GERMAN STANDARD

November 2006

DIN EN 50367 (VDE 0115-605)

This norm is also a VDE regulation in the sense of VDE 0022. After the approval procedure decided by the VDE Presidium, it has been included in the VDE regulations under the number given above and published in "etz Elektrotechnik + Automation".

ICS 29.280

Railway applications - Interaction of the systems - Technical criteria for the interaction between pantograph and overhead contact line for free access; German version EN 50367: 2006

Railway applications -
Current collection systems -
Technical criteria for the interaction between pantograph and overhead line (to achieve free access);
German version EN 50367: 2006

Applications ferroviaires - Systèmes de captage de courant -
Critères techniques d'interaction entre le pantographe et la ligne aérienne de contact (réalisation du libre accès);
Version allemande EN 50367: 2006

Total length 35 pages

DKE German Commission for Electrical, Electronic and Information Technologies of DIN and VDE

Start of validity

The EN 50367 adopted by CENELEC on 2005-10-01 is valid as a DIN standard from 2006-11-01.

National Foreword

Previous draft standard: E DIN EN 50367 (VDE 0115-605): 2002: 07.

The national working committee UK 351.2 "Fixed installations" of the DKE German Commission for Electrical, Electronic and Information Technologies of DIN and VDE (http://www.dke.de) is responsible for this standard.

National Annex NA
(informative)

Relationship with European and International Standards

In the event of an undated reference in the normative text (reference to a standard without specifying the date of issue and without reference to a section number, table, figure, etc.), the reference refers to the latest valid edition of the referenced standard.

In the case of a dated reference in the normative text, the reference always refers to the edition of the standard referred to.

Information on the relationship between the cited standards and the corresponding German standards is given in Table NA.1.

Table NA.1

European Standard	International standard	German standard	Classification in VDE regulations
EN 50119: 2001	-	DIN EN 50119 (VDE 0115-601): 2002-01	VDE 0115-601
EN 50149: 2001	-	DIN EN 50149 (VDE 0115-602): 2001-10	VDE 0115-602
EN 50163: 2004	-	DIN EN 50163 (VDE 0115-102): 2005-07	VDE 0115-102
EN 50206-1: 1998	-	DIN EN 50206-1 (VDE 0115-500-1): 1999-02	VDE 0115-500-1
EN 50317: 2002 + A1: 2004	-	DIN EN 50317 (VDE 0115-503): 2003-03 + A1: 2005-10	VDE 0115-503
EN 50318: 2002	-	DIN EN 50318 (VDE 0115-504): 2003-04	VDE 0115-504
EN 50388: 2005	-	DIN EN 50388 (VDE 0115-606): 2006-03	VDE 0115-606
EN 50405	-	-	-
-	IEC 60050-811	IEV part 811	-
EN ISO 3166-1: 1997	ISO 3166-1: 1997	DIN EN ISO 3166-1: 1998-04	-
UIC 505: 1997	-	-	-
UIC 506	-	-	-
UIC 608	-	-	-

National annex NB
(informative)

Bibliography

DIN EN 50119 (VDE 0115-601): 2002-01, Railway applications - Fixed installations - Overhead lines for electrical train operation; German version EN 50119: 2001.

DIN EN 50149 (VDE 0115-602): 2001-10, Railway applications - Fixed installations - Electric train operation - Grooved contact wires made of copper and copper alloy; German version EN 50149: 2001.

DIN EN 50163 (VDE 0115-102): 2005-07, Railway applications - supply voltages of railway networks; German version EN 50163: 2004.

DIN EN 50206-1 (VDE 0115-500-1): 1999-02, Railway applications - Railway vehicles - Characteristics and tests of pantographs - Part 1: Pantographs for mainline vehicles; German version EN 50206-1: 1998.

DIN EN 50317 (VDE 0115-503): 2003-03, Railway applications - Current collection systems - Requirements and validation of measurements of the dynamic interaction between pantograph and overhead contact line; German version EN 50317: 2002.

DIN EN 50318 (VDE 0115-504): 2003-04, Railway applications - Current collection systems - Validation of simulation systems for the dynamic interaction between pantograph and overhead line; German version EN 50318: 2002.

DIN EN 50388 (VDE 0115-606): 2006-03, Railway applications - Railway energy supply and vehicles - Technical criteria for the coordination between railway energy supply systems and vehicles in order to achieve interoperability; German version EN 50388: 2005.

DIN EN ISO 3166-1: 1998-04, Codes for the names of countries and their sub-units - Part 1: Codes for country names (ISO 3166-1: 1997); German version EN ISO 3166-1: 1997.

IEV part 811, International Electrotechnical Dictionary - Chapter 811: Electric Train Handling (IEC 60050-811).

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EUROPEAN STANDARD

EUROPEAN STANDARD

NORMS EUROPÉENNE

EN 50367

April 2006

ICS 29.280

German version

Railway applications - Interaction of the systems - Technical criteria for the interaction between pantograph and Overhead line for free access

Railway applications -
Current collection systems -
Technical criteria for the interaction between pantograph and overhead line (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)

This European Standard was approved by CENELEC on 2005-10-01. The CENELEC members are bound to comply with the CEN / CENELEC Internal Regulations, which stipulate the conditions under which this European Standard is to be given the status of a national standard without any change.

Up-to-date lists of these national standards with their bibliographical details are available on request from the Central Secretariat or from any CENELEC member.

This European Standard exists in three official versions (German, English, French). 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 Belgium, Denmark, Germany, Estonia, Finland, France, Greece, Ireland, Iceland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Austria, Poland, Portugal, Romania, Sweden, Switzerland, Slovakia, Slovenia, Spain, the Czech Republic, Hungary, the United Kingdom and Cyprus.

CENELEC
European Committee for Electrotechnical Standardization
Comité Européen de Normalization Electrotechnique

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Ref.No.EN 50367: 2006 D.

Preface

This European Standard was prepared by SC 9XC "Electrical supply and earthing systems for public transport facilities and auxiliary equipment (fixed installations)" of the 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 50367 on 2005-10-01.

The following dates have been specified:

- Latest date by which the EN must be adopted at national level through publication of an identical national standard or through recognition	(dop):	2006-11-01
- Latest date by which national standards that conflict with the EN must be withdrawn	(dow):	2008-10-01

This European Standard was drawn up under a mandate given to CENELEC by the European Commission and the European Free Trade Association. This European standard covers the basic requirements of an EC directive or of EC directives. See Appendix ZZ.

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1 Scope

The combination of different overhead lines and pantographs leads to differences in the quality of the interaction.

This European Standard defines the parameters of interoperability in relation to the interaction between pantograph and overhead contact line. The document specifies the interface requirements for the vehicles and the infrastructure for free access to the European rail network.

This document describes the parameters and values for all planned and all future routes.

In Appendix B. some essential parameters for existing routes are given. The route

categories according to Table 1 are applicable:

Table 1 - Route categories

Line speed v [km / h]	$v \leq 160$	$160 < v \leq 220$	$220 < v < 250$	$v \geq 250$
AC network category	AC 1	AC 2	AC 3	AC 4
Line speed v [km / h]	$v \leq 160$	$160 < v \leq 220$	$220 < v \leq 250$	-
Category for direct current network	DC 1	DC 2nd	DC 3	-

AC 1: conventional and connecting lines - alternating current

AC 2 and AC 3: upgraded routes around 200 km / h - alternating current

AC 4: high-speed routes - alternating current conventional and

DC 1: connecting routes - direct current upgraded routes around

DC 2: 200 km / h - direct current

DC 3: High-speed lines - direct current

The energy supply system is not described in this standard.

2 Normative references

The following referenced documents are required 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.

96/48 / EG, Council Directive 96/48 / EC of 23 July 1996 on the interoperability of the trans-European high-speed rail system (Official Journal No. L 235 of 17/09/1996 pp. 0006–0024).

01/16 / EG, Directive 01/16 / EC of the European Parliament and of the Council of March 19, 2001 on the interoperability of the conventional trans-European rail system (Official Journal No. L 110 of 20/04/2001 pp. 0001-0027).

EN 50119: 2001, Railway applications - Fixed systems - Overhead lines for electrical train operation.

EN 50149: 2001, Railway applications - Fixed installations - Electric train operation - Grooved contact wires made of copper and copper alloy.

EN 50163: 2004, Railway applications - supply voltages of railway networks.

EN 50206-1: 1998, Railway applications - Railway vehicles - Characteristics and tests of pantographs - Part 1: Pantographs for mainline vehicles.

EN 50317: 2002, Railway applications - Current collection systems - Requirements and validation of measurements of the dynamic interaction between pantograph and overhead line (+ A1: 2004).

EN 50318: 2002, Railway applications - current collection systems - validation of simulation systems for the dynamic interaction between pantograph and overhead line.

EN 50367: 2006

EN 50388: 2005, Railway applications - Railway energy supply and vehicles - Technical criteria for the coordination between railway energy supply systems and vehicles to achieve interoperability.

EN 50405 [1], Railway applications - Current collection systems - Current collectors for catenary vehicles - Test methods for carbon contact strips.

IEC 60050-811, International Electrotechnical Vocabulary - Chapter 811: Electric traction.

EN ISO 3166-1: 1997, Codes for the names of countries and their sub-units - Part 1: Codes for country names (ISO 3166-1: 1997).

UIC 505: 1997, Railway vehicles - vehicle boundary line.

UIC 506, Rules for using the GA, GB and GC extended gauges. UIC 608, Conditions for the

pantographs of the locomotives in international traffic.

3 terms

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

3.1
maximum current drawn
the highest value of the current drawn from an overhead line by a pantograph

3.2
Contact force
the vertical force that the pantograph exerts on the overhead contact line. The contact pressure is the sum of the forces at all contact points of a pantograph

3.3
static contact pressure
the mean vertical force that the pantograph head exerts upwards on the overhead line, caused by the pantograph lifting device, when the pantograph is raised and the vehicle is at a standstill

3.4
mean contact force
the statistical mean value of the contact force

3.5
maximum contact force
the maximum value of the contact force

3.6
minimal contact force
the minimum value of the contact force

3.7
Overhead line
overhead (or to the side) of the upper vehicle gauge, which supplies vehicles with electrical energy via a current pick-up device mounted on the roof

[IEC 60050-811-33-02]

3.8
Protection route
Section of a contact line that is provided with a separation point on both sides in order to avoid interconnection of two consecutive electrical sections with different voltage, phase position or frequency via the pantographs passing through

[IEC 60050-811-36-16]

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[1] To publish.

3.9
nominal voltage
Voltage with which a system or part of a system is identified

[EN 50163]

3.10
Contact wire height
the right-angled measured distance between the rail head touching and the underside of the contact wire

[EN 50119]

3.11
minimum contact wire height
Minimum value of the contact wire height that may occur in any case during the service life of the catenary

3.12
Nominal contact wire height
Nominal value of the contact wire height at the suspension point under normal conditions

[EN 50119]

3.13
maximum contact wire height
maximum value of the contact wire height that may occur in any case during the service life of the overhead contact line

3.14
automatic lowering device
a device that lowers the pantograph in the event of a fault or damage to the pantograph head

[EN 50206-1]

3.15
electric arc
the current flow through an air gap between the contact strip and contact wire, which can usually be recognized by strong light emission

[EN 50317]

3.16
Percentage of arcs described by the
following equation:

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

With

t_{arc} Duration of an arc that lasts for 5 ms;

t_{total} Measurement time with a current> 30% of the nominal current.

The result is to be given in% for a specific train speed. [EN 50317]

3.17
maximum width
the maximum distance, measured along the track axis, between the outer edges of the contact strips

3.18
dynamic boundary line
maximum envelope of the pantograph under all operating conditions

3.19
Inclination of the pantograph head
vertical distance between the highest point of the pantograph and the contact point

ANNOTATION Additional information can be found in UIC Leaflet 608.

4th Symbols and abbreviations

C.	Length of the overlap area Total length
D.	of the protection section Effective length
D '	of the protection section
d	Length of the insulator installed in the contact wire.
F_m	Average contact force
F_{Max}	Maximum contact force
F_{min}	Minimal contact force
GC	Gauging line C according to UIC leaflet 506
L.	Distance between pantographs closest to each other Distance between
L '	pantographs furthest apart
L "	Distance between 3 consecutive pantographs
l	Maximum width
NQ	Percentage of arcs
σ_{Max}	Maximum standard deviation of the contact force

5 geometry

The infrastructure manager must ensure that the geometric values of the overhead contact line specified in the Tables 2 and 3 are listed.

The pantographs of the trains must have the geometric parameters in Table 4 in accordance with the type of infrastructure on which they want to operate under the rules of free access.

5.1 Overhead line properties

For free access, the following essential parameters of the interaction between the overhead contact line and pantograph are required depending on the geometry of the overhead contact line (see EN 50119) to note:

- contact wire height;
- boundary line;
- permissible contact wire inclination;
- permissible lateral deflection of the contact wire in cross winds;
- Contact wire lift at the base;
- Protected route.

In accordance with Directive 96/48 / EC, the operation of vehicles on European high-speed lines is permitted which the boundary line "GC " comply with UIC leaflet 506. At line speed (AC 4), the contact wire height must not exceed a certain limit for aerodynamic reasons. Boundary lines greater thanGC (as with piggyback traffic) are therefore excluded. The limit value of the lift of the overhead line is given inEN 50119: 2001, 5.2.1.3 Are defined. The permissible contact wire inclination is also shown inEN 50119: 2001, 5.2.8.2 Are defined. The wind speed to be taken into account is defined by the infrastructure operator.

The functional requirements for protective routes are defined below:

- The trains must be able to move from one section to the next (which is supplied by a different phase or system) without bridging the protective section;

- The protective route is to be designed so that trains with several pantographs can pass through a maximum of 400 m with raised pantographs;
- the current consumption of the train must be zero when entering the protective route; see alsoEN 50388;
- the infrastructure manager must ensure that a train that has stopped in the protective route can start up again;
- If one of the above requirements cannot be met, trains with several pantographs must lower them over the entire length of the protective route. In order to guarantee the required safety and reliability, technical or operational measures must be taken.

With regard to the compatibility between protective sections and the pantograph arrangement, see 5.2 and A.1.

Table 2 - Overhead contact line properties for AC networks

category	AC 1	AC 2	AC 3	AC 4
Nominal contact wire height (m)	5.0 up to 5.75	5.0 up to 5.5		5.08 up to 5.3
Minimum contact wire height (m)	4.95	4.95		-
Maximum contact wire height (m)	6.2	6.0		-
Maximum lateral deflection of the contact wire from the track center axis in cross winds (m)	0.4[a]			0.4
[a] This value is valid for contact wire heights of up to 5.3 m and straight sections. This value must be used accordingly for heights greater than 5.3 m or track radiiA.3 be adjusted.				

Table 3 - Overhead contact line properties for direct current networks

category	DC 1	DC 2nd	DC 3
Nominal contact wire height (m)	5.0 up to 5.6	5.0 up to 5.5	5.0 up to 5.3
Minimum contact wire height (m)	4.9	4.9	4.9
Maximum contact wire height (m)	6.2	6.2	5.3
Maximum lateral deflection of the contact wire from the track center axis in cross winds (m)	0.4[a]		0.4
[a] This value is valid for contact wire heights of up to 5.3 m and straight sections. For heights greater than 5.3 m or a track radius, this value must be used accordinglyA.3 be adjusted.			

The overhead line must EN 50119 correspond.

5.2 Pantograph characteristics

The geometry of the pantograph is described by the following essential parameters with regard to the interaction of overhead contact line and pantograph:

- geometric profile of the pantograph head;
- range of working height;
- length of the contact strips;
- maximum width;
- Inclination of the pantograph head.

The functional requirements for uninterrupted power consumption are described in this section. These requirements relate to the geometric rocker profile of the pantograph and the dynamic vehicle behavior (e.g. dynamic boundary profile) and ensure that at least one contact wire is located within the contact area of the pantograph head (including all tolerances).

The permissible value for the inclination of the pantograph head is 60 mm.

The maximum lateral deflection of the European pantograph is shown in A.3 Are defined. Further properties related to the trains must be taken into account for the interaction:

- automatic lowering device;
- minimum and maximum distance between two raised pantographs;
- In AC systems, there must be no electrical connection between raised pantographs;

- Reduction times under normal conditions. From the moment of tripping, the pantograph must reach the minimum insulation distance in less than 3 s. The pantograph must be lowered to the lowering position in less than 10 s.

NOTE 1 The maximum width limit is important for the proper operation of section insulators. The limits for the distances between raised pantographs are important for the proper operation of the protective sections. Please referA.1.

NOTE 2 In direct current (DC) systems, if there is an electrical connection between raised pantographs, a device must be provided to interrupt this connection.

The design of the pantograph must be designed for an operating behavior in accordance with the Section 7 for the speed range and a contact wire height according to Tables 2 and 3 respectively. The maximum working height is 6.5 m.

The compatibility between the pantograph arrangement and the protective section is in A.1 described.

Table 4 - Pantograph characteristics for AC and DC systems

category	AC 1 to AC 4 and DC 1 to DC 3
Pantograph rocker profile[a]	A.2
Maximum width (m)[b]	0.65
Automatic lowering device	necessary
Minimum and maximum distance between two raised pantographs (m)	A.1
Inclination of the pantograph head (mm)	60
Maximum lateral shift of the European pantograph head	A.3

[a] Please refer Figures B.2 to B.8 for the national profiles on existing routes.

[b] Maximum width see A.1.

The pantograph must EN 50206-1 correspond.

6 material interfaces

The wear of the contact wire and the contact strips as well as the current permissible at the contact point depend largely on the materials of these two components. For satisfactory operating behavior, the contact wire and contact strips must be designed in accordance with 6.1 and 6.2.

6.1 Contact wire

The contact wire must meet the requirements of the EN 50149 meet and is in accordance with EN 50119 to use. The materials permitted for the contact wire are copper and copper alloys.

ANNOTATION If other materials are used, it must be demonstrated that the properties are equal to or better than the properties of the permitted materials.

6.2 Contact strips

Contact strips must meet the requirements EN 50206-1 fulfill. The type of contact strip used must comply with the following specifications:

- current carrying capacity;

- contact force;
- Contact material.

The contact strip material must be accepted by the infrastructure operator. The recommended material for contact strips is graphite carbon (hard carbon), if necessary impregnated with an additive.

If other materials are used, it must be demonstrated that their properties are the same as or better than the properties of the recommended material.

NOTE 1 Other common materials are:

- Copper steel, copper alloys, copper;
- copper clad carbon;
- sintered materials.

The operation of different contact strip materials in the infrastructure network (see Table C.1) must be agreed between the infrastructure manager and the transport company.

NOTE 2 If mixed contact strip materials are used in the railway network, the wear of the contact strips and / or contact wires can increase. Examination results seeTable C.2.

The contact strip material must comply with EN 50405. For

additional tests for DC systems, seeA.4.

7 Interaction overhead line - pantograph

Approval from the infrastructure manager is required for the quality of the interaction between pantograph and overhead line.

7.1 Current carrying capacity

The current in the overhead line depends on the speed, the weight of the train, the distance between the trains, the incline of the line and the type of overhead line. The properties of the pantograph and contact wire are to be selected so that no inadmissible heating occurs.

The maximum current is determined by:

- the number and materials of the contact wires;
- Number and materials of the contact strips;
- contact forces at the contact points;
- train speed;
- Environmental conditions.

The current consumption of the train must correspond to the operational limit values of the overhead contact line. Please referEN 50388, table 2.

The static contact force should be adjustable for safe current consumption when the vehicle is at a standstill.

There is a static contact force of 70 $^{+20}_{-10}$ N for AC systems and 90 N ± 20 N for 1.5 kV DC systems and 110 $^{+10}_{-20th}$ N to be used for 3 kV direct current systems at a standstill.

For some DC systems, it may be necessary to use a static contact force of around 140 N to improve the contact between the carbon contact strips and the contact wire, in order to prevent dangerous heating of the contact wire when the train is stationary and auxiliary services are running.

The maximum current at standstill is given in Table 5.

Table 5 - Maximum current at standstill

category	AC 1 to AC 4	DC 1 to DC 3 1.5 kV	DC 1 to DC 3 3 kV
Maximum current at standstill per pantograph (A)	80	300	200

7.2 Dynamic behavior

The safety and the efficiency of the train operation as well as the wear of contact strips and contact wire are influenced by the dynamic interaction between pantograph and overhead line.

The dynamic behavior depends on the pantograph and overhead contact line properties and on the operating conditions. The main operating conditions to be observed are train speed and the number, spacing and position of pantographs.

The permitted number of pantographs and their minimum distance is limited by the dynamic behavior of the pantograph and the overhead contact line.

The permissible limit value for the maximum lift of the side holder for the safe operation of the system in accordance with EN 50119, 5.2.1.2 must be observed.

Good dynamic behavior with minimal wear results from sufficient contact quality. The following parameters can be used for evaluation:

- F_m; σ;

- Percentage of arcs (NQ).

The infrastructure operator decides which measurement method is used. The requirements are met if the criteria F_m; σ or percentage of arcs and the lift at the support point are observed
are.

The values are accordingly EN 50317 to eat.

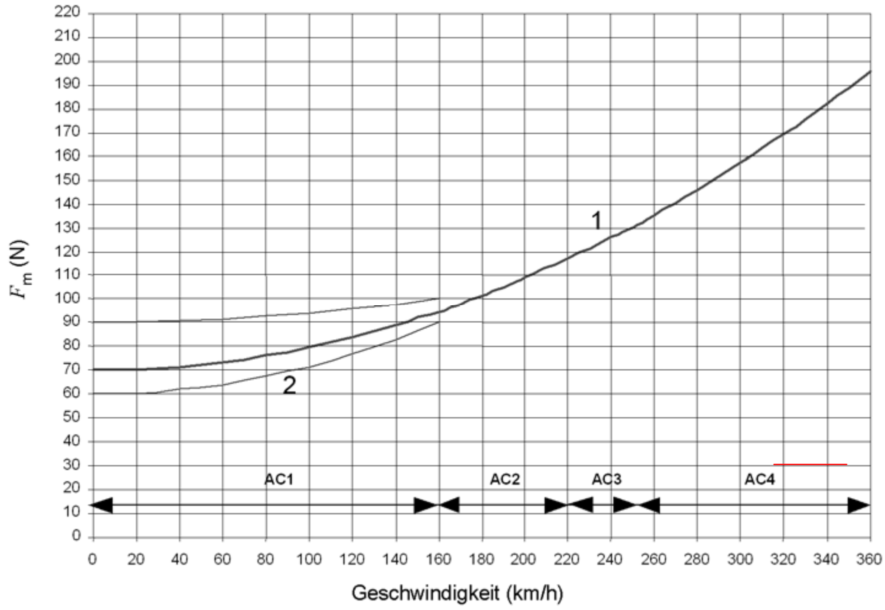
When testing the operating behavior with more than one pantograph, the pantograph with the most critical values must be taken into account. The pantograph with the most critical values can be determined by simulations EN 50318 or by measurements accordingly EN 50317 to be established.

Table 6 contains the values of the dynamic interaction. These values must be observed for all pantographs, even in the case of trains with several pantographs connected at the same time.

Table 6 - Values for the interaction between overhead contact line and pantograph

category	AC 1	AC 2	AC 3	AC 4	DC 1	DC 2nd	DC 3
F_m (N)	Curve (see Image 1)				Curve (see Picture 2)		
σ_{Max} (N) at maximum speed	0.3 F_m				0.3 F_m		
NQ (%) at maximum speed	0.1[a]	0.1[a]		0.2[a]	0.1	0.2	0.2
Minimum duration of the arcs to be taken into account (ms)	5	5		5	5	5	5
Space for the free and unhindered lifting of the contact wire	Please refer EN 50119, 5.2.1.3						
If simulations are used, they must be checked EN 50318 be validated.							
[a] If, in the event of a pantograph malfunction, another pantograph is used and the driving speed must be maintained, the value for NQ (%) ≤ Be 0.5. If it is not necessary to maintain the normal operating speed, the new operating speed must be selected so that the normal values for NQ are complied with.							

Picture 1 and picture 2 show the curves $F_m = f(v)$ for AC and DC systems.



$F_m = 970 \times 10^{-6} \times V^2 + 70$ [N]

Legend

1 Target curve

2 Tolerance range

Figure 1 - Target value of the mean contact force F_m for AC systems depending on the speed

F_m represents a target value that is to be achieved in order, on the one hand, to consume power without excessive
To secure arcs, which on the other hand should not be exceeded in order to limit wear and tear and damage to the contact strips.

F_m each pantograph must correspond to or be less than the value given in the curve.

It must be taken into account that the criteria of the quality of the current consumption must be met for every pantograph.

F_m for the existing routes, in Table B.5, Figure B.1a and Image B.1b cited.

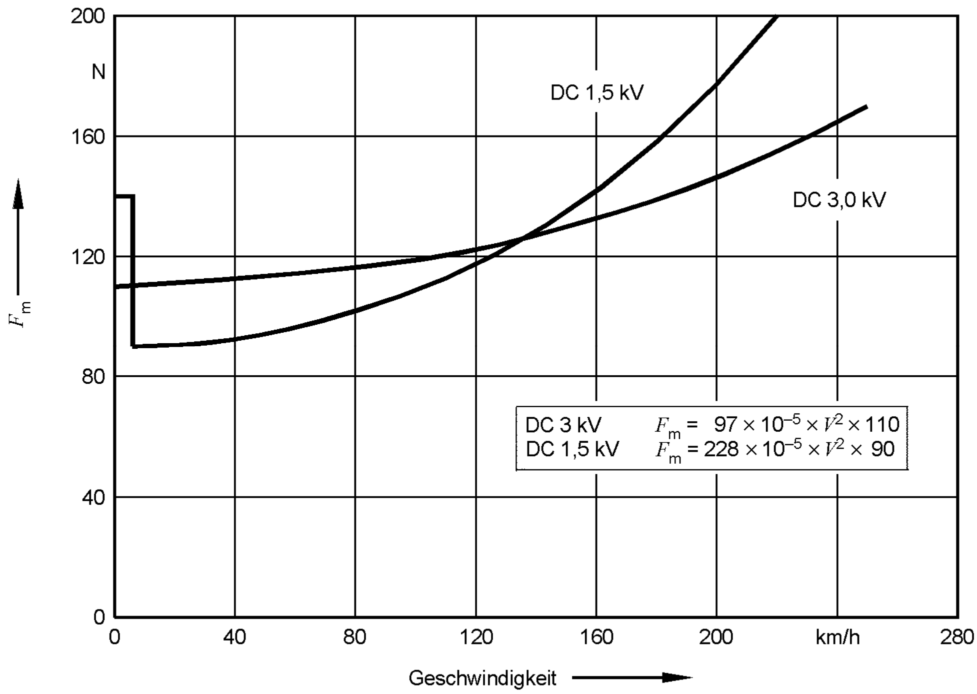


Figure 2 - Goal of the mean contact force for F.m for DC 1.5 kV and DC 3.0 kV lines depending on the speed

F.m represents a target value that is to be achieved in order, on the one hand, to consume power without excessive

To secure arcs, which on the other hand should not be exceeded in order to limit wear and tear and damage to the contact strips.

F.m each pantograph must be equal to or below the value given by the curve.

It must be taken into account that the criteria of the quality of the current consumption must be met for every pantograph.

F.m for direct current systems for the existing lines is in Table B.6 cited.

Appendix A.
(normative)

Special requirements

A.1 Protected routes

A.1.1 General

The following arrangements (Figs. A.2 to A.5) must be used and ensure interoperability between pantographs and protective sections.

The following symbols are used, which are shown in Figures A.1 and A.4 are shown.

C.	Length of the overlap area Total length of the
D.	protective section Effective length of the protective
D '	section Length of the insulator installed in the
d	contact wire
L.	Distance between the pantographs closest to each other
L '	Distance between the most widely spaced pantographs
L ”	Distance between 3 consecutive pantographs Maximum
l	width

Isolation distance and vehicle tolerances must be taken into account.

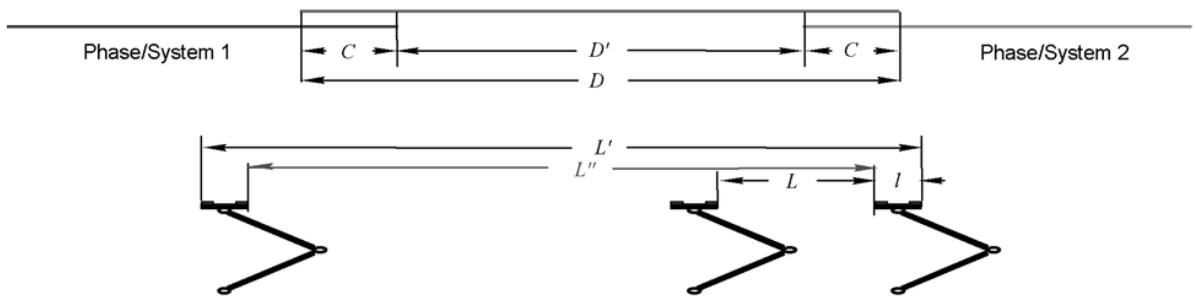
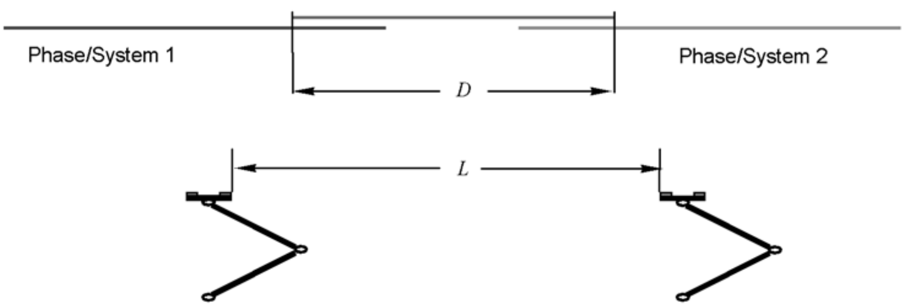


Figure A.1 - Explanation of symbols

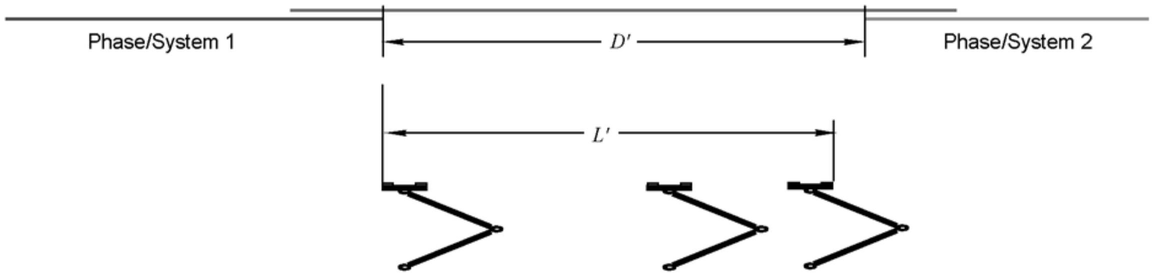
A.1.2 Short protection route



Condition: L> D

Figure A.2 - Short protective section

A.1.3 Long protection route



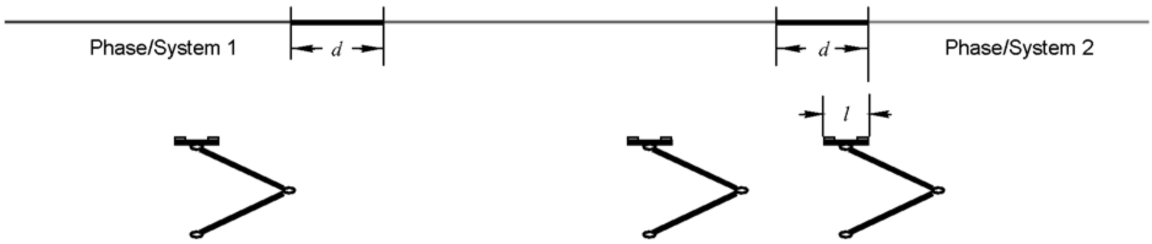
Conditions: L '< 400 m

D '> 402 m

Figure A.3 - Long protective section

ANNOTATION With an arrangement according to Figure A.3, the protective distance is longer than the distance between the am farthest apart, raised pantographs on an interoperable train which is 400 m.

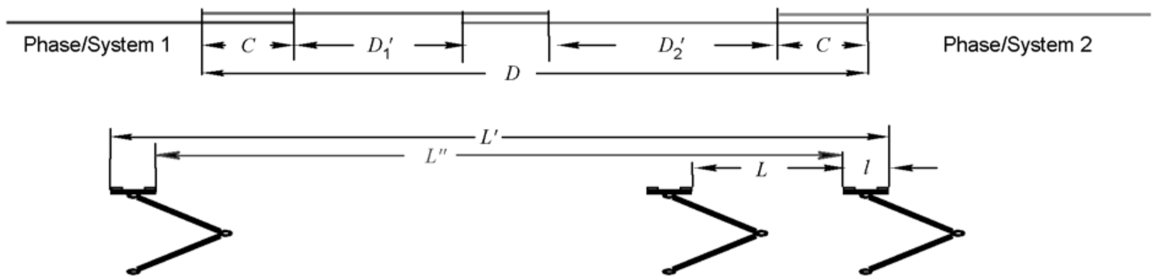
A.1.4 Protected section with passable insulators (section separators)



Condition: d> l

Figure A.4 - Protected section with traversable insulators (section isolators)

A.1.5 Subdivided protective section



Conditions:	L '	> D + 2 l-	D < 142 m
	L + 2-l-	< D '1	L ”> 143 m
	L + 2-l-	< D '2	

Figure A.5 - Subdivided protective section

ANNOTATION With an arrangement according to Figure A.5, the entire length of the protective section (D) shorter than that Distance between three consecutive pantographs that is greater than 143 m (L ”) is.

A.1.6 Pantograph arrangements on trains

The maximum distance between the pantographs is 400 m, which corresponds to the maximum train length, in order to drive on the various protective routes. In addition, the distance between three consecutive pantographs must be more than 143 m. The pantograph in the middle can be arranged in any way. The infrastructure manager must determine the maximum operating speed depending on the minimum distance between two pantographs. There must be no electrical connection between raised pantographs.Fig. A.6 shows the pantograph arrangement.

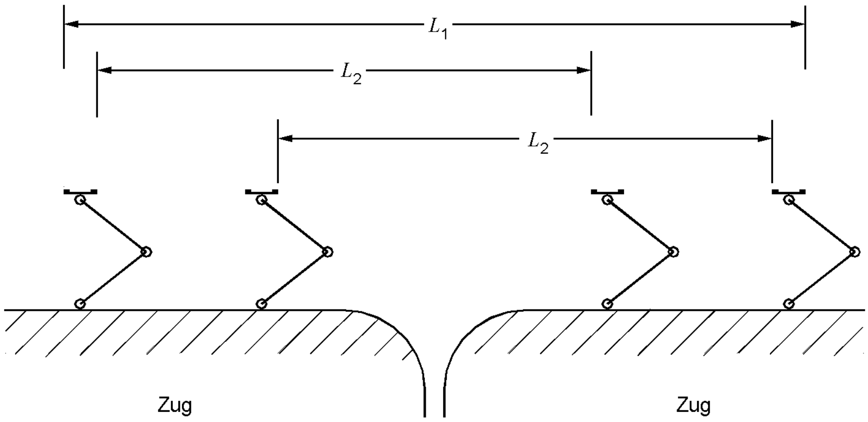


Figure A.6 - Pantograph arrangement

Figure A.6 shows the pantograph arrangement on trains, which with the arrangements according to the Figures A.3 and A.5 is compatible.

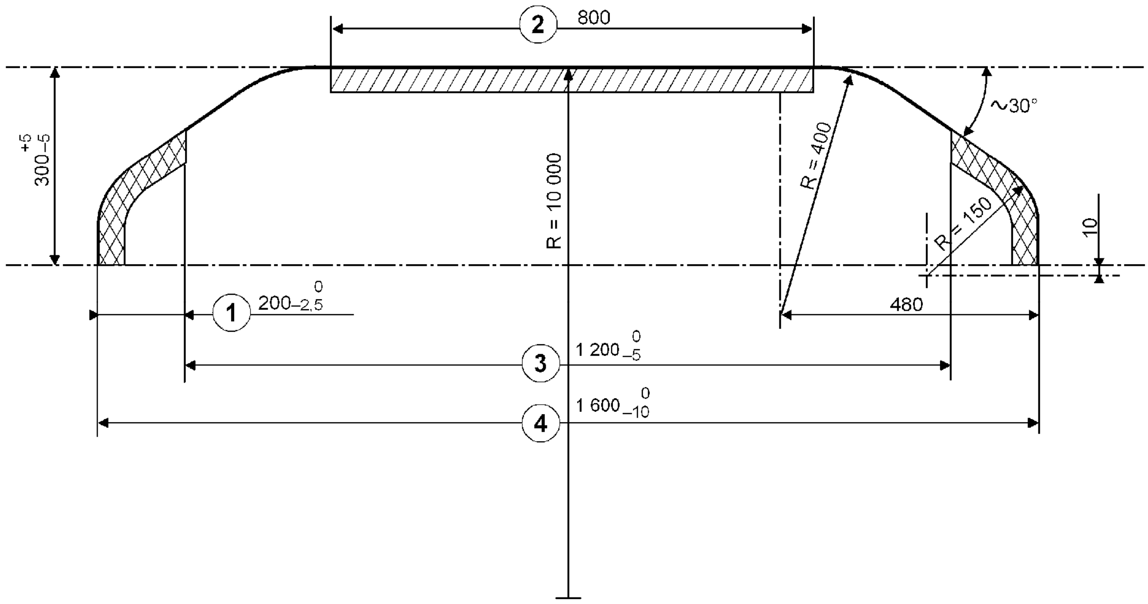
For solutions according to the Figures A.2 and A.4 the pantograph arrangement must be coordinated with the infrastructure operator.

Conditions: L '= L_1 <400 m

L "= L_2 > 143 m

A.2 Standard profile of the European pantograph head

Dimensions in millimeters



- Horn made of insulating material (projected length 200 mm)
- Minimum length of the contact strips
- Working area of the pantograph head

Width of the pantograph head

Figure A.7 - Standard profile of the European pantograph head

A.3 Dynamic limiting profile for the use of the European pantograph head

Figure A.8 shows the dimensions of the boundary line for the use of the Euro pantograph on interoperable routes. In addition to this boundary line, the space for the installation of the overhead line itself and the associated safety clearances must be taken into account for the infrastructure. The space depends on the design of the individual overhead lines and the associated electrical voltage.

In Figure A.8 the width refers L.1 to a contact wire height of 5.0 m, while L.2 of that for the individual Route depends on the contact wire height to be used. The valueS. corresponds to the space for the free and unhindered lifting of the contact wire Table 6.

The value L.2 can be obtained according to UIC leaflet No. 505, 1997 edition with:

$$L_2 = 0.74 \text{ m} + 0.04 \times H + 0.15 \times H \times C - 0.075 \times C + 2.5 / R,$$

where the largest track width is assumed to be 1.45 m. The superelevationC, the radius R. and the height H are measured in meters.

Dimensions in millimeters

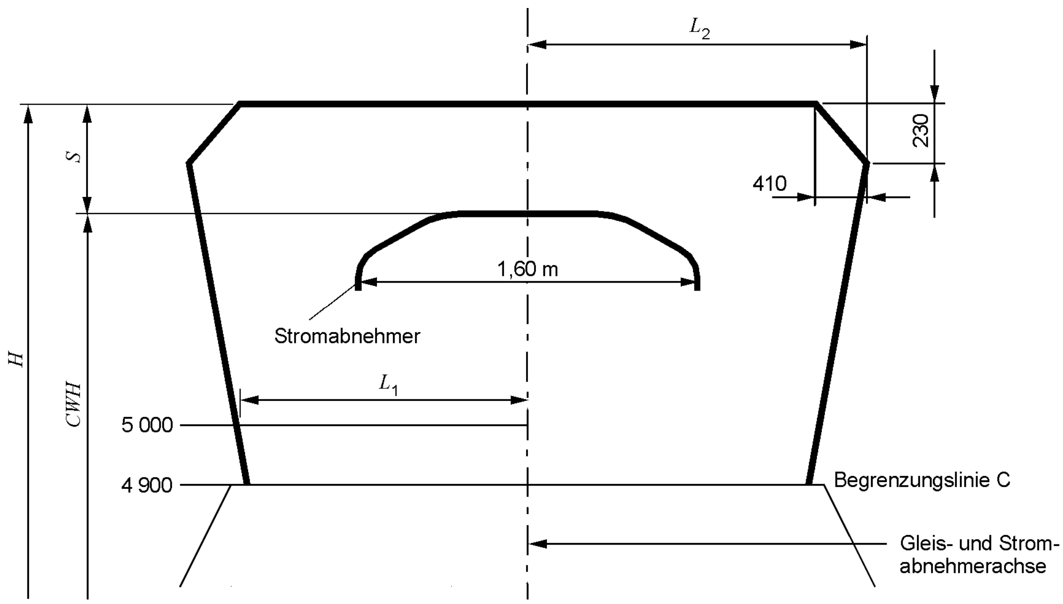


Figure A.8 - Kinematic delimitation for the use of the European pantograph head on interoperable routes

Table A.1 shows examples of the relationships between the track radius, cant and dimensions L.1 and L.2 for high-speed lines with a track radius of more than 3,000 m
H is the sum of the contact wire height CWH and the default S. for the lift.

Table A.1 - Dimensions for the boundary line for using the pantograph on High-speed lines (examples, track radius more than 3,000 m)

Cant C. m	broad L.1 at a height of 5.00 m m	broad L.2 (see figure A.8) m
0.0	0.94	0.74 + 0.04 × H
0.066	0.99	0.74 + 0.05 × H
0.180	1.06	0.73 + 0.07 × H

A.4 Additional tests for direct current systems

A.4.1 Electricity at standstill

In the case of direct current systems, the heating of the contact wire due to the current when the vehicle is stationary must be checked if requested by the infrastructure operator.

NOTE 1 Testing of AC systems is not necessary as the current is lower when the vehicle is stationary.

NOTE 2 This applies particularly to the power consumption of the train's auxiliaries.

A.4.1.1 Test conditions

The test is to be carried out with a pantograph equipped with a specified rocker.

The contact surfaces of the two contact strips on the contact wire must be in one plane. The contact strips must be run in for this purpose.

The pantograph must be mounted on a traction vehicle or a confirmed test setup.

The test must be carried out in a protected environment (in a closed workshop) so that the influence of air currents is avoided.

The tests are to be carried out with one or two contact wires, which are to be equipped with temperature sensors. The temperature sensors are to be placed as close as possible to the contact surface.

A.4.1.2 Test procedure

The test is carried out with static contact force according to the specification in 7.1 perform.

The current transmitted by the pantograph must be representative of the maximum current consumption of the vehicle, taking into account the in Table 5 listed limit values.

Each exam must last 30 minutes. If the maximum permissible value for the temperature of the contact wires (this value must be determined by the infrastructure manager) is reached at one of the temperature sensors, the test must be ended.

Current strength and temperature must be recorded continuously.

The test result is satisfactory if the maximum temperature of the contact wires after 30 minutes does not exceed the value specified by the infrastructure manager.

A.4.2 Electricity while driving

If required, the wear of the contact strips must be checked by the current while driving.

A.4.2.1 Test conditions

The pantograph must be mounted on a traction vehicle with a capacity that allows it to absorb the maximum current.

The pantograph equipped with the test contact strips must be set during the test drives and before the measurements in such a way that the most unfavorable current transmission conditions exist.

A.4.2.2 Test procedure

The locomotive must pull a train with the maximum permissible mass at a speed at which the maximum current is reached.

In each configuration, the maximum current intensity must be transmitted for 30 minutes.

In order for the values to be representative of the running behavior of the contact strips, 10 measurement runs must be carried out in each configuration.

It is recommended to always replace the contact strips after a cycle of 10 runs.

After each cycle, the condition of the contact strips must be checked and the extent of wear determined (mm per 1,000 km) in order to be able to evaluate their wear behavior during driving.

The test result is satisfactory if no damage is found that has an impact on the wear behavior of the contact strips during operation, and if the wear corresponds to the mileage stated by the train operator.

Appendix B.
(normative)

Special national conditions

Special national condition: National characteristic or practice that cannot be changed even after a long period of time, e.g. B. climatic conditions, electrical grounding conditions.

ANNOTATION If it affects the harmonization, it is part of the European standard.

For countries to which the relevant special national conditions apply, these are normative; for the other countries this information is of an informative nature.

B.1 National characteristics

The ones in the Tables B.5 and B.6 specified values of the contact forces are based on national measuring systems.

Table B.1 - Overhead contact line properties for AC systems

	AT	CH	DE	DK	Euro-tunnel	FI	FR	GB	NL	NO	SE	SK
Nominal contact wire height (m)	5.3 5.5 5.75	5.3	5.5	5.5	5.93	6.15	5.5	4.7	5.5	5.6	5.5	5.5
Max. Contact wire height (m)	6.2	6.0	6.5	6.0	6.2	6.5	6.2	5.94	5.7	6.0	6.1	6.3
Min. Contact wire height (m)	4.85	4.8	4.95	4.91	5.93	5.6	4.59	4.14[a]	5.2	4.80	4.8	5.0
Maximum lateral deflection of the contact wire from the track center axis with maximum cross wind (m)	0.55	0.4	0.55	0.385	0.4	0.46	0.4	0.56	0.4	0.55	0.55	0.5

[a] Can be reduced to 3.925 m for special routes.

Table B.2 - Overhead line properties for DC systems

	BE	IT	FR	IT	NL	PL	SI	SK
Nominal contact wire height (m)	5.3	5.5	5.5	5.0	5.5	5.6	5.35	5.5
Max. Contact wire height (m)	6.0	6.2	6.3	6.2	5.75	6.2	6.2	6.3
Min. Contact wire height (m)	4.8	4.6	4.47	4.51	4.8	4.9	4.95	4.95
Maximum lateral deflection of the contact wire with maximum cross wind (m)	0.4	0.4	0.4	0.4	0.53	0.5	0.35	0.55

Table B.3 - Vehicle characteristics for AC systems

	AT	CH	DE	DK	FI	FR	GB	NO	SE	SK
Geometric profile of the pantograph	please refer Fig. B.3	please refer Fig. B.4	please refer Fig. B.3	please refer Fig. B.3	please refer Fig. B.3	please refer photos B.2, B.4	please refer photos B.4a, B.7	please refer Fig. B.6	please refer Fig. B.6	variable
Horizontal working area for normal operation (m)	4.7 - 6.5	4.6 - 6.5	4.8-6.3	4.9-6.1	4.8 - 7.0	4.5 - 6.50	4.14 - 6.2 3.925 (redu- adorns)	4.6-6.2	4.8-6.1	4.8 - 6.3
Horizontal working area for low speed (m)	4.7 - 6.5	4.6 - 6.5	4.7 - 6.5	4.7 - 6.5	4.8 - 7.0	4.6 - 6.50	4.14 - 6.2 3.925 (redu- adorns)	4.6-6.2	4.8-6.1	4.8 - 6.3
Length of contact strips (m)	1.03	0.696	1.03	1.03	≥ 1.1	various the	various the	1.03	1.0	1.2
Maximum width (m)	0.65	0.6	0.62	0.6	≤ 0.415	0.6	0.46a	0.65	0.65	0.6
Min. Value $F_{stat.}$ (N)	65	65	60	70	60	70	70	55	50	65
Automatic lowering device	emergency agile	emergency agile	emergency agile	emergency agile	emergency agile	-	emergency agile	-	emergency agile	-
Number of power outlets in operation taker per train	1, 2, 3	1, 2, 3, 4	1, 2, 3, 4	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4	1, 2, 3	1, 2.3	1, 2, 3, 4, 5	1, 2, 3, 4th
Min. And max. Distance between two operating current outlets takers (m)			20 < L < 35b			7-354			20 < L. < 30th	
	b L> 7th	L> 7th	L> 85	L> 18th	19 < L < 200		L> 10	L> 20th	L> 40	L> 8th

NOTE On some existing French high-speed lines, a device to limit the working height (device that prevents the pantograph from exceeding the allowable lift of the contact wire) may be required.

a Only for the rail connection through the Channel Tunnel (channel tunnel rail link (CTRL)).

b Trains with a distance between two adjacent pantographs less than 20 m are accepted by the infrastructure operator if the limit values for the contact wire lift and the contact forces are observed.

Table B.4 - Vehicle characteristics for DC systems

	BE	IT	FR	IT	NL	PL	SI	SK
Geometric profile of the pantograph	please refer photos B.3, B.6	please refer photos B.3, B.6	please refer Pictures B.3, B.4, B.5	please refer Fig. B.2	please refer Fig. B.3	please refer Fig. B.8	please refer Fig. B.2	variable
Horizontal working area for normal operation (m)	4.6 - 6.5	4.6 - 6.5	4.5 - 6.5	4.51-6.2	4.8-5.75	4.8-6.2	4.9 - 6	4.8-5.6
Horizontal working area for low speed (m)					4.8-5.75			4.8-5.6
Length of contact strips (m)	0.7	0.95	variable	1.07 - 1.27	≥ 0.8	1.1	0.8-0.9	1.2
Maximum width (m)	0.6	0.6	0.6	0.56	0.64	0.6	0.42	0.6
Min. Value $F_{stat.}$ (N)	90	90	90	90	[a]	70	70	65
Automatic lowering device	emergency agile	emergency agile	necessary	necessary	wish-worth	wish worth	wish worth	-
Number of pantographs in operation per train	1, 2, 3, 4	1, 2, 3	1, 2, 3, 4	1, 2	1, 2, 3, 4, 5	1, 2	1, 2	1, 2, 3, 4
Min. And max. Distance between two pantographs in operation (m)	10 - 365	6-200	6 - 354	9 < L < 295	8 < L.	7-200	8 < L.	L> 8th

[a] For some existing lines in the Netherlands, a device to limit the maximum lift height is required. The maximum height of lift is 5.86 m and the maximum temperature of the contact point at a standstill is 150 ° C.

Table B.5 - Interaction properties for AC systems

	AT	CH	DE	DK	SE	FI	FR		GB		NO, NL
v (km / h)	≤ 200	≤ 200	≤ 200	< 200	< 250	≤ 200	≤ 160	160 < v ≤ 200	≤ 160	160 < v ≤ 200	<200
F_m (N)	≤ 120	< 120 please refer Image B.1b	please refer image B.1b	< 120	< 110	< 120	< 120	< 150 v > 250 km / h please refer Fig. B.1a	< 120	< 120	< 100
F_{Max} (N)	200	230 250[b]	200	< 200	200	200	200	250	250[a]	250[a]	200
F_{min} (N)	40	> 10 > 0[b]	40[c]	> 0	0	> 0	20th	20th	> 0	> 0	10
σ (N)	24	36	24	24	-	-	-	-	-	-	-
NQ (%)	-	-	-	-	-	-	0.1 (5 ms)	0.1 (5 ms)	-	-	-
Max. low lift of the contact wire tes on the support point (mm)	120	EN 50119, 5.2.1.3	120	150	120	120	80	120	80	125	120

[a] Open route.
[b] Two pantographs and a short distance (~ 36 m). Values
[c] without acceleration correction.

Table B.6 - Interaction properties for DC systems

	BE	IT	FR		IT	NL	PL	SI
v (km / h)	< 160	≤ 220	< 160	160 < v ≤ 200	< 160	≤ 250	≤ 250	≤ 160
F_m (N)	170	170	< 160	< 220	170	170	170	85
F.Max (N)	300	300	300	350	300	300	300	100
F.min (N)	40	40	20th	20th	40	40	40	70
σ (N)	43	43	-	-	43	43	43	28
NQ (%)	-	-	0.1 (5 ms)	0.1 (5 ms)	-	-	-	
Max.permissible lift of the contact wire at the support point (mm)	100	100	80	80	120	100	100	100

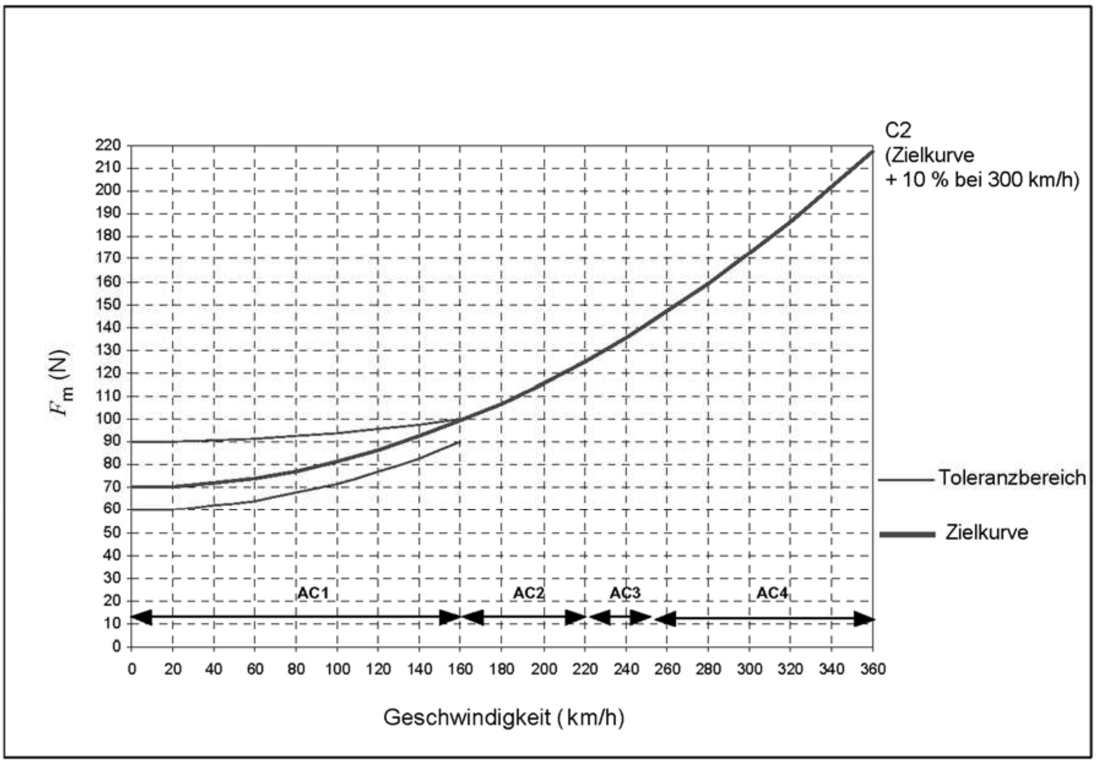


Figure B.1a - Average contact force F.m (+ 10%) depending on the speed for FR

(please refer Table B.5)

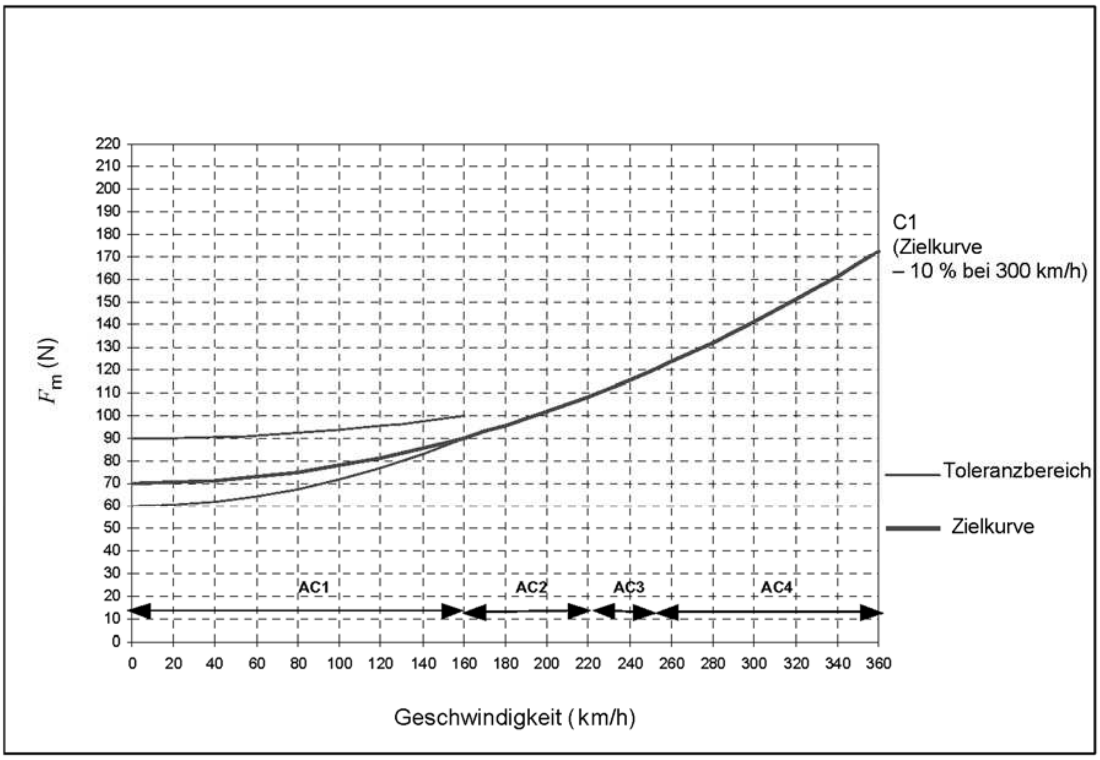


Figure B.1b - Average contact force F.m (- 10%) depending on the speed for CH, DE

(please refer Table B.5)

B.2 Basic properties of pantograph heads

All dimensions in millimeters

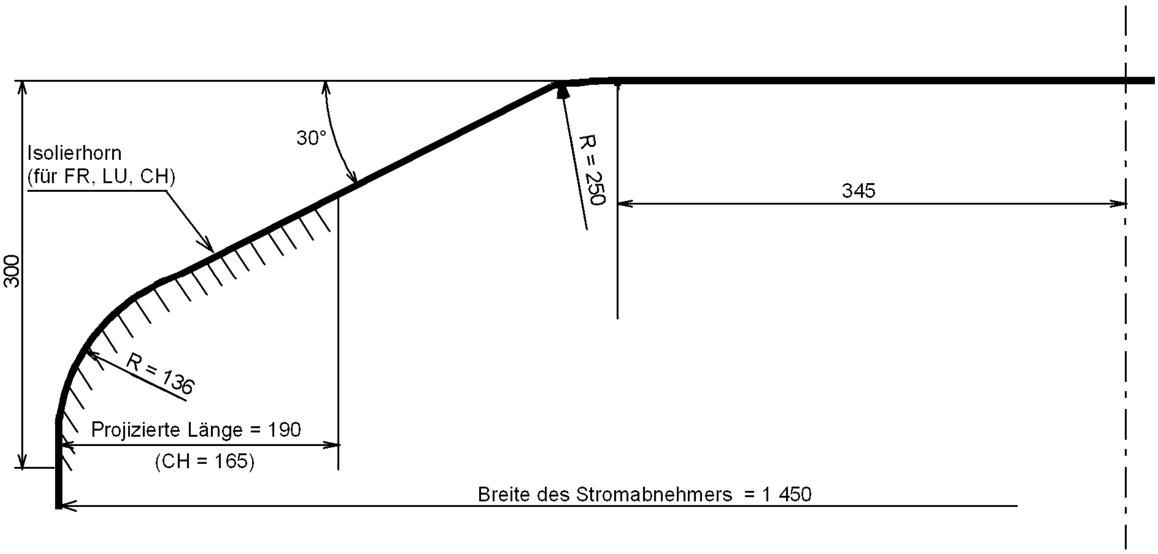


Figure B.2 - Pantograph with a width of 1 450 mm

All dimensions in millimeters

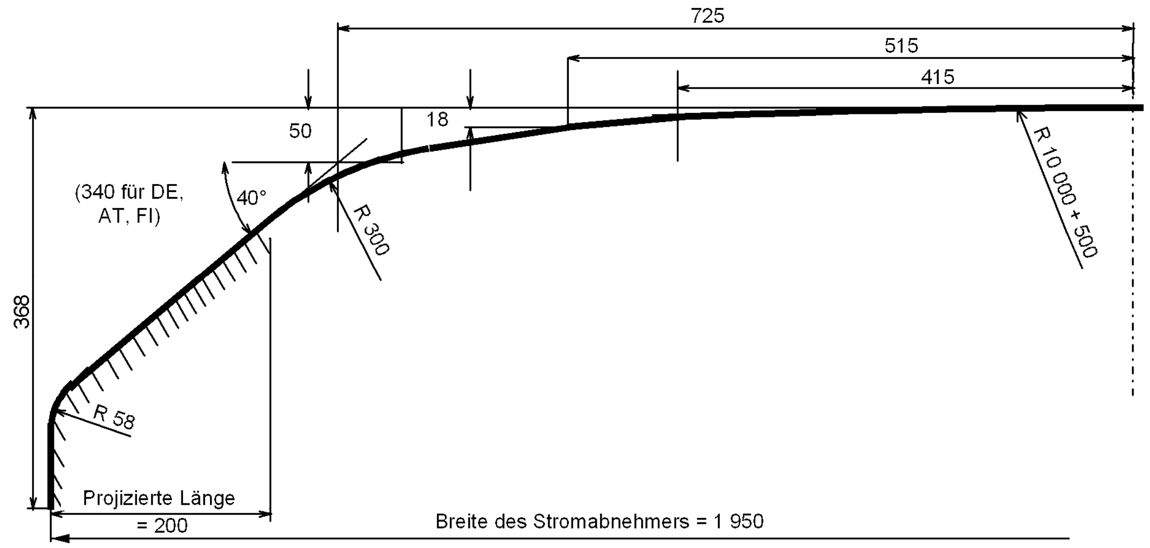


Figure B.3 - Current collector with a width of 1,950 mm (type 1)

All dimensions in millimeters

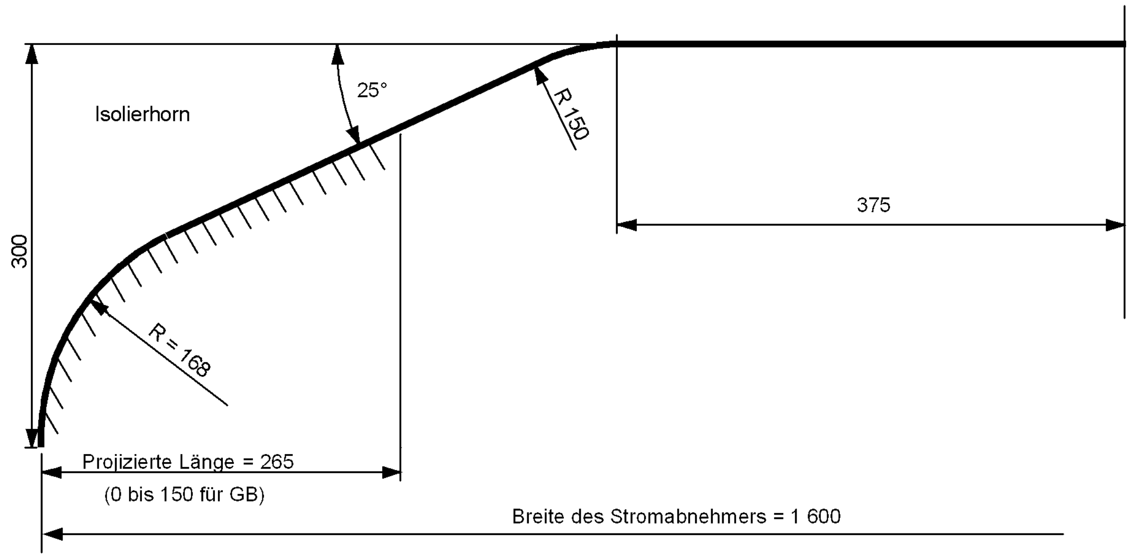
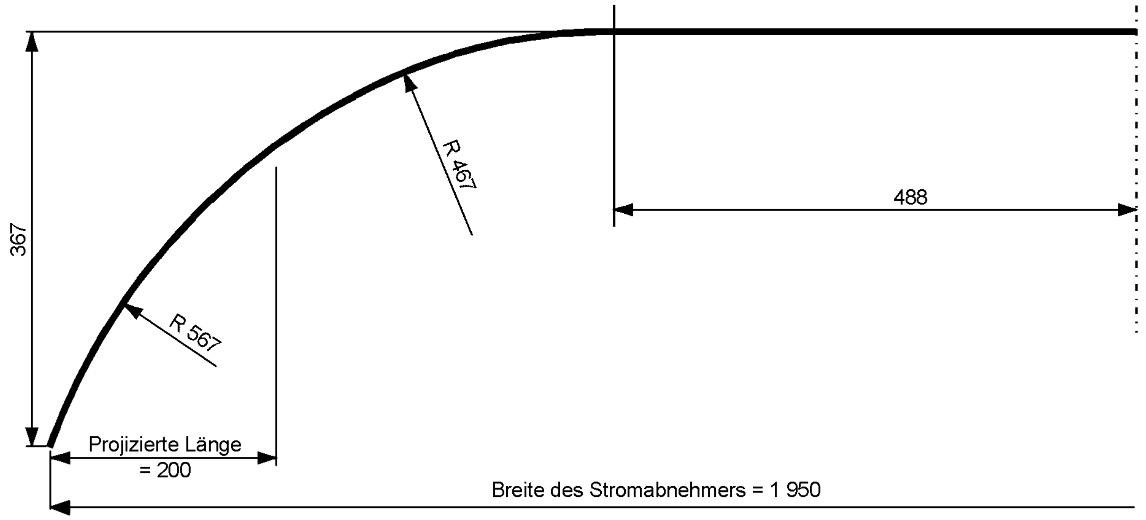


Figure B.4 - Current collector with a width of 1,600 mm (GB, CTRL)

All dimensions in millimeters



All dimensions in millimeters

Figure B.5 - Current collector with a width of 1,950 mm (type 2)

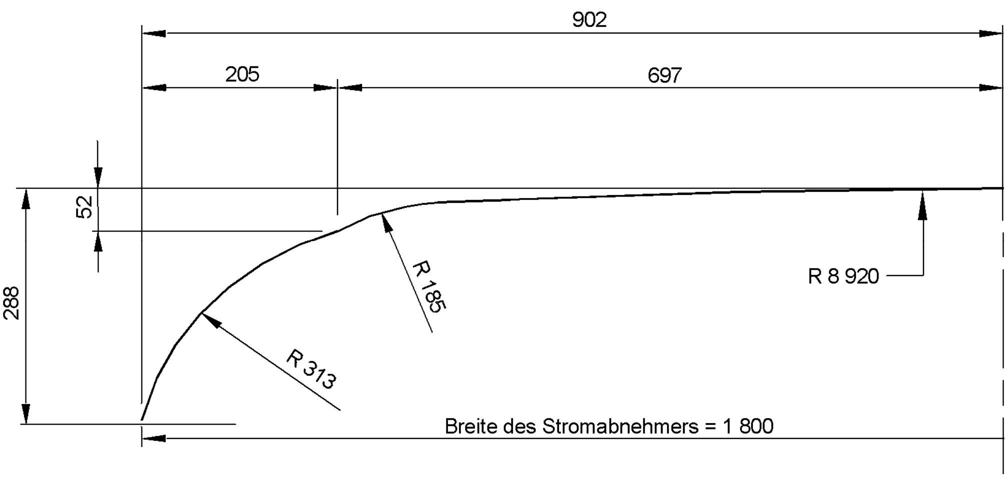


Figure B.6 - Pantograph with a width of 1,800 mm (NO, SE)

All dimensions in millimeters. Not to scale.

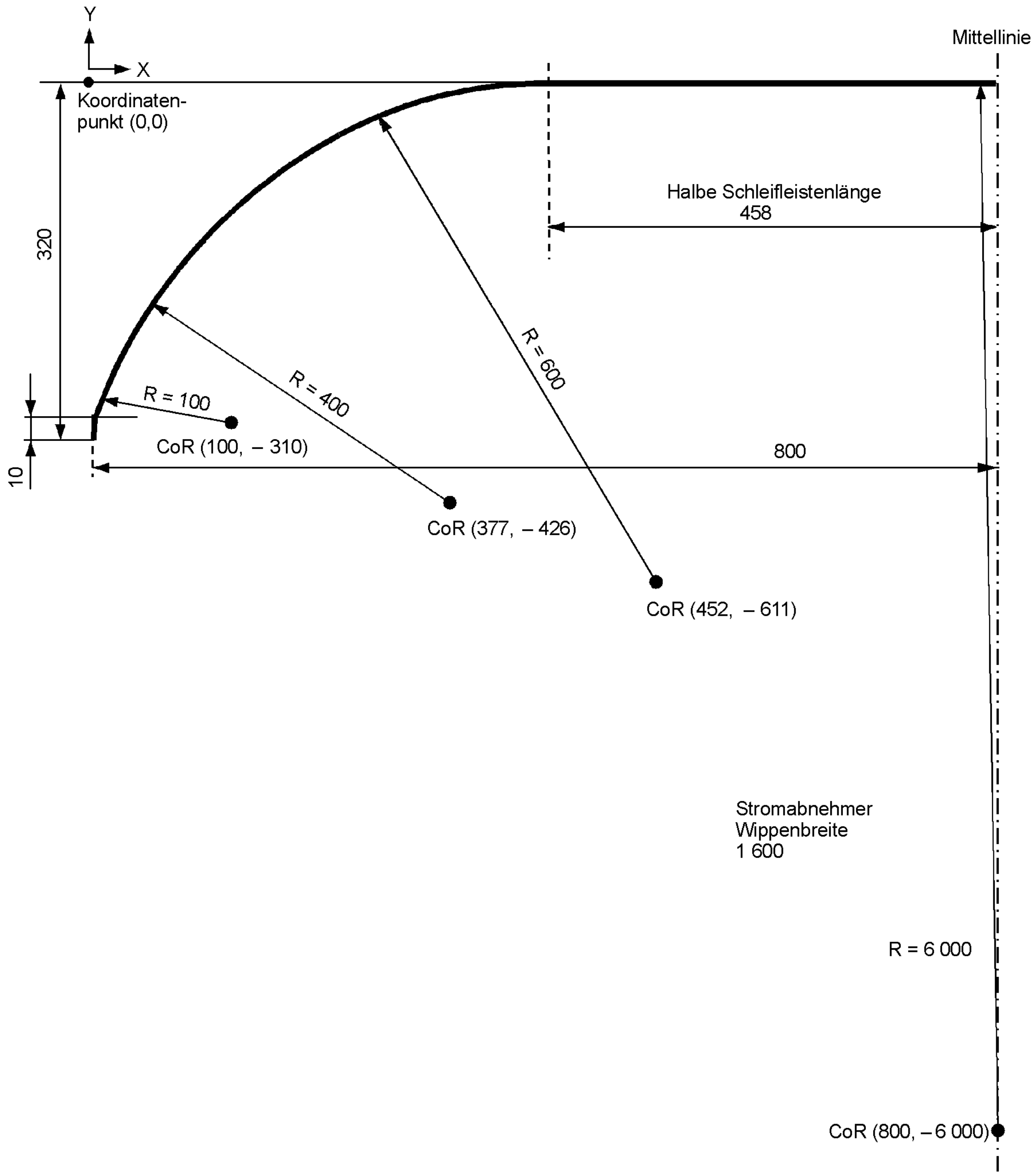


Figure B.7 - Current collector with a width of 1,600 mm (type GB)

NOTE 1 This type of pantograph does not have insulated horns.

NOTE 2 Maximum usable length of the contact strip 915 mm.

NOTE 3 Overview of manufacture see details in relevant national standards.

All dimensions in millimeters

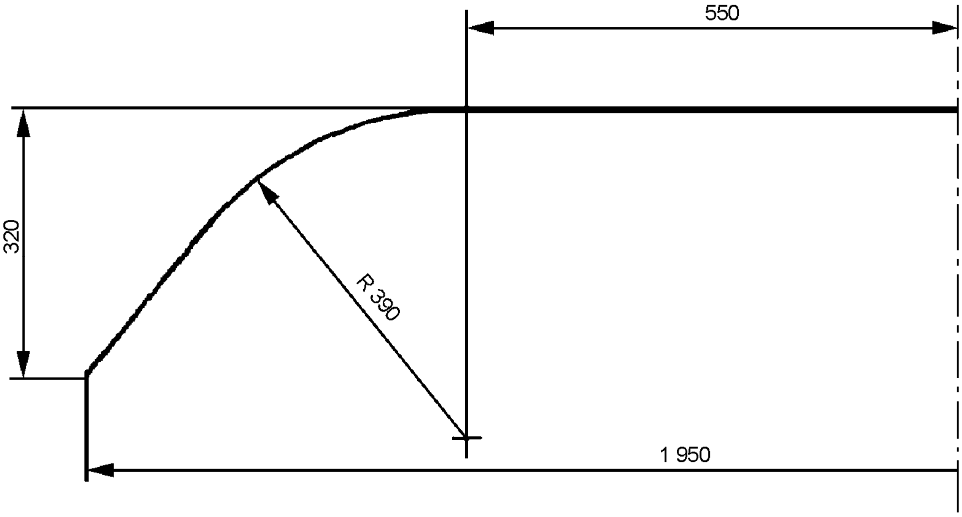


Figure B.8 - Current collector with a width of 1,950 mm (PL)

Appendix C.
(informative)

Contact strip materials

Table C.1 - Commonly used contact strip materials

Contact strip	Alternating current							Direct current							
	AT / DE / DK / FI / NO / SE	CH	IT	FR	GB	NL	SK	BE	IT	FR	IT	NL	SI	SK	PL
money	X	X	X	X		X	X	X		X	X	X		X	X
Copper alloy - Copper steel									X	X	X		b		
Copper-clad charcoal		X						X		X	X		a		
Copper or Copper alloy									X		X		X		X
metallized coal			X	X	X	X		X		X		X	a		
sintered copper							X			X	X		b	X	

a In examination.

b Depending on the results of the exam.

Table C.2 - Results of an investigation into the use of alternative materials[1]

		Usually used contact strip material			
		money	Metallized money	Copper steel	Copper-clad charcoal
Alternative grinding piece material	money			wear and tear 0.2 mm / 1,000 km, only recommended for small ones Currents	applicable
	Metallized money	Wear and tear: normal: < 0.2 mm / 1,000 km alternatively: 0.13 mm / 1,000 km Roughness of the contact wire ~ no change		with high currents: wear and tear 0.5 mm / 1,000 km, no to recommend	Wear and tear: normal: < 0.07 mm / 1,000 km alternatively: 0.05 mm / 1,000 km Roughness of the contact wire ~ no change
	Copper steel	Wear and tear: normal: < 0.3 mm / 1,000 km alternatively: 0.03 mm / 1,000 km roughness of the contact wire ~ no change			Wear and roughness of the Contact wire acceptable if contact strips <10% of the total number of contact strips used
	Copper-clad money	applicable			

[1] Extract from ERRI A 186

Appendix ZZ
(informative)

Relation to the basic requirements of EC directives

This European Standard was drawn up under a mandate given to CENELEC by the European Commission and the European Free Trade Association. Within its scope, this European Standard covers all relevant basic requirements that are contained in Annex III of EC Directive 96/48 / EC.

Conformity with this standard is one way of declaring conformity with the specified basic requirements of the relevant EC directive (s).

WARNING: For products that fall within the scope of this standard, further requirements and further EC directives may apply.

Bibliography

1692/96 / EG, Decision No. 1692/96 / EC of the European Parliament and of the Council of 23 July 1996 on Community guidelines for the development of a trans-European transport network
(Official Gazette No. L 228 of 09/09/1996 pp. 0001-0104).

ERRI A 186, Reports on the interaction between pantograph and overhead contact line.