	Inductive --- Conductive [c e]	Inductive --- Conductive [c d]	Inductive --- Conductive [c e]

[a] Capacitive coupling from a railway system has to be considered in case of approach at a distance lower than
- 10 m in case of 15 kV, 16,7 Hz systems,
- 50 m in case of 25 kV, 50 Hz systems.

[b] Capacitive coupling from a.c. power supply systems shall be considered in case of approach at a distance lower than 100 m.

[c] Conductive coupling from an a.c. railway system shall be considered in case of crossing or approach at a distance lower than 5 m from the nearest rail or masts or metallic components connected to the rails.

[d] Not to be considered for the a.c. power supply systems.

[e] Conductive coupling from a.c. power supply systems shall be considered in case of approach at a distance lower than
- 5 m from the closest visible part of the tower of a HV power line rated at 50 kV or less,
- 20 m from the closest visible part of the tower of a HV power line provided with earth wire(s) with nominal voltage greater than 50 kV,
- 100 m from the closest visible part of the tower of a HV power line not provided with earth wire(s) with nominal voltage greater than 50 kV,
- 20 m from earthing systems of HV power cables with nominal voltage greater than 50 kV,
- 150 m from the earthing grid of a power substation.

In any case a minimum distance of 2 m from the closest part of the earthing system of a tower shall be observed.

In case any metallic part connected to the pipeline is accessible to people, conductive coupling has to be considered within the interference distance (see Clause 5).

NOTE It is assumed that fault current values associated with isolated and resonant earthed systems are low and do not result in danger or in significant risk of damage or disturbance and calculations or measurements are only required when interference occurs.

For pipelines without longitudinal electrical continuity, e.g. cast iron pipelines, interference effects are negligible.