IEC 62486

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Railway applications – Current collection systems – Technical criteria for the interaction between pantograph and overhead contactline (to achieve free access)

Applications ferroviaires – Systèmes de captage de courant – Critères techniques d'interaction entre le pantographe et la ligne aérienne de contact (réalisation du libre accès)

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RAILWAY APPLICATIONS – CURRENT COLLECTION SYSTEMS – TECHNICAL CRITERIA FOR THE INTERACTION BETWEEN PANTOGRAPH AND OVERHEAD CONTACTLINE (TO ACHIEVE FREE ACCESS)

FOREWORD

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International Standard IEC 62486 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This second edition cancels and replaces the first edition published in 2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the upper line properties for both AC and DC power systems as well as the current collector characteristics have been clarified;
b) the requirements for pantograph with individually spring parts of the pantograph head were taken;
c) the lateral deviation of the contact wire is made to EN 15273;
d) in Annex A have been added to specific conditions of CN and JP;

e) in Annex B, special national conditions have been supplemented by the data of additional IEC members.

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

FDIS	Report on voting
9/2277/FDIS	9/2298/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

This international standard is derived from the European standard EN 50367 that was offered to the IEC by CENELEC.

The reader's attention is drawn to the fact that Annexes B and C list all of the “in-some-country” clauses on differing practices of a less permanent nature relating to the subject of this standard.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,
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RAILWAY APPLICATIONS – CURRENT COLLECTION SYSTEMS – TECHNICAL CRITERIA FOR THE INTERACTION BETWEEN PANTOGRAPH AND OVERHEAD CONTACTLINE (TO ACHIEVE FREE ACCESS)

1 Scope

This document specifies requirements for the interaction between pantographs and overhead contact lines, to achieve interoperability.

NOTE These requirements are defined for a limited number of pantograph types, referred to as 'interoperable pantograph', together with the geometry and characteristics of compatible overhead contact lines.

This document describes parameters and values for all planned lines and future lines.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60050-811:1991, *International Electrotechnical Vocabulary – Chapter 811: Electric traction*

IEC 60494-1:2013, *Railway applications – Rolling stock – Pantographs – Characteristics and tests – Part 1: Pantographs for main line vehicles*

IEC 60913:2013, *Railway applications – Fixed installations – Electric traction overhead contact lines*

IEC 62313:2009, *Railway applications – Power supply and rolling stock – Technical criteria for the coordination between power supply (substation) and rolling stock*

IEC 62499:2008, *Railway applications – Current collection systems – Pantographs, testing methods for carbon contact strips*

IEC 62846:2016, *Railway applications – Current collection systems – Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line*

IEC 62917, *Railway applications – Fixed installations – Electric traction – Copper and copper alloy grooved contact wires*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-811:1991 and the following apply.

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- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
arcing
flow of current through an air gap between a contact strip and a contact wire usually indicated by the emission of intense light

3.2
automatic dropping device
device that lowers the pantograph in the event of pantograph head failure or damage of the pantograph head

[SOURCE: IEC 60494-1:2013, 3.2.19]

3.3
contact force
vertical force applied by the pantograph to the overhead contact line

Note 1 to entry: The contact force is the sum of forces of all contact points.

3.4
contact point
point of the mechanical contact between a contact strip and a contact wire

3.5
contact wire height
distance from the top of the rail (or road surface for overhead contact line system for trolleybus applications) to the lower face of the contact wire, measured perpendicular to the track

Note 1 to entry: The contact wire height is measured perpendicular to the track or road surface.

3.6
continuous pantograph head profile
pantograph head with collector strips and horns suspended in one piece

3.7
encroachment of the pantograph head above the contact plane
perpendicular distance from the contact plane to the highest point of the pantograph head. The contact plane is the plane parallel to base frame of pantograph at the contact point

Note 1 to entry: Additional information is given in EN 15273-1:2013, Figure 46.

3.8
maximum contact wire height
maximum value of the contact wire height above rail level occurring in any possible case during the lifetime of the overhead contact line

3.9
maximum design contact wire height
maximum theoretical contact wire height not including tolerances and uplift, which the pantograph is required to reach

3.10
maximum width of pantograph head
maximum distance measured along the axis of the track between the outer edges of the contact strips

3.11
mean contact force F_m
statistical mean value of the contact force

Note 1 to entry: F_m is formed by the static and aerodynamic components of the pantograph contact force.

3.12
mechanical kinematic pantograph gauge
gauge of the pantograph head under all operating conditions

Note 1 to entry: Additional information is given in EN 15273-1:2013, Clause 3.

3.13
minimum contact wire height
minimum value of the contact wire height above rail level occurring in any possible case during the lifetime of the overhead contact line

3.14
neutral section
section of a contact line provided with a sectioning point at each end, to prevent successive electrical sections differing in voltage or phase being connected together by the passage of current collectors

[SOURCE: IEC 60050-811:1991, 811-36-16]

3.15
nominal contact wire height
nominal value of the contact wire height above rail level at a support in the normal conditions

3.16
non-continuous pantograph head profile
pantograph head with collector strips separately (independently) suspended from the main horns

3.17
overhead contact line
contact line placed above or beside the upper limit of the vehicle gauge and supplying vehicles with electric energy through roof mounted current collection equipment

[SOURCE: IEC 60050-811:1991, 811-33-02]

3.18
percentage of arcing *NQ*
proportion of driving time with arcing

NQ this is given by the following formula:

$$NQ = \frac{\sum t_{arc}}{t_{total}} \times 100$$

where

t_{arc} is the duration of an arc lasting longer 5 ms;

t_{total} is the measuring time with a current greater than 30 % of the nominal current.

The result, given in %, is a characteristic for a given speed of the vehicle

3.19
static contact force
vertical force exerted upward by the pantograph head on the overhead contact line, caused by the pantograph-raising device, whilst the pantograph is raised and the vehicle is stationary

3.20
transition zone of pantograph head
range for the transition point between non independently suspended parts and independently suspended parts of the pantograph head (see Figures 1 and 2)

3.21
gradient
ratio of the difference in height of the overhead contact line above top of rail (or road surface for overhead contact line system for trolleybus applications) at two successive supports to the length of the span

[SOURCE: IEC 60913:2013, 3.4.2]

3.22
contact loss
condition where the contact force is zero

Note 1 to entry: Contact loss surely induces arcing except in the case of coasting. However, if two or more pantographs are connected electrically each other, arc will immediately disappear and then the condition will shift to 'current loss'.

3.23
current loss
condition where current flowing through a pantograph is zero under the condition of contact loss

Note 1 to entry: When a train is equipped with two or more pantographs electrically connected by a bus cable, necessary traction power can be supplied by other pantographs through the bus cable in case of contact loss. Therefore, current loss condition will generally not affect driving of the train.

4 Symbols and abbreviated terms

AC	Alternative Current
AQ	percentage of all arcing
CQ	percentage of current loss
DC	Direct Current
D'	length of neutral zone excluding overlapping parts taking into account the uplift by pantograph passage and insulation clearances
D	overall length of neutral section as distance between adjacent systems/phases including overlapping parts taking into account the uplift by pantograph passage and insulation clearances
d	length of insulator inserted in contact wire
F_{m}	mean contact force
F_{max}	maximum contact force
$F_{m,\ min}$	minimum mean contact force
$F_{m,\ max}$	maximum mean contact force
F_{min}	minimum contact force
F_{stat}	static contact force
GC	gauge C according to EN 15273
L	Inner distance between two adjacent pantographs
L'	Outer distance between first and last operating pantographs
L''	Inner distance between one and the second following operating pantographs
l	maximum width of pantograph head

NQ	percentage of arcing
σ	standard deviation of contact force
σ_{max}	maximum standard deviation of contact force
d_l	Lateral deviation of contact wire
b_w	Half-length of the pantograph head
$b_{w,c}$	Half-length of the pantograph head conducting length (with insulating horns) or working length (with conducting horns)
b'_h	Length of mechanical kinematic pantograph gauge at contact wire height
h'_o	Maximum verification height of the pantograph gauge in a collecting position
h'_u	Minimum verification height of the pantograph gauge in a collecting position
h'_{c0}	Reference roll centre height for the pantograph gauge
I'_0	Reference cant deficiency taken into account by the vehicle for the pantograph gauging
D'_0	Reference cant taken into account by the vehicle for the pantograph gauge
s'_0	Flexibility coefficient taken into account by agreement between the Railway Undertaking and the Infrastructure Manager for pantograph gauging
α	Angle of independent suspended part of the pantograph head at the transition point
β	Angle of the main horn on the fixed part of the pantograph head

5 Geometry

5.1 General

The geometric characteristics of the overhead contact line shall be designed and built in accordance with 5.2. The geometric characteristics of the pantograph(s) shall be designed and built in accordance with 5.3, according to the type of infrastructure on which it will operate.

5.2 Overhead contact line characteristics

5.2.1 General

The following geometric parameters of the overhead contact line are defined in order to achieve free access:

- gauge;
- contact wire height;
- contact wire gradient;
- lateral deviation of the contact wire from the track centre line under action of a crosswind;
- free and unrestricted contact wire uplift at the support;
- neutral section arrangements.

The overhead contact line shall conform to IEC 60913.

5.2.2 Gauges

The design of the overhead contact line shall allow the operation of vehicles compliant to the appropriate vehicle gauge for the route.

NOTE This gauge is calculated according to EN 15273.

5.2.3 Contact wire height

The range of nominal contact wire height shall be in accordance with Table 1.

The contact wire may be higher in certain cases such as level crossings, loading areas, etc. In these cases the maximum design contact wire height shall not be greater than 6,20 m.

The maximum contact wire height is 6,5 m.

The contact wire height may be lower in certain cases related to gauge such as bridges and tunnels. Minimum contact wire height shall be calculated in accordance with IEC 60913:2013, 5.10.4.

Table 1 – Range of nominal contact wire height for AC and DC systems

Line speed v km/h	**$v \leq 200$**	**$200 < v < 250$**	**$v \geq 250$**
Range of nominal contact wire height [m]	5,0 up to 5,75	5,0 up to 5,5	5,0 up to 5,3

5.2.4 Contact wire gradient

The permissible contact wire gradient is defined in IEC 60913:2013, 5.10.3.

The variation in contact wire height shall fulfil the requirements imposed by IEC 60913:2013, 5.10.3.

The contact wire gradient specified in IEC 60913:2013, 5.10.3 may be exceeded on an exceptional basis, where a series of restrictions on the contact wire height such as level crossings, bridges, tunnels, etc., prevents compliance. In this case the requirements of 7.3 are not applicable, and the contact force shall not exceed the maximum value defined in IEC 60913:2013, 5.2.5.2.

5.2.5 Lateral deviation

The maximum lateral deviation of the contact wire shall be calculated by taking into consideration the total movement of the pantograph with respect to the nominal track position and the conducting range (or working length, for pantographs with horns made from a conducting material) as follows:

$$d_l = b_{w,c} + b_w - b'_h$$

The values shall be adjusted taking into account the pantograph movement, track gauge and track tolerances according to appropriate gauging standard and the following reference parameters:

s'_0 = 0,225

h'_{c0} = 0,5 m

I'_0 = 0,066 m and D'_0 = 0,066 m

h'_o = 6,500 m and h'_u = 5,000 m

$b_{w,c}$ = 600 mm for pantographs in accordance with Figure A.6

b_w = 800 mm for pantographs in accordance with Figure A.6

$b_{w,c}$ = 775 mm for pantographs in accordance with Figure A.7

b_w = 975 mm for pantographs in accordance with Figure A.7

NOTE Appropriate gauging standard could be EN 15273 (or equivalent or UIC 505 series).

For interoperable pantographs defined in A.2 the limit for the maximum permissible lateral deviation of the contact wire normal to the design track centre line under the action of cross wind is given in Table 2.

Table 2 – Maximum lateral deviation

Dimensions in millimetres

Pantograph length	Maximum lateral deviation
1 600	400
1 950	550

In the case of a multi-rail track, the requirement shall be fulfilled for each pair of rails (designed to be operated as separated track) that is intended to be interoperability.

NOTE For additional national requirements outside Europe, see Clauses A.5 and A.6.

The wind speed and the pantograph length to be considered will be defined by the infrastructure manager.

5.2.6 Contact wire uplift

The requirements for the allowance for contact wire uplift at the support are defined in IEC 60913:2013, 5.10.2.

5.2.7 Neutral sections

For operation through neutral sections see IEC 62313. The requirements for the design of neutral sections are defined as follows:

- trains shall be able to move from one section to an adjacent one (which is fed from a different phase or system) without bridging the neutral section;
- the neutral section shall be designed in such a way that trains with multiple pantographs arranged according to A.1.5 at an overall separation up to a maximum of 400 m can pass through with their pantographs raised;
- adequate means shall be provided to allow a train that is stopped within the phase separation section to be restarted.

In the case of trains with multiple pantographs, the pantographs shall be lowered for the entire length of the neutral section if any of the above requirements cannot be met. Technical or operational measures shall be taken to meet safety and availability requirements.

For compatibility between neutral sections and certain arrangements of pantographs, see Clause 8.

5.2.8 Change over area between pantograph profiles

At connections between lines which are designed for different pantograph profiles, a change over area shall be provided. In the changeover area one pantograph type shall be lowered and the other type shall be raised. In the area which is common to the different pantograph profiles, the overhead contact line shall be designed as follows:

- the lateral deviation of the contact wire according to 5.2.5 shall be calculated for a pantograph with the shortest length of head;
- the pantograph gauge according to 5.2.2 shall be calculated for a pantograph with the largest length of head.