IEC 62846

Edition 1.0 2016-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Railway applications – Current collection systems – Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line

Applications ferroviaires – Systèmes de captage de courant – Exigences et validation des mesures de l'interaction dynamique entre le pantographe et la caténaire

IEC 62846:2016-10(en-fr)

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RAILWAY APPLICATIONS – CURRENT COLLECTION SYSTEMS – REQUIREMENTS FOR AND VALIDATION OF MEASUREMENTS OF THE DYNAMIC INTERACTION BETWEEN PANTOGRAPH AND OVERHEAD CONTACT LINE

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This standard has been derived from EN 50317.

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

FDIS	Report on voting
9/2198/FDIS	9/2205/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 reader's attention is drawn to the fact that Annex A lists all of the "in-some-country" clauses on differing practices of a permanent nature relating to the subject of this standard.

The following differing practices of a less permanent nature exist in the countries indicated below.

– Subclause 3.20: t_{total} is the total measuring time (China).
– Subclause 9.5: The evaluation of the interaction includes counting the number of arcs longer than a predefined length (China).

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

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RAILWAY APPLICATIONS – CURRENT COLLECTION SYSTEMS – REQUIREMENTS FOR AND VALIDATION OF MEASUREMENTS OF THE DYNAMIC INTERACTION BETWEEN PANTOGRAPH AND OVERHEAD CONTACT LINE

1 Scope

This International Standard specifies the functional requirements for output and accuracy of measurements of the dynamic interaction between pantograph and overhead contact line.

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 62486:2010, *Railway applications – Current collection systems – Technical criteria for the interaction between pantograph and overhead line (to achieve free access)*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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

3.1
collector head
pantograph head
part of the pantograph supported by the frame which includes contact strips, horns and may include a suspension

[SOURCE: IEC 60494-1:2013, 3.2.3, modified – the term "pantograph head" has been added.]

3.2
contact point
point of mechanical contact between a contact strip and a contact wire

3.3
working area of the pantograph head
lateral and vertical range of possible contact points on the contact strips during normal operation

3.4
contact force
vertical force applied by the pantograph to the overhead contact line. The contact force is the sum of forces for all contact points of one pantograph

[SOURCE: IEC 62486:2010, 3.2]

3.5
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.

[SOURCE: IEC 62486:2010, 3.4, modified – the symbol F_m and the note have been added.]

3.6
static contact force
mean vertical force exerted upwards by the pantograph head on the overhead contact line, and caused by the pantograph-raising device, whilst the pantograph is raised and the vehicle is at standstill

[SOURCE: IEC 62486:2010, 3.3]

3.7
standard deviation of contact force σ
square root of the sum of the squared differences between data values and the mean contact force divided by the number of data values minus 1

3.8
aerodynamic force
additional vertical force applied by the pantograph as a result of air flow around the pantograph assembly

3.9
statistical minimum of contact force
value of contact force represented by $F_m - 3\sigma$

3.10
statistical maximum of contact force
value of contact force represented by $F_m + 3\sigma$

3.11
cord force
measured force in a cord restraining a contact strip at a defined height

3.12
total mean uplift force
vertical force measured at the pantograph head, the latter not touching the contact line

Note 1 to entry: It is equal to the sum of static contact force and the aerodynamic force caused by the air at the considered speed for a given height of contact points.

3.13
transfer function magnitude
magnitude of the ratio between the applied and the measured forces of the pantograph and instrumentation determined by a dynamic excitation of the pantograph, at the pantograph head for a range of frequencies

3.14
tension length
length of overhead contact line between two terminating points

[SOURCE: IEC 60913:2013, 3.4.1]

3.15
control section
representative part of the total measuring length, over which the measuring conditions are compliant with standard conditions

3.16
pantograph current
current that flows through the pantograph

3.17
arcing
flow of current through an air gap between a contact strip and a contact wire usually indicated by the emission of intense light

[SOURCE: IEC 62486:2010, 3.15]

3.18
sensitivity curve
relationship between the power density of the arc in µW/cm² and the response of the detector in volts within the spectral range of interest

3.19
nominal current
current that flows through one pantograph for nominal power of train

3.20
percentage of arcing
NQ
this is given by the following formula:

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

where

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

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

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

Note 1 to entry: Refer to the Foreword for special national conditions.

[SOURCE: IEC 62486:2010, 3.16, modified – a note has been added.]

3.21
contact wire bending stress
bending stress variation of a contact wire which is caused by a passing pantograph

3.22
percentage of all arcing
this is given by the following formula:

$$AQ = \frac{\sum t_{\text{all\_arc}}}{t_{\text{total}}} \times 100$$

where

$t_{\text{all\_arc}}$ is the duration of an arc by measuring the visible light of arcing;

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

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

[SOURCE: IEC 62486:2010, 3.20]

3.23
percentage of current loss
this is given by the following formula:

$$CQ = \frac{\sum t_{\text{cl}}}{t_{\text{total}}} \times 100$$

where

t_{cl} is the duration of current loss (e.g. measurement with waveform of collected current of pantograph which is connected with another pantograph);

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

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

Note 1 to entry: This method is only applicable for at least two electrically connected pantographs. In the context of this measuring method "current loss" means that the current flowing through one of these pantographs is zero.

[SOURCE: IEC 62486:2010, 3.21, modified – a note has been added.]

3.24
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 to each other, the arc will immediately disappear and then the condition will shift to 'current loss'.

3.25
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 the driving of the train.

4 Symbols and abbreviated terms

$a_{\text{Sensor,i}}$ acceleration measured in acceleration sensor i

c coefficient for calculation of speed dependent limit of effect of measurement system on the aerodynamic force

d	measurement distance between arc detector and light source (see Figure 4)
d_{ref}	reference distance between arc detector and light source
$F_{applied}$	force applied to pantograph head
F_c	contact force
$F_{corr,aero}$	aerodynamic force correction
F_m	mean contact force
$F_{measured}$	force measured
$F_{Sensor,i}$	measured force in sensor i
$F_{z,i}$	measured force in cord i
f_1	minimum frequency
f_i	actual frequency
f_n	maximum frequency
g	surface power density generated by the smallest arc that shall be detected at reference distance
J	accuracy of the transfer function
k_a	number of acceleration sensors
k_f	number of force sensors
m_{above}	mass between contact point and force sensors
NQ	percentage of arcing
AQ	percentage of all arcing
CQ	percentage of current loss
n	number of frequency steps
t_{arc}	duration of an arc recorded longer than a specified value
t_{all_arc}	duration of any arc recorded
t_{cl}	duration of current loss
t_{total}	measured duration with a pantograph current greater than a specified value
v	speed
x	surface power density generated by the smallest arc that shall be detected at measurement distance
x_{ref}	surface power density generated by the smallest arc that shall be detected at reference distance
σ	standard deviation of contact force

5 General

The measurement of the interaction of the contact line and the pantograph is intended to prove the safety of operation and the quality of the current collection system. Results of measurements of different current collection systems shall be comparable, in order to approve components for free access within operated railway lines.

To check the performance capability of the current collection system, measurements shall be done in accordance with the requirements for dynamic interaction performance defined in IEC 62486 including the type of measurement methods which shall be used. The methods are described in detail in Clauses 6 to 9. Special national conditions are described in Annex A.

In addition to the measured values, the operating conditions (train speed, location, etc.) shall be recorded and/or processed continuously and the environmental conditions (rain, ice, temperature, wind, tunnel, etc.) and test configuration (parameters related to pantographs and overhead line systems, etc.) during the measurement shall be recorded in the test report. This additional information shall ensure repeatability of the measurement and comparability of the results.

NOTE In case of assessing the risk of a contact wire fatigue crack caused by bending stress, a measuring method is provided in Annex B for information.

6 Measurement of total mean uplift force

Where a tethered test (see Figure 1) is used to measure the total mean uplift force the following requirements shall be fulfilled.

A tethered test determines cord force(s). The total mean uplift force is the sum of all mean values of the measured cord forces at the chosen height, speed and measurement conditions.

The aerodynamic force is the difference between the total mean uplift force and the static contact force.

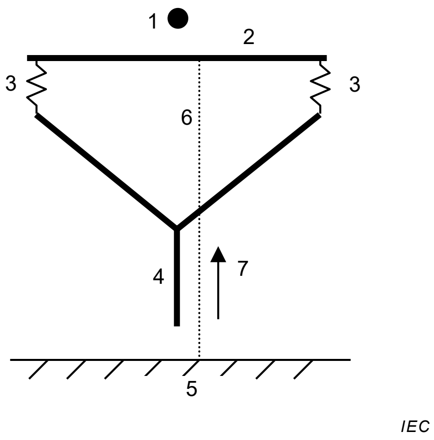
For this measurement the pantograph shall be restrained at a height as near as possible to the contact wire height for which the result shall be valid. The restraint shall be provided by vertical cords to each collector strip. The cords shall have adequate tensile stiffness, to constrain pitching of the head.

The accuracy of adjustment shall be checked on a horizontal track without cant. The collector strips shall be adjusted so that the along track and cross track errors are less than 1,5° relative to the plane of rails.

The contact wire shall not touch the testing pantograph during the test.

NOTE 1 A typical distance between collector head and contact wire is 10 cm to 15 cm. Simulation results can be used to take into account maximum dynamic movement of the contact wire caused by any other pantograph in operation.

The force in each cord shall be measured.



Key

1 contact wire

2 contact strip(s)

3 suspension of pantograph head

4 upper arm of pantograph

5 base frame or roof of vehicle

6 cord(s)

7 cord force(s) $F_{z,1}(t)$... $F_{z,i}(t)$

Figure 1 – Principle arrangements for a tethered test

The dynamic behaviour of the cord forces depends on a number of influences (surrounding conditions, turbulence around the cords, track conditions, tunnels, etc.).

To achieve confidence with the results the variance of the forces recorded and their repeatability over different sections shall be demonstrated.

The speed dependency of the total mean uplift force shall be evaluated by measurement of the cord force(s) between an initial test speed according to Table 1 and the maximum train speed in steps. The step shall be chosen in accordance with the maximum train speed.

Table 1 – Initial test speed

Maximum train speed [km/h]	≤ 200	> 200
Initial test speed [km/h]	100	160

NOTE 2 A typical step is 20 km/h or 5 steps for the complete speed range.

In addition to the conditions recorded according to Clause 5, the train configuration and driving direction and also the restrained height and wear conditions of the collector strips shall be noted.

As a result of the tethered test the total mean uplift force as a function of speed for the measured configuration shall be presented.

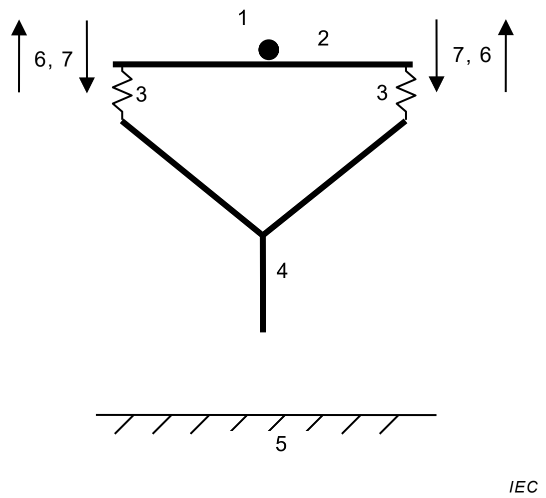
NOTE 3 The results of the test can be used for optimization of pantograph aerodynamic properties, for example optimization of angle of wind deflectors on the pantograph.

In case the contact wire height is so low that the tethered pantograph is below its height at the "lower operating position", a wind tunnel test can be chosen as an alternative test method. The aerodynamic conditions around the pantograph (roof layout) shall be taken into account for this test method.

7 Measurement of contact force

7.1 General requirements

The measurement of contact force (see Figure 2) shall be carried out on the pantograph using force sensors. The force sensors shall be located as near as practicable to the contact points.



Key

1 contact wire

2 contact strip(s)

3 suspension of pantograph head

4 upper arm of pantograph

5 base frame

6 force sensor(s) $F_{\text{Sensor},1}(t) \ldots F_{\text{Sensor},i}(t)$

7 acceleration sensor(s) $a_{\text{Sensor},1}(t) \ldots a_{\text{Sensor},i}(t)$

Figure 2 – Contact force measurement

The measurement system shall measure the vertical component of the contact forces, minimising interference from forces in other directions (e.g. contact friction).

All sensors shall be temperature compensated for the measuring conditions.

For pantographs with independent contact strips each contact strip shall be measured separately.

Segmented contact strips (see Figure 3) are considered as one contact strip.