4. APTA PR-E-RP-004-98 Recommended Practice for Gap and Creepage Distance

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Abstract: This recommended practice describes a method to determine the minimum safe gap and creepage distance for passenger rail vehicle electrical circuits and cabling where potentials do not exceed 2000 volts to ground.

Keywords: cabling, gap, creepage distance, electrical circuits, passenger rail vehicle

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The American Public Transportation Association (APTA) greatly appreciates the contributions of the following individual(s), who provided the primary effort in the drafting of the *Recommended Practice for Gap and Creepage Distance:*

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1. Overview

1.1 Scope

The passenger rail industry phased this recommended practice into practice over the six-month period from July 1 to December 31, 1999. The recommended practice took effect January 1, 2000.

1.2 Purpose

This recommended practice describes a method to determine the minimum safe gap and creepage distance for passenger rail vehicle electrical circuits and cabling where potentials do not exceed 2000 volts to ground. This reccommended practice applies to passenger rail vehicle electrical circuits and cabling where potentials do not exceed 2000 volts to ground.

2. References

NFPA 130-1997, “Fixed Guideway Transit Systems”

IEEE 100-1997, “IEEE Standard Dictionary of Electrical and Electronic Terms.”

3. Definitions, abbreviations, and acronyms

3.1 Definitions

For the purpose of this recommended practice, the following terms and definitions apply. IEEE Std 100-1996, “The IEEE Standard Dictionary of Electrical and Electronics Terms”, should be referenced for terms not defined in this section.

3.1.1 corona effect: A type of localized discharge resulting from transient gaseous ionization in an insulation system, when the voltage exceeds a critical value. The ionization is usually localized over a portion of the distance between the electrodes of the system.

3.1.2 creepage: The shortest distance between two conducting parts measured along the surface or joints of the insulating material between them.

3.1.3 gap: The shortest distance measured through air, between parts of different potentials.

3.1.4 highly exposed (no external protection): Includes third rail shoe beams and current collection devices. Short circuit current not limited by onboard devices.

3.1.5 low energy: Electronic and protected electrical devices, one-half ampere maximum.

3.1.6 ordinary (enclosed environment with breathing): Control and power devices mounted in control group enclosures or lockers. Short circuit current is limited by on-board devices.

3.1.7 underfloor or roof-mounted, exposed environment: Includes power resistors, open disconnect devices mounted outside protective enclosures.

4. Technical information

To the extent possible, use the following table taken from *NFPA 130, 1997*[1], Appendix E to determine minimum safe creepage distances. This table covers many relatively standard passenger rail vehicle electrical system applications.

Creepage distance
(taken from NFPA 130, 1997, Table E-1)

Class:		**Low energy**	**Ordinary**	**Underfloor exposed**	**Highly exposed**
Application:		Electronic & protected electrical devices (.5 amp max)	Control & power devices mounted in control group enclosures (short circuit limits)	Power resistors, open disconnect devices mounted outside protective enclosures	Third rail shoe beams and current collection devices (short circuit current unlimited by onboard devices)
Nominal Voltage	**Surface**				
38	horizontal	1/16 inches (.16 cm)	1/8 inches (.32 cm)	3/4 inches (1.91 cm)	N/A
	vertical	1/16 inches (.16 cm)	1/8 inches (.32 cm)	½ inches (1.27 cm)	N/A
230	horizontal	3/8 inches (.95 cm)	5/8 inches (1.59 cm)	3 inches (7.62 cm)	4 inches (10.16 cm)
	vertical	3/8 inches (.95 cm)	5/8 inches (1.59 cm)	2 inches (5.08 cm)	2 1/4 inches (10.8 cm)
600	horizontal	3/4 inches (1.91 cm)	1 1/4 inches (3.18 cm)	7 inches (17.78 cm)	10 inches (25.4 cm)
	vertical	3/4 inches (1.91 cm)	1 1/4 inches (3.18 cm)	5 inches (12.70 cm)	6 inches (15.24 cm)

For voltages other than those include in NFPA 130, 1997, Table E1, utilize the formulas given below to calculate gap and creepage distances under normal environmental conditions. Voltages that exceed 1500 volts must be considered with the corona effect, as

[1] For references in Italics, see section 2.

these voltages are not calculated strictly linearly.

Gap (inches) = 0.125 + (0.0005 x nominal voltage)

(Gap (cm) = .32 +(0.00127 x nominal voltage))

Creepage (inches) = 0.125 + (0.001875 x nominal voltage)

(Creepage (cm) = 0.32 + (0.00476 x nominal voltage)

NOTE: Ionized gas situations are treated through enclosure ventilation and do not have an effect on these calculations.

Caution: Electrical circuits and associated cabling should be designed with gap and creepage distance between voltage potentials and car body ground considering the environmental conditions to which the circuits and cabling will be subjected to.

Caution: Do not use the methods described in this recommended practice when potentials to ground exceed 2000 volts.