APTA STANDARDS DEVELOPMENT PROGRAM
RECOMMENDED PRACTICE
American Public Transportation Association
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PRESS Electrical Working Group

# Gap and Creepage Distance

**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 V to ground.

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

**Summary, scope and purpose:** This recommended practice applies to passenger rail vehicle electrical circuits and cabling where potentials do not exceed 2000 volts to ground. The passenger rail industry phased in this recommended practice over the six-month period from July 1 to Dec. 31, 1999. It took effect January 1, 2000.

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## Introduction

*This introduction is not part of APTA PR-E-RP-004-98, Rev. 2 "Gap and Creepage Distance."*

This recommended practice applies to all:

1. Railroads that operate intercity or commuter passenger train service on the general railroad system of transportation; and
2. Railroads that provide commuter or other short-haul rail passenger train service in a metropolitan or suburban area, including public authorities operating passenger train service.

This recommended practice may not apply to:

1. Rapid transit operations in an urban area that are not connected to the general railroad system of transportation;
2. Tourist, scenic, historic or excursion operations, whether on or off the general railroad system of transportation;
3. Operation of private cars, including business/office cars and circus trains; or
4. Railroads that operate only on track inside an installation that is not part of the general railroad system of transportation.

# Gap and Creepage Distance

## 1. Technical information

To the extent possible, use the following table taken from NFPA 130, 2020, Appendix F to determine minimum safe creepage distances. **Table 1** covers many relatively standard passenger rail vehicle electrical system applications.

**TABLE 1**
Creepage Distance[1]

| | | Class and Application | | | |
|---|---|---|---|---|---|
| **Nominal Voltage** | **Surface** | **Low Energy:** Electronic and protected electrical devices (0.5 amp max) | **Ordinary:** Control and power devices mounted in control group enclosures (short circuit limits) | **Underfloor Exposed:** Power resistors, open disconnect devices mounted outside protective enclosures | **Highly Exposed:** Third-rail shoe beams and current collection devices (short circuit current unlimited by onboard devices) |
| 37.5 | horizontal<br>vertical | 1/16 in. (1.59 mm)<br>1/16 in. (1.59 mm) | 1/8 in. (3.18 mm)<br>1/8 in. (3.18 mm) | 3/4 in. (19.05 mm)<br>1/2 in. (12.70 mm) | N/A<br>N/A |
| 74 | horizontal<br>vertical | 1/8 in. (3.18 mm)<br>1/8 in. (3.18 mm) | 1/4 in. (6.35 mm)<br>1/4 in. (6.35 mm) | 1 9/16 in. (39.69 mm)<br>1 in. (25.40 mm) | N/A<br>N/A |
| 230 | horizontal<br>vertical | 3/8 in. (9.53 mm)<br>3/8 in. (9.53 mm) | 5/8 in. (15.88 mm)<br>5/8 in. (15.88 mm) | 3 in. (76.20 mm)<br>2 in. (50.80 mm) | 4 in. (101.60 mm)<br>2 1/4 in. (57.15 mm) |
| 600 | horizontal<br>vertical | 3/4 in. (19.05 mm)<br>3/4 in. (19.05 mm) | 1 1/4 in. (31.75 mm)<br>1 1/4 in. (31.75 mm) | 7 in. (177.80 mm)<br>5 in. (127.00 mm) | 10 in. (254.00 mm)<br>6 in. (152.40 mm) |
| 750 | horizontal | By agreement between manufacturer and authority having jurisdiction | 1 9/16 in. (39.69 mm) | By agreement between manufacturer and authority having jurisdiction | By agreement between manufacturer and authority having jurisdiction |

1. Taken from NFPA 130, 2020, Table F.1

For voltages other than those included in NFPA 130, 2020, Table F.1, utilize the formulas given below to calculate gap and creepage distances under normal environmental conditions. Voltages that exceed 1500 V must be considered with the corona effect, as these voltages are not calculated strictly linearly.

$$Gap\ (in.) = 0.125 + (0.0005 \times nominal\ voltage)$$
$$(Gap\ (mm) = 3.175 + (0.0127 \times nominal\ voltage))$$

$$Creepage\ (in.) = 0.125 + (0.001875 \times nominal\ voltage)$$
$$(Creepage\ (mm) = 3.175 + (0.047625 \times nominal\ voltage))$$

**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.

**CAUTION:** Do not use the methods described in this recommended practice when potentials to ground exceed 2000 V.

## References

NFPA 130-2020, "Fixed Guideway Transit Systems"

IEEE 100-CD, 2013, "Standards Dictionary: Glossary of Terms and Definitions."

## Definitions

For the purpose of this recommended practice, the following terms and definitions apply. IEEE 100-CD, 2013, "Standards Dictionary: Glossary of Terms and Definitions," should be referenced for terms not defined in this section.

**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.

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

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

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

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

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

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

## Abbreviations and acronyms

**NATSA** North American Transportation Services Association
**NFPA** National Fire Protection Association
**V** volts

## Summary of document changes

- Document formatted to the new APTA standard format.
- Sections have been moved and renumbered.
- Scope and summary moved to the front page.
- Sections of definitions, abbreviations and acronyms moved to the rear of the document.
- Three new sections added: "Related APTA standards," "Summary of document changes" and "Document history."
- Some global changes to section headings and numberings resulted when sections dealing with references and acronyms were moved to the end of the document, along with other cosmetic changes, such as capitalization, punctuation, spelling, grammar and general flow of text.
- Updated Table 1 to include 37.5V (rather than 38V), 74V, and 750V.

 

## Document history

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