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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Power supply and rolling stock – Technical criteria for the coordination between power supply (substation) and rolling stock

Applications ferroviaires – Alimentation électrique et matériel roulant – Critères techniques pour la coordination entre le système d'alimentation (sous-station) et le matériel roulant

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CONTENTS

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RAILWAY APPLICATIONS – POWER SUPPLY AND ROLLING STOCK – TECHNICAL CRITERIA FOR THE COORDINATION BETWEEN POWER SUPPLY (SUBSTATION) AND ROLLING STOCK

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

FDIS	Report on voting
9/1225/FDIS	9/1258/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.

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- reconfirmed,
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- replaced by a revised edition, or
- amended.

RAILWAY APPLICATIONS – POWER SUPPLY AND ROLLING STOCK – TECHNICAL CRITERIA FOR THE COORDINATION BETWEEN POWER SUPPLY (SUBSTATION) AND ROLLING STOCK

1 Scope

This International Standard is intended to be used to set up the requirements for the acceptance of rolling stock on infrastructure in the field of:

– co-ordination of protection principles between power supply and traction units, especially fault discrimination for short-circuits;

– co-ordination of installed power on the line and power demand of the trains;

– co-ordination of traction unit regenerative braking and power supply receptivity;

– co-ordination of harmonic behaviour.

This standard deals with the definition and quality requirements of the power supply at the interface between traction unit and fixed installations.

The standard specifies the interface between rolling stock and electrical fixed installations for traction, in the frame "supply system". The interaction between pantograph and overhead line and the interaction with subsystem "control-command" (especially signalling) are not dealt with in the standard.

Requirements are given for the following categories of line:

– high speed lines,

– conventional lines.

For classical lines, values, if any, are given for the existing European networks. A set of values is also specified for the future network, which is named "target" network.

The following electric traction systems are concerned:

– railways;

– guided mass transport systems that are integrated with the railways;

– material transport systems that are integrated with the railways.

This standard does not apply retrospectively to rolling stock already accepted by infrastructure managers. However, on new infrastructure, existing rolling stock may be accepted by the infrastructure manager, provided there is an agreement.

Information is given to the train operating companies on electrification parameters to enable them to confirm after consultation with the rolling stock manufacturers that there will be no consequential disturbance on the electrification system.

2 Normative references

The following referenced documents are indispensable 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.

IEC 60050-811, *International Electrotechnical vocabulary (IEV) – Chapter 811: Electric traction*

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

IEC 61133, *Railway applications – Rolling stock – Testing of rolling stock on completion of construction and before entry into service*

IEC 61992-1, *Railway applications – Fixed installations – D.C. switchgear – Part 1: General*

ISO 3166-1:2006, *Codes for the representation of names of countries and their subdivisions – Part 1: Country codes*

3 Terms and definitions

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

3.1
high speed line
specially built or upgraded line equipped for speeds generally equal to or greater than 200 km/h

3.2
conventional line
line on which conventional freight and passenger trains run. It is not specially built for high speed as defined in 3.1.

It includes:

- information on European networks named with their national country code (see ISO 3166-1);
- future target network named ”target“, see 3.25

3.3
type of line
classification of lines as a function of the parameters described in 3.4 to 3.6

3.4
train power at the pantograph
active power of the train taking into account power for traction, regeneration and auxiliary

3.5
minimum possible headway
interval at which trains can run as allowed by the signalling system

3.6
maximum line speed
speed for which the line was approved for operation

3.7
contact line
conductor system for supplying electric energy to vehicles through current-collecting equipment

[IEV 811-33-01]

3.8
overhead contact line
contact line placed above (or beside) the upper limit of the vehicle gauge and supplying vehicles with electric energy through roof–mounted current collection equipment

[IEV 811-33-02]

3.9
(traction) substation
installation, the main function of which is to supply a contact line system, at which the voltage of a primary supply system, and in certain cases the frequency, is converted to the voltage and frequency of the contact line

3.10
total power factor λ

$$\lambda = \frac{active\ power}{apparent\ power}$$

3.11
deformation factor υ

$$\upsilon = \frac{\lambda}{\cos\varphi}$$

3.12
power factor of the fundamental wave

$$\cos\varphi = \frac{active\ power\ of\ the\ fundamental\ wave}{apparent\ power\ of\ the\ fundamental\ wave}$$

NOTE This is also the displacement factor cos φ.

3.13
different source section
a section of a contact line to prevent successive electrical sections, differing in voltage, phase or frequency being connected together by the passage of current collectors

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

- **[IEV 811-36-16]**
  insulator section
  section of a contact line to prevent successive electrical sections, differing in voltage, phase or frequency being connected together by the passage of current collectors, formed by an insulator inserted in a continuous run of contact line

- **changeover section**
  section of a contact line provided with a section in the middle to enable energization from either power supply source at each end by switching

3.14
vehicle
general term denoting any single item of rolling stock, e.g. a locomotive, a coach or a wagon

[IEV 811-02-02]

3.15
traction unit
general term covering a locomotive, motor coach or train unit

[IEV 811-02-04]

3.16
rolling stock
general term covering all vehicles with or without motors

[IEV 811-02-01]

3.17
train
any combination of rolling stock coupled together. It includes banking locomotives

3.18
normal operating conditions
traffic operating to the design timetable and train formation used for power supply fixed installation design.

Power supply equipment is operated according to standard design rules.

NOTE Standard rules may vary depending on the infrastructure manager's policy.

3.19
abnormal operating conditions
either higher traffic loads or outage of power supply equipment outside the design standard

NOTE Under these conditions, traffic may not operate to the design timetable.

3.20
mean useful voltage at the pantograph
U **mean useful**

3.20.1
U **mean useful (zone)**
voltage giving an indication of the quality of the power supply in a geographic zone during the peak traffic period in the timetable

3.20.2
U **mean useful (train)**
voltage identifying the dimensioning train and enables the effect on its performance to be quantified

3.21
dimensioning train
train with the lowest mean useful voltage

3.22
register of infrastructure
a single document which compiles, for each section of line, the characteristics of the lines concerned for all subsystems that include fixed equipment.

This "register of infrastructure" should be drawn up by the infrastructure manager or its authorised representative.

3.23
infrastructure manager
any body or undertaking that is responsible in particular for establishing and maintaining railway infrastructure. This may also include the management of infrastructure control and safety systems. The functions of the infrastructure manager on a network or part of a network may be allocated to different bodies or undertakings.

3.24
new element
generally, any new, rebuilt or modified (hardware or software) traction-unit or power supply component having a possible influence on the harmonic behaviour of the power supply system.

This new element will be integrated in an existing power supply network with traction units, for example for fixed installation side:

– transformer;
– HV cable;
– filters;
– converter

3.25
target network
network whose design allows the requirements of European interoperability and should avoid later costly investments

4 Periods over which parameters can be averaged or integrated

This clause is informative and refers to Annex A.

The train operators or infrastructure managers use parameters for:

– their dimensioning computations;
– protection measures;
– planning;
– etc.

These are effective only if they are averaged over precisely defined time spans.

Annex A gives, for information, the periods over which those parameters should be averaged.

5 Different source sections

There are several types of different source sections, such as the insulator section, the neutral section and the changeover section, as shown in Annex E.

5.1 AC phase separation sections

There are four possibilities for the train to run through phase separation sections:

a) with traction/regenerative current carried;
b) with auxiliary load current carried;
c) with no-load current of the transformer carried;
d) with no power consumption.

The choice between a) to d) shall be made by the infrastructure manager.

The requirements for the design of the infrastructure and rolling stock are:

a) Traction/regenerative current carried

If the phase separation sections are to be negotiated with traction/regenerative current carried, changeover sections shall be installed in the infrastructure. See Clause E.4 for the information on the changeover section.

Changeover operation of supplied power for the changeover section shall be performed automatically in the infrastructure.

Trains shall allow short interruptions of supply voltage during changeover operations without causing any damages or failures.

b) Auxiliary load current carried

If the phase separation sections are to be negotiated with auxiliary load current carried, sections and pantographs shall be capable of breaking auxiliary load current, and also making and carrying inrush current of transformers.

Traction/regenerative current shall be brought to zero when entering the phase separation section. Automatic operation is preferred; however, manual on board operation is also permitted.

Sections shall have enough length to avoid the two phases bridged by the arc of traction/regenerative current in case traction/regenerative current fails to become zero.

See Clause E.1 for the information on the insulator section.

c) No-load current of transformer carried

If the phase separation sections are to be negotiated with no-load current of transformer carried, sections and pantographs shall be capable of making and carrying inrush current of transformers.

Both traction/regenerative current and auxiliary load current shall be brought to zero when entering the phase separation section. Automatic operation is preferred; however, manual on board operation is also permitted.

Sections shall have enough length to avoid the two phases bridged by the arc of traction/regenerative current in case traction/regenerative current fails to become zero.

See Clause E.1 for the information on the insulator section.

d) No power consumption

If the phase separation sections are to be negotiated with power consumption of the train brought to zero, power consumption shall be brought to zero when entering the phase separation section.

For high-speed lines, this shall be done automatically.

For conventional lines, automatic operation is preferred; however, manual on board operation is also permitted.

Lowering of the pantographs is not necessary.

See Clauses E.2 and E.3 for the information on the suitable sections.

The infrastructure manager shall provide adequate means to allow a train that is gapped underneath the phase separation to be restarted. Such means, however, are not necessarily required for the insulator section.

5.2 System separation sections

The trains shall be able to move from one energy supply system to an adjacent one which uses a different energy supply without bridging the two systems. The necessary actions (opening of the main circuit-breaker, lowering of the pantographs) depend on the type of both supply systems as well as on the arrangement of pantographs on trains and the running speed.

There are two possibilities for the train to run through system separation sections:

a) with pantograph raised and touching the contact wire;

b) with pantograph lowered and not touching the contact wire.

The choice between a) and b) shall be made by the infrastructure manager.

The requirements for the design of the infrastructure and rolling stock are:

a) Pantograph raised

If the system separation sections are negotiated with pantographs raised to the contact wire, provisions shall be taken in the infrastructure to avoid bridging of both adjacent power supply systems when the opening of the on-board circuit-breaker(s) fails, e.g. earthing of neutral section.

For High Speed lines, on rolling stock, devices shall open automatically the circuit-breaker before reaching the separation section and recognise automatically the voltage of the new power supply system at the pantograph in order to switch the corresponding circuits.

For conventional lines, these requirements for High Speed lines may be applied.

b) Pantograph lowered

If the system separation sections are negotiated with pantographs lowered the following conditions apply:

The design of separation section between differing energy supply systems shall ensure that, in case of a pantograph unintentionally applied to the contact line, bridging of two power supply systems is avoided and switching off both supply sections is triggered immediately. Triggering of a short-circuit ensures the operation of insulated sections.

– For High Speed lines, at supply system separations which require a lowering of the pantograph, the pantograph shall be lowered without the driver's intervention, triggered by control signals.

– For conventional lines, these requirements for High Speed lines may be applied.

Examples of the section length to avoid bridging by arcs are given in Clause E.4.

5.3 Acceptance criteria

Infrastructure, traction units and control command designers shall comply with the requirements of 5.1 and 5.2.

6 Power factor of a train

6.1 General

The higher the power factor of a train, the better the power supply performance, therefore the rules below apply.

Capacitive or inductive power from a train can be utilised to change the overhead contact line voltage.

6.2 Inductive power factor

This subclause deals only with inductive power factor and power consumption over the range of voltages from U_{min1} to U_{max1} defined in IEC 60850.

Table 1 gives the total inductive power factor λ of a train. For the calculation of λ, only the fundamental of the voltage at pantograph is taken into account.