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**Railway applications – Rolling stock – Pantographs – Characteristics and tests –
Part 1: Pantographs for main line vehicles**

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**Applications ferroviaires – Matériel roulant – Pantographes – Caractéristiques et
essais –**

Partie 1: Pantographes pour véhicules grandes lignes

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ROLLING STOCK – PANTOGRAPHS –
CHARACTERISTICS AND TESTS –****Part 1: Pantographs for main line vehicles**

FOREWORD

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International Standard 60494-1 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This standard is based on EN 50206-1.

This second edition cancels and replaces the first edition issued in 2002 and constitutes a technical revision.

The main technical changes with regard to the previous edition are as follows:

- simplification and standardization of the tolerances for static contact force (Annexes A and B);
- definition of a new investigation test "Measurement of mean static contact force at ambient temperature" (6.3.4);
- deletion of combined test "Total contact force" (6.11);

- definition of a new combined test "Check of operating system at maximum speed" (6.13);
- adjustment of terms (static contact force instead of static force);
- deletion of Clause 10;
- new Annex D " Static contact force tolerances in Japan ".

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

FDIS	Report on voting
9/1821/FDIS	9/1845/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 in the IEC 60494 series, published under the general title *Railway applications – Rolling stock – Pantographs – Characteristics and tests*, can be found on 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- withdrawn,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
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INTRODUCTION

The electrical power supply of a tractive unit is achieved by the collection of current from one or more contact wires by means of one or more pantograph(s), installed on the traction unit or on the trainset's vehicle.

The contact strips of the pantograph which slide along the contact wire facilitate the transmission of power.

The pantograph and the overhead contact line system form two oscillating sub-systems which can be displaced. There exists a unilateral sliding linkage between them, which shall ensure continuous contact. Their design shall allow for minimum wear of both sub-systems when used.

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RAILWAY APPLICATIONS – ROLLING STOCK – PANTOGRAPHS – CHARACTERISTICS AND TESTS –

Part 1: Pantographs for main line vehicles

1 Scope

This part of IEC 60494 specifies the general assembly characteristics which are to be applied to pantographs, to enable current collection from the overhead contact line system. It also specifies the tests the pantographs have to perform, excluding insulators.

This Standard is not applicable to pantograph dielectric tests, which are to be performed on the pantograph installed on the vehicle roof. If no other requirement is agreed between customer and supplier, insulation coordination according to IEC 62497-1 may be used.

This Standard is not applicable to pantographs used on isolated metros and light rail systems. These pantographs are considered in IEC 60494-2.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60077 (all parts), *Railway applications – Electric equipment for rolling stock*

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

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

IEC 61373, *Railway applications – Rolling stock equipment – Shock and vibration tests*

IEC 62278 (all parts), *Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS)*

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

IEC 62498-1, *Railway applications – Environmental conditions for equipment – Part 1: Equipment on board rolling stock*

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

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EN 50317, *Railway applications – Current collection systems – Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line*¹

3 Terms and definitions, symbols and abbreviations

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

3.1 General

3.1.1

supplier

manufacturer of the pantograph

3.1.2

customer

either operating authority or vehicle manufacturer

3.1.3

pantograph (see Figure 1)

apparatus for collecting current from one or more contact wires, formed of a hinged device designed to allow vertical movement of the pantograph head

[IEC 60050-811:1991, 811-32-02]

3.2 Design

IEC 60494-1:2013

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Table 1 – Design definitions

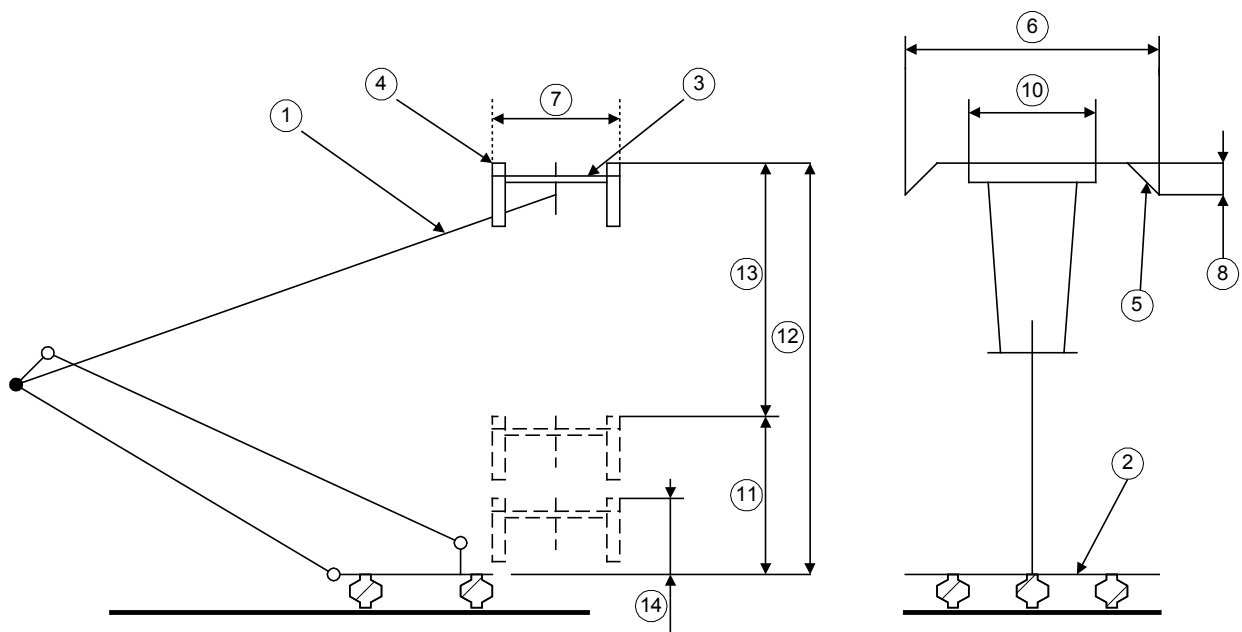
Def. No.	Term	Item No.	Definition
3.2.1	frame	1	articulated structure which enables the collector head to move in a vertical direction with respect to the base frame of the pantograph
3.2.2	base frame	2	fixed part of the pantograph which supports the frame and is mounted on insulators fixed to the vehicle roof
3.2.3	collector head	3	part of the pantograph supported by the frame which includes contact strips, horns and may include a suspension
3.2.4	contact strip	4	replaceable wearing part of the collector head which interfaces with the overhead contact line system
3.2.5	horns	5	ends of the collector head which ensure smooth engagement with the contact wire
3.2.6	collector head length	6	dimension of collector head measured transversely in the horizontal plane in relation to the vehicle
3.2.7	collector head width	7	maximum distance measured along the axis of the track between the outer edges of the contact strips
3.2.8	collector head height	8	vertical distance between the lowest point of the horns and the uppermost point of the contact strips
3.2.9	collector head pivot	9	pitching axis of the collector head
3.2.10	length of contact strips	10	total length of wearable material intended for normal interaction measured transversely in relation to the vehicle

¹ EN 50317 is under consideration at the IEC and will be published as IEC 62846.

Def. No.	Term	Item No.	Definition
3.2.11	height at "lower operating position"	11	vertical distance between the pantograph mounting plane on the top of insulators and the upper surface of contact strips, the pantograph being raised to the lowest level at which it is designed to collect current
3.2.12	height at "upper operating position"	12	vertical distance between the pantograph mounting plane on the top of insulators and the upper surface of the contact strips, the pantograph being raised to the highest level at which it is designed to collect current
3.2.13	working range	13	difference between the "upper operating position" height and the "lower operating position" height
3.2.14	housed height	14	vertical distance between the pantograph mounting plane on the top of insulators and the upper surface of the contact strips or any other part of the pantograph structure if higher (pantograph being in the housed position)
3.2.15	pantograph "electrical thickness"	15	vertical distance between the highest live part and the lowest live part of the pantograph at housed position
3.2.16	operating system	16	device which provides a force to raise or to lower the pantograph
3.2.17	maximum extension	17	maximum extended height to mechanical stops (vertical distance between the pantograph mounting plane on the top of insulators and the upper surface of contact strips, without any device which will limit the pantograph extension within the working range)
3.2.18	limited maximum extension	18	reduced extension allowed by intermediate mechanical stops (vertical distance between the pantograph mounting plane on the top of insulators and the upper surface of contact strips)
3.2.19	Automatic dropping device	19	Device that lowers the pantograph in the event of pantograph head failure or damage of the pantograph head.

NOTE The definitions are related to Figure 1, except items 9, 15, 16, 17, 18, and 19.

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IEC 2234/13

NOTE The sketch in Figure 1 is an example only and does not exclude other types of pantographs (diamond type, for example).

Figure 1 – Pantograph terminology

3.3 General characteristics

3.3.1

rated voltage

voltage at which the pantograph is designed to function

3.3.2

rated current, vehicle at standstill

average value of that current withstood for 30 min by the pantograph at standstill

3.3.3

maximum current, vehicle at standstill

maximum value of that current withstood by the pantograph at standstill for a given time

3.3.4

rated current, vehicle running

continuous current transfer capacity of the pantograph

3.3.5

static contact force

vertical force exerted upward by the collector head on the overhead contact line system at standstill

3.3.6

nominal static contact force

specified set point for the static contact force

3.3.7

mean static contact force

average of the actual values of static contact forces

[IEC 60494-1:2013](#)

[http://standards.iteh.ai/catalog/standards/sist/b0ad44a0-a497-4c37-9d15-dddc25f0ff7a/iec-60494-1-2013](#)

Note 1 to entry: evaluated as follows: the static contact forces are measured continually within the working range during raising (F_r) and lowering (F_l) operation. By convention, the mean static contact force at any point is equal to $\frac{F_r + F_l}{2}$.

3.3.8

target static contact force

upward force measured at the standard working height of the pantograph when the pantograph is raised at 0,05 m/s under the same conditions as in actual use

3.3.9

total mean uplift force

vertical force measured at the collector head, the latter not touching the contact wire

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 collector height, the results being referred to zero ambient wind conditions.

3.3.10

total contact force

total force between collector head and contact wire while running

3.3.11

housing force

force applied vertically to the collector head to maintain the whole pantograph in housed position

3.4 Symbols and abbreviations

AC Alternating current

ADD	Automatic dropping device
DC	Direct current
F_0	Natural transverse frequency
F_r	Force during raising the pantograph
F_l	Force during lowering the pantograph
MDBF	Mean distance between failure
Γ	Acceleration at collector head pivot

4 Technical requirements

4.1 General

All general characteristics are given in the customer specifications. Unless otherwise specified, environmental conditions are defined in IEC 62498-1. The category of environment has to be specified by the customer.

4.2 Gauge

The pantograph, at housed position and operating position, shall comply with the gauge specified in the customer specifications or shall be in accordance with IEC 62486.

4.3 Extension of the pantograph

The customer specifications shall state the values in relationship with items 10 to 13 in Table 1. In the absence of specifications in the tender documents, when the pantograph is raising or lowering, the collector head trajectory over the working range shall be within a range of ± 50 mm in the longitudinal direction, and ± 10 mm in the lateral direction in relation to the vertical line. <https://standards.iteh.ai/catalog/standards/sist/b0ad44a0-a497-4c37-9d15-dddc25f0ff7a/iec-60494-1-2013>

4.4 Electrical values

The supply voltages of traction systems are specified in IEC 60850.

The customer specifications shall also state the duration and values of the exceptional voltages for operating pantographs and housed pantographs.

Values defined in 3.3.2 to 3.3.4 shall be given in the customer specifications.

4.5 Force requirements

Unless larger tolerances are agreed between user and supplier, static contact forces measured during raising and lowering shall lie within the boundaries defined in Annex A.

Operating requirements for static contact force, total mean uplift force and total contact force shall follow the requirements in IEC 62486 if not specified in the customer specifications.

4.6 Transverse rigidity

When a transverse force is exerted on the part of the frame which supports the collector head at the upper operating position, the deflection shall not exceed the value defined in 6.6 and no permanent deformation shall occur.

4.7 Collector head

4.7.1 Length

If not specified in the customer specification, lengths defined in IEC 62486 shall be used.

4.7.2 Width

The collector head width shall be defined according to the type of suspension, the number of wear strips and the system characteristics of the overhead contact line system.

4.7.3 Head profiles

If not specified in the customer specification, the collector head outline profiles and maximum allowable tilt defined in IEC 62486 shall be used.

4.7.4 Contact strips

When not specified in IEC 62486 wear strip material, maximum current at standstill and under running conditions shall be specified in the customer specifications. If applicable, testing methods according to IEC 62499 are recommended.

4.8 Operating system

The installation and the definition of the operating system shall be provided by the supplier.

If not specified by the customer, the operating system shall be designed to ensure, at standstill and up to the maximum speed of the traction unit, a break from the contact wire, within 3 s, over the minimum insulation distance.

The housing force shall prevent the pantograph from raising from the housed position at all speeds up to maximum speed of the vehicle.

The housing force may be agreed between the customer and the supplier. Alternatively, provision may be made for the fitting of a holding down device.

4.9 Automatic dropping device (ADD)

The automatic dropping device has to be mounted only when the customer so requires. Impact or damage occurring to contact strips liable to cause subsequent damage to overhead contact line system shall be detected by ADD. Impacts or damages to other parts of the collector head like horns can be included in the ADD, if specified by the customer.

When designing, the following characteristics shall be taken into account:

- ADD reaction time;
- ADD failure to safe condition;
- ADD self-test in workshop;
- ADD reliability;
- pantograph integrity after work of ADD.

The ADD system shall be designed to ensure that minor damage to the contact strips as may be experienced in daily service shall not cause operation of ADD system.

The ADD shall not cause additional damage to the pantograph.

4.10 Pantograph mass and force on the roof

The supplier shall specify the mass of the pantograph with or without insulators and the maximum force at every fixing point. In addition the supplier shall specify all relevant parameters to enable the calculation of the maximum efforts at every fixing point.

4.11 Protection against corrosion

The specifications regarding the application requirements and type of corrosion protection shall be given in the customer specifications.

5 Marking

As a minimum the following shall be labelled on the pantograph:

- manufacturer's name;
- pantograph serial number;
- type of pantograph;
- month and year of production.

6 Tests

6.1 Categories of tests

6.1.1 Overview

There are four categories of tests:

- type tests; <https://standards.iteh.ai/catalog/standards/sist/b0ad44a0-a497-4c37-9d15-dddc25f0ff7a/iec-60494-1-2013>
- routine tests;
- investigation tests;
- combined tests.

The above tests are described in 6.1.2 to 6.1.5.

Annex B summarises the tests which shall be performed.

6.1.2 Type tests

This International Standard distinguishes the basic model of a pantograph from the derived model of the same pantograph. The derived model can incorporate modifications to the basic design which shall be considered to be covered by the existing relevant type tests. This is provided that any such changes can be demonstrated to be at least equal to the basic design through calculation or operational experience of at least two years on operational lines, and with technical requirements at least equal to those for which the basic model was designed.

Type tests shall be performed on a single piece of apparatus of a given design.

Equipment in current manufacture shall be considered to have satisfied the type tests and shall be exempted from them, if the manufacturer provides signed reports of type tests already made on identical apparatus constructed previously.

Supplementary type tests shall be required if they are requested in the customer specification and after agreement with the supplier.