

Proposal for draft amendments to Annex 12 of Regulation No. 107 (M₂ and M₃ vehicles) - Additional safety prescriptions for trolleybuses

The text reproduced below has been prepared by the expert from Belgium to amend the additional safety prescriptions for trolleybuses in order to update these to the respective electrical standards. The modifications to the current text of the regulation are marked in bold for new or strikethrough for deleted characters.

I. Proposal

Paragraph 1.1., amend to read:

"1.1. *"Line voltage"* means the voltage provided to the ~~vehicle~~ **trolleybus** from the external ~~power~~ **current** supply.

Trolleybuses shall be designed to operate at a rated line voltage of either:

- (a) 600 V (a working range of 400 to 720 V, **with recuperation 750 V DC, for 5 minutes 800 V DC**); or
- (b) 750 V (a working range of 500 to 900 V, **with recuperation 937 V DC, for 5 minutes 1000 V DC**); and
- (c) **withstand over-voltages of 1270 V for 20ms.**"

Paragraph 1.2., amend to read:

"1.2. The electrical circuits of a trolleybus are classified ~~as~~ **according to their rated voltage in the following bands:**

1.2.1. ~~"High voltage circuits" means circuits energised at line voltage~~ **"Voltage band A":**

rated voltage \leq 30 V AC

rated voltage \leq 60 V DC.

1.2.2. ~~"Low voltage circuits" means circuits energised at a nominal voltage of 12 V, 24 V or 42 V~~ **"Voltage band B":**

30 V AC < rated voltage \leq 1000 V AC

120 V DC < rated voltage \leq 1500 V DC.

1.2.3. *"Three phase circuits"* means circuits supplied with a three-phase voltage not exceeding 400 V AC."

Paragraph 1.3., amend to read:

"1.3. Rated climatic conditions

Trolleybuses shall be designed to operate reliably under the following environmental conditions:

1.3.1. A temperature range of minus ~~40~~ **25** °C to plus 40 °C, **if not otherwise specified by the operator**;

...

1.3.4. An altitude range from sea level to a maximum of ~~1,000~~ **1400** m above the sea level, **if not otherwise specified by the operator.**"

Insert a new paragraph 1.5., to read :

"1.5. "Insulation" : there are different types of insulation:

1.5.1. Basic insulation : protects persons from electrical hazards in systems with protective bonding;

1.5.2. Supplementary insulation: protects persons from electrical hazards in systems without protective bonding;

1.5.3. Functional insulation: ensures the functionality of the equipment;

1.5.4. Double insulation: combination of basic and supplementary, or functional and supplementary insulation, each individually testable by a metallized intermediate layer."

Insert a new paragraph 1.6., to read :

"1.6. "Rated insulation voltage"

1.6.1. For circuits connected to the line voltage, the rated insulation voltage (U_{Nm}) for each part of the double insulation is the maximum line voltage according to 1.1.; and

1.6.2. For circuits insulated from the line voltage, the rated insulation voltage (U_{Nm}) is the maximum permanent voltage that occurs in the circuit."

Paragraph 2., amend to read :

2. Power Current collection"

Paragraph 2.1., amend to read :

"2.1. Electrical power Current shall be obtained from the contact wires by means of one or more power collection ~~power collection~~ **connecting devices, normally comprising two ~~trolley booms~~ **current collectors**. (A single ~~trolley boom~~ **current collector** or a pantograph may be used in guided applications). A ~~trolley boom~~ **current collector** shall consist of a roof mounting (trolley base), a ~~pole~~ **trolley rod**, an ~~electrical power~~ **current collector head** (~~trolley head~~) and a replaceable contact surface insert. ~~Trolley booms~~ **Current collectors** shall be mounted so that they can turn in both horizontal and vertical directions. **A current collector shall achieve, as a minimum, a $\pm 55^\circ$ rotation about the vertical axis of its attachment to the trolleybus and a $\pm 20^\circ$ rotation about the horizontal axis of its attachment to the trolleybus."****

Paragraph 2.2., amend to read:

"2.2. **Poles Trolley rods** shall be made **either of an insulated a material providing insulation or of metal covered with insulating material representing functional insulation to avoid short circuiting between the overhead lines in case of their detachment (de-wiring)** and shall be resistant to mechanical shocks."

Paragraph 2.3., amend to read:

"2.3. ~~Power~~ **Current** collectors shall be designed to maintain adequate positive contact with the contact wires when the wires are located at between 4 and 6 metres above the ground and, ~~in the case of trolley booms,~~ to allow the longitudinal axis of the trolleybus to deviate at least 4.0 metres to either side of the mean axis of the contact wires. **Different heights of the contact wires or a different lateral deviation may be specified by the operator.**"

Paragraph 2.4., amend to read :

"2.4. ~~If the power collector becomes accidentally detached from the contact wire (de-wired), the upper end of the power collector(s) shall not be raised higher than 7.2 metres above the road, or 1 metre maximum above the contact wires at the time of de-wiring, nor lower than 0.5 metres above the roof of the trolleybus~~ **Each trolley rod shall be equipped with a device that automatically retracts the rod in the event of the current collector becoming accidentally detached from the contact wire (de-wired).**"

Paragraph 2.5., amend to read:

"2.5. ~~Each trolley boom shall be equipped with a device which retracts the boom automatically if the pole unwires~~ **The trolley rod shall be equipped with mechanical stops to prevent the values specified in paragraph 2.3. being exceeded. In the event of de-wiring, contact between the retracted rods and any part of the roof shall be prevented.**"

Paragraph 2.6., amend to read:

"2.6. The ~~trolley~~ **current collector** head, if ~~dismounted~~ **disconnected** from its normal position on the ~~pole~~ **trolley rod**, shall be remain attached to the ~~pole~~ **trolley rod** and ~~must not fall down.~~ "

Paragraph 2.7., should be deleted.

Paragraph 2.8. (former), amend to read and renumber as paragraph 2.7.:

"~~2.8.2.7.~~ **Power Current** collectors may be equipped with remote control from the driver's compartment, at least for retraction. "

Paragraphs 2.9 (former), renumber as paragraph 2.8.

Paragraph 3.5., amend to read:

"3.5. All electrical circuits and circuit branches **of voltage band B** shall be of dual wiring. The trolleybus body ~~can be used for current earth return only for low voltage circuits~~ **may be used as a conductor for protective bonding of circuits, double insulated from the line voltage, of voltage band B. It also may be used as return connection for voltage band A circuits."**

Paragraph 3.7., amend to read:

"3.7. Electrical components ~~energized at the line voltage shall have additional insulation from the vehicle~~ **shall have, in addition to their basic insulation, a supplementary insulation from the trolleybus body, the onboard power supply and signal interfaces."**

Insert a new paragraph 3.7.1., to read:

"3.7.1. **With normal pollution, outside insulations shall have a minimum creepage distance of 20 mm and a minimum clearance of 10 mm."**

Paragraph 3.8., amend to read:

"3.8. **The current conducting parts of** electrical components, with the exception of **current collectors, surge arrestors and** traction resistors, shall be protected against ~~penetration of moisture and dust into the body and onto insulated and current conducting parts.~~

Paragraph 3.9., amend to read:

"3.9. **Means shall be provided for a periodic resistance test to be conducted of each basic and supplementary insulation of components with double insulation.** Within the rated climate conditions, with the trolleybus **new and dry and clean**, the insulation resistance of electrical circuits **at a test voltage of 1000 V DC**, ~~when all rotating machines and apparatus are switched on~~, shall not be less than:

3.9.1. ~~Body to high voltage circuits~~ **Basic insulation: 5 MΩ (500 kΩ for an in-service trolleybus and wet);**

3.9.2. ~~High voltage circuits to low voltage circuits~~
Supplementary insulation: 5 MΩ (500 kΩ for an in-service trolleybus and wet);

3.9.3. ~~Body to positive pole of low voltage circuits~~
Double insulation: 10 MΩ (1 MΩ for an in-service trolleybus and wet)."

Paragraph 3.10.1., amend to read:

"3.10.1. ~~Only multi-core~~ **Flexible** wires shall be used for ~~high voltage~~ **all** circuits. ~~All high voltage DC wiring shall have insulation rated~~

~~for 3,000 V DC or AC~~ **The rated insulation voltage of wires to ground shall be at least the rated insulation voltage according to paragraph 1.6."**

Paragraph 3.10.4., amend to read:

"3.10.4. Wiring of different voltage **bands** shall be mounted separately."

Paragraph 3.10.5., amend to read:

"3.10.5. Wiring conduits shall be made of non-flammable **or self-extinguishing** material. **Conduits inside the passenger compartment of voltage band B shall be closed and be made of metal.**"

Paragraph 3.10.12.1., amend to read:

"3.10.12.1. **Each of the insulations of voltage band B equipment onboard the trolleybus shall be tested with an AC power supply at test frequency of 50 - 60 Hz for 1 min.**

The test voltage (U_{Test}) for wiring and components at the trolleybus shall be:

$$\text{Basic Insulation: } U_{Test} = 2 \times U_{Nm} + 1,500 \text{ V}$$

$$\text{Supplementary Insulation: } U_{Test} = 1.6 \times U_{Nm} + 500 \text{ V}$$

The values for basic and supplementary insulations may be reversed.

For circuits double insulated from overhead line voltage, the test voltage (U_{Test}) shall be at least 1,500 V, with U the highest occurring voltage:

$$\text{Basic Insulation: } U_{Test} = 2 \times U + 1,000 \text{ V}$$

The equivalent DC test voltage is $\sqrt{2}$ times the AC value.

Components that have already been tested at their time of manufacture shall be excluded. The factory tests may be performed with other voltages or durations according to EN/IEC product standards.

Reinforced insulation in trolleybuses is not allowed for circuits directly connected to overhead line."

Paragraph 4.1., amend to read:

"4.1. At the rated climate conditions, with the trolleybus **new and dry and clean and connected to both positive and negative power supply via the power collection devices, the earth leakage current from the body shall not be higher than 0.2 mA** **the insulation resistance of the third insulations of the entrance areas at a test voltage of 1,000 V DC shall not be less than:**

$$\text{5 M}\Omega \text{ (500 k}\Omega \text{ for an in-service trolleybus and wet).}$$

Means for a periodically resistance test by the operator shall be provided."

Paragraphs 4.2. should be replaced by new paragraph 4.2. to read:

"4.2. **Electrical safety is to be ensured by the double insulation of the equipment connected to the line voltage (paragraph 3.7).**

The influence of dynamic charge currents, caused by capacitive couplings between voltage band B equipment and electric chassis, shall be reduced by the protective impedance of insulating materials used in entrance areas, as required in paragraphs 4.3 to 4.5 below.

If specified by the operator, trolley buses may be equipped with an automatic monitoring device, i.e. a leakage detector. The device shall give an optical and/or acoustic alarm signal when the insulating resistance, between the circuits fed at line voltage and the trolleybus body, decreases to a value less than that specified in paragraph 3.9.

When the above mentioned limit value is reached the leakage detector may, when the trolleybus is stationary, effect both the opening of the line contactor circuit breaker and the automatic lowering of the current collector.

The leakage detector, or at least the relevant optical and/or acoustic alarm device, if any, shall be mounted in a location to permit it to be easily visible or audible, as appropriate, to the driver."

Paragraphs 4.6. and 4.7., should be deleted.

Paragraph 5.2.5., should be deleted.

II. Justification

Paragraph 1.1.

The definition of line voltage is updated with reference to EN50163/IEC60850 Railway applications – Supply voltages of traction systems.

Paragraph 1.2.

The classification of voltage bands is updated with reference to EN50153/IEC61991 Railway applications – Rolling stock – Protective provision relating to electrical hazards.

Note : In France and Italy different limits apply because of legal prescriptions. Because voltage band II does not appear in new electrical road vehicles, voltage band II is combined with band III. In accordance to ISO6469-3, band I is renamed band A and the combination of Bands II and III is renamed band B.

Paragraph 1.3.

The rated climatic conditions are updated with reference to EN50125 Railway applications – Environmental conditions for equipment / IEC60077 Railway applications – Electrical equipment for rolling stock / IEC60721.

The mentioned values are part of the prescriptions for normal service conditions of IEC60077-1, referring to IEC60721-3-5: 5Z1, 5K2, 5B2, 5C2, 5S2

Paragraph 1.5.

The definitions for insulations are added with reference to EN50153/IEC61991 Railway applications – Rolling stock – Protective provisions relating to electrical hazards.

Paragraph 1.6.

The definition of rated insulation voltage is added with reference to EN50124-1 Railway applications – Insulation coordination – Clearances and creepage distances for all electrical and electronic equipment. Annexes A and D.

Paragraph 2., title

Current is new wording for (electrical) power.

Paragraph 2.1.

New wording for the current collector and parts thereof replaces the old wording with reference to TS50502 Railway applications – Rolling stock Electric equipment in trolley buses – Safety requirements and connection systems.

Paragraph 2.2.

The prescription for the trolley rod is updated with reference to TS50502 Railway applications – Rolling stock Electric equipment in trolley buses – Safety requirements and connection systems.

Paragraph 2.3.

The prescription for the current collector is added with reference to TS50502 Railway applications – Rolling stock Electric equipment in trolley buses – Safety requirements and connection systems.

Paragraph 2.4.

New wording.

Paragraph 2.5.

New wording.

Paragraph 2.6.

New wording.

Paragraph 2.7.

This paragraph should be deleted. For the insulation resistances of the current collector see new wording of paragraph 3.10.12.

Paragraph 2.8.(former)

New wording.

Paragraph 3.5.

The prescription for the electrical circuits is updated with reference to TS45545 Railway applications – Fire protection on railway vehicles and EN50343 Railway applications – Rolling stock – Rules for installation of cabling.

Electrical power installations shall be separated by firewalls from passenger compartment or air ducts to the passenger compartment. Power cabling shall be halogen free and self-extinguishing.

Paragraph 3.7.

New wording with reference to EN50153/IEC61991 Railway applications – Rolling stock – Protective provisions relating to electrical hazards.

Paragraph 3.7.1.

The prescription for outside insulations is added with reference to EN50124-1 Railway applications – Insulation coordination.

Paragraph 3.8.

New wording with reference to EN60529 Degrees of Protection provided by enclosures (IP Code) and to EN60322/IEC 60322 Railway applications – Electrical equipment for rolling stock – Rules for power resistors of open construction.

Paragraph 3.9.

New wording.

Note: In Switzerland and Italy the test periods are fixed by legal prescriptions.

Paragraph 3.10.1.

The prescription for all circuits is updated with reference to EN50343 Railway applications – Rolling stock – Rules for installation of cabling.

Paragraph 3.10.4.

New wording with reference to TS45545 Railway applications – Fire protection on railway vehicles

Paragraph 3.10.5.

The prescription for wiring conduits is updated with reference to TS45545 Railway applications – Fire protection on railway vehicles.

Paragraph 3.10.12.1.

New wording with reference to EN60077/IEC60077 Railway applications – Electrical equipment for rolling stock: this includes auxiliary power supplies as well as batteries and motor-generator units.

Reinforced insulation with reference to EN50153/IEC61991

Paragraph 4.1.

New wording for the insulation resistance.

Paragraph 4.2.

New wording with reference to IEC60479-1 Effects of current on human beings and livestock.

Paragraph 4.6.

This Paragraph should be deleted, because paragraph 4.7 is not valid (see below).

Paragraph 4.7.

This paragraph should be deleted, because single insulated equipment connected to the line voltage is not allowed with reference to EN50153/IEC61991 Railway applications – Rolling stock – Protective provision relating to electrical hazards.

Paragraph 5.2.5.

Because of modification of paragraph 4.2, this paragraph is optional and should be deleted.
