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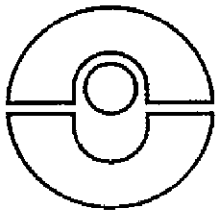
Pantograph - Overhead line interaction on the European high-speed network



International Union of Railways

Leaflet to be classified in volumes :

V - Transport Stock
VII - Ways and Works

Amendments

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Preliminary remarks :

A double vertical line (||) in the margin denotes amendments introduced on the date shown at the foot of the page.

Enforcement of this leaflet is governed by the provisions listed under "Application" at the end of the document.

Note

This leaflet forms part of a set which also includes :

- Leaflet 505-1 : Railway transport stock - Rolling stock construction gauge
- Leaflet 600 : Electric traction with aerial contact line
- Leaflet 606-1 : Consequences of the application of kinematic gauges defined by UIC leaflets in the 505 series on the design of the contact lines
- Leaflet 606-2 : Installation of 25 kv and 50 or 60 Hz overhead contact lines
- Leaflet 608 : Conditions to be complied with for the pantographs for tractive units used on international services
- Leaflet 870 : Technical specification for grooved contact wires

Contents

1 - Introduction

The aim of this leaflet is to ensure proper working between different pantograph and overhead line designs on the European high speed network defined by the European Union, whilst taking account of the need for for reliability and cost effectiveness.

This high-speed network comprises lines designed for minimum speeds of 250 km/h, upgraded lines designed for speeds of up to 200 km/h and other lines forming part of the European rail network. Future high-speed lines are to be installed using alternating current (AC) systems.

This leaflet sets out requirements and recommendations for pantographs and overhead lines for speeds of over 100 km/h, taking account of the present situation on the Railways. The pantograph design incorporates standard-bow geometry for operation on AC rail networks. A second pantograph may be designed or introduced to cater for the needs of regional rail networks. These parameters shall only relate to AC rail systems.

The specifications contained in the leaflet are mandatory for the design of pantograph and overhead-system components and then shall apply to the design and building of new installations on the European high speed network. For existing lines, which are a constituent part of this high-speed rail network, every effort should be made to meet these same requirements.

The recommendations contained in the leaflet constitute current state-of-the-art technology and reflect the experience gained by different Railways operating high-speed trains.

2 - Arrangements

The following UIC leaflets contain specifications for pantograph/overhead-line system components :

2.1 - Gauge - UIC 505/606-1

2.2 - Overhead equipment - UIC 870/606-1

Contact wire stagger - UIC 606-2

2.3 - Voltage - UIC 600

2.4 - Bow - UIC 608

2.5 - Static contact force - UIC 608

3 - Basic requirements to be met by overhead-line and pantograph to ensure interaction of components

3.1 - Overhead line Table 1

3.2 - Pantograph Table 2

4 - Recommendations for improving the quality of pantograph/overhead-line interaction

4.1 - Overhead line Table 3

4.2 - Pantograph Table 4

5 - Recommendations for a mathematical model

Mathematical simulation models can be used to assess the dynamic performance to be expected of individual types of pantograph in combination with different types of overhead line. It is recommended that the finite element method be used as a simulation model

The results of these simulation calculations must be verified by test runs before the individual components of the pantograph and overhead-line are approved.

5.1 - Calculation method

- Mathematical/physical finite element method.

5.2 - Variable input parameters

- Dimensions of the overhead line system.
- Cables, wires (cross-section, material properties, etc.).
- Frequency-dependent dynamic apparent mass - value and phase relationship (obtained by measurement)
- Mass, spring and damper modelling of pantograph.
- Number and spacing of pantographs.
- Aerodynamic force (as per Leaflet 608).

5.3 - Resulting values

- Contact force patterns
- Dynamic performance of overhead line.

5.4 - Comparison of calculation and test results

Series No.	Description	Line speed (km/h)				
		V ≤ 100	100 < V ≤ 200	200 < V ≤ 230	230 < V ≤ 300	V > 300
Table 1 : Overhead line requirements						
1.	Height of contact wire (mm) Current situation (mm) Current BR variation (mm) Current SNCF variation(mm) (all standard height)	CENELEC specifications ⇓	5 500 4 800 - 6 000 4 550 - 6 000 4 640 - 6 200	5 500 4 800 - 6 000 4 550 - 6 000 4 640 - 6 200	5 300(1) or 5 080(1)	5 300(1) or 5 080(1)
2.	Height tolerance from one support to another when erected (mm)		± 30	± 30	± 10	± 10
3.	Maximum contact wire slope in relation to the track (‰)		1(2)	1(2)	0	0
4.	Lateral deflection of the contact wire in maximum cross wind (mm) Current DB situation Current RENFE situation		≤ 400 ≤ 550	≤ 400 ≤ 550	≤ 400 ≤ 500 ≤ 500	≤ 400
5.	Permissible maximum contact wire uplift (when pantograph passes the support) (mm) Current SNCF situation Current DB situation Current RENFE situation (see Table 2.4)		120 100 100	120 100 100	120 120 100 100	120

Footnote :
(1) Standard heights for the GC gauge are dependent on certain criteria (e.g. electric insulation, ice load, building and maintenance tolerances, etc.)
(2) Proposal in the CENELEC standard EN 50 119

Series No.	Description	Line speed (km/h)				
		V ≤ 100	100 < V ≤ 200	200 < V ≤ 230	230 < V ≤ 300	V > 300
Table 2 : Pantograph requirements						
1.	Width of pantograph bow (mm) Current situation - SNCF - DB, RENFE - MÁV, ÖBB - BV/SJ, NSB - CFF	CENELEC Specifications ⇓	1 600 1 450 1 950 1 950 1 800 1 450	1 600 1 450 1 950	1 600 1 450 1 950	1 600
2.	Working range of the pantograph bow (mm)		1 200	1 200	1 200	1 200
3.	Profile of pantograph bow		Appendix 1	Appendix 1	Appendix 1	Appendix 1
4.	Permissible maximum aerodynamic contact force (N) at maximum speed		120(1) (2) or 150(2)	120(1) (2) or 150(2)	120(1) (2) or 200(2)	120(1) (2) or 200(2)
5.	Current collection criterion (s) Fm - 3σ en N(3) Current DB situation Current RENFE situation Current SNCF situation		> 0(4) > 40(5) Demonstration using checks on arcs. criteria to be agreed.	> 0(4) > 40(5)	> 0(4) > 40(5) > 40(5)	> 0(4)

Footnote :
(1) With two pantographs per train, 140 N for the trailing pantograph
(2) Values dependent on type of overhead line
(3) Fm is the average value for the contact force after statistical analysis of the results obtained with the contact force measurement
(4) Provisional value
(5) See also ERRI A 186 Document dated 12.1.1994

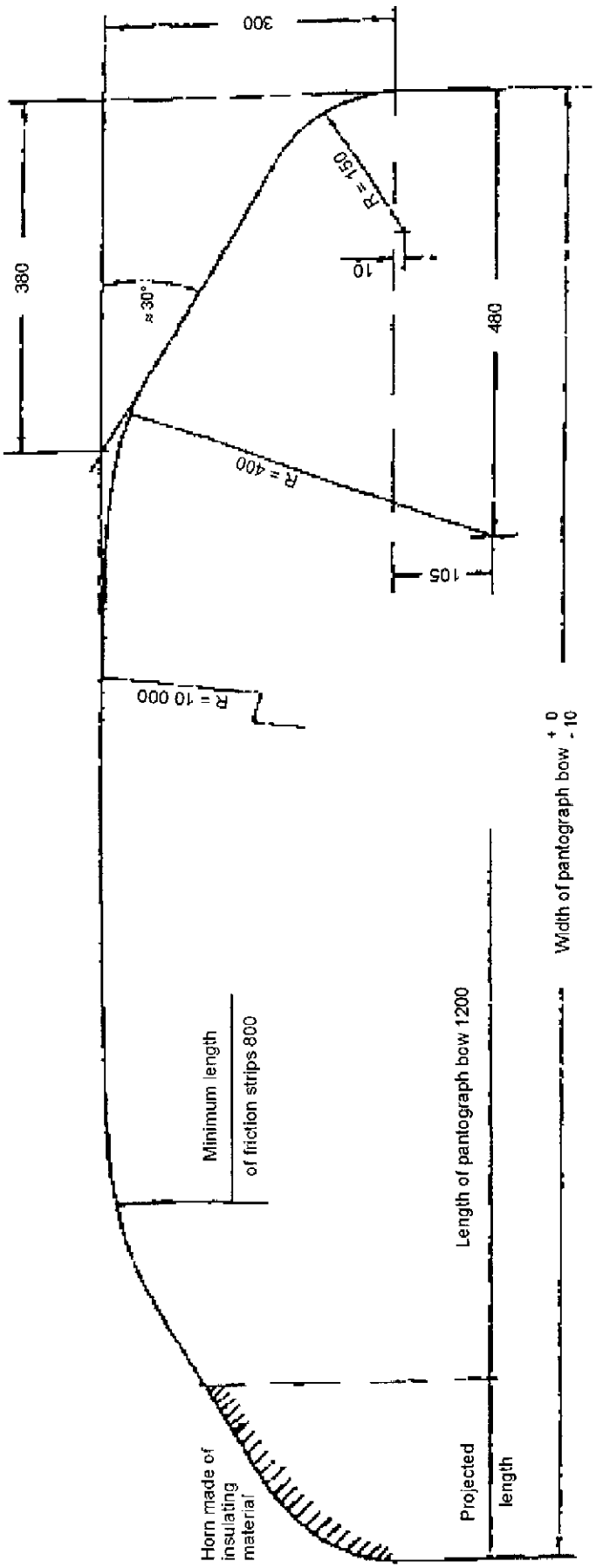
Series No.	Description	Line speed (km/h)				
		V ≤ 100	100 < V ≤ 200	200 < V ≤ 230	230 < V ≤ 300	V > 300
6.	Safety device to protect against crosswinds (limitation of height of pantograph)		not necessary	desirable	necessary	necessary
7.	Contact strip material		Plain carbon - if necessary, impregnated with added material	Plain carbon- if necessary, impregnated with added material	Plain carbon - if necessary, impregnated with added material	Plain carbon - if necessary, impregnated with added material
8.	Device to detect defects in pantograph bow		desirable	necessary	necessary	necessary
Table 3 : Overhead-line recommendations						
1.	Maximum longitudinal span (m)		65	65	65	65
2.	Minimum wave propagation speed (m/s)(1)		100	110	120	V_{max} + 40 m/s
3.	Degree of variability (2)(en %) with stitch wire without stitch wire		 < 15 < 38	 < 10 < 38	 < 10 < 39	 < 10 < 25
4.	Sag in longitudinal span (‰)		≤ 1	≤ 0.5	≤ 0.5	≤ 0.5

Footnote :

(1) See UIC 57H3 "Characteristics of overhead line for high-speed lines".
(2) Values depend on the type of overhead line

Serial No.	Description	Line speed (km/h)				
		V ≤ 100	100 < V ≤ 200	200 < V ≤ 230	230 < V ≤ 300	V > 300
Table 4 : Pantograph recommendations						
1.	Maximum number of active pantographs per trainset			2	2	2
2.	Minimum spacing between 2 active pantographs (m)			> 200	> 200	> 200
3.	Secondary damping		desirable	necessary	necessary	necessary

Profile of pantograph bow in idle position and contact force at mid-span of pantograph bow



Application

With effect from 1 January 1996.

All members of the Union.

Record references

Title under which the question has been studied :

Item 8 - Other business - Approval of Leaflet 794.
(Sub Committee 57 H " Overhead lines - Pantograph/Overhead line interaction - Tractive power supply " : Paris, January 1996).