# 2. APTA PR-PS-S-002-98, Rev. 3 Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment

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**APTA PRESS Task Force**

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Revision 2 Authorized January 11, 2003
Revision 3 Authorized October 7, 2007
**APTA Commuter Rail Executive Committee**

**Abstract:** This standard contains minimum requirements for the physical characteristics, informational content, and placement of all emergency signs and markings and instructions for passenger rail car egress/access points on both the interior and exterior of all said equipment.

**Keywords:** instructions, luminescent, markings, photoluminescent (PL), retroreflective, signs

## Introduction

(This introduction is not a part of APTA PR-PS-S-002-98, Rev. 3, Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment.)

Review of past passenger rail accidents involving passenger and train crew emergency evacuation has indicated that in certain cases, both passengers and emergency responders lacked sufficient information necessary for expedient emergency egress and access due to the absence of clear markings and instructions. The lack of adequate signage in conjunction with lighting system failures and/or low levels of illumination during conditions of darkness when these accidents occurred were cited as a cause for confusion and as a contributing factor to the injuries and casualties that resulted.

To address these concerns, the National Transportation Safety Board (NTSB) made the following recommendations to the Federal Railroad Administration (FRA)[1] after investigation of a 1996 passenger train accident:

> "Issue interim standards for the use of luminescent material, retroreflective material, or both to mark all interior and exterior emergency exits in all passenger cars as soon as possible and incorporate the interim standards into minimum car standards (*FRA R-97-16),* and
>
> Require all passenger cars to contain reliable emergency lighting fixtures that are each fitted with a self-contained independent power source and incorporate the requirements into minimum passenger car safety standards *(R-97-17).*"

In 1998, FRA issued passenger rail equipment regulations that require that the interior location of each door intended for emergency egress be lighted or conspicuously marked by luminescent material and that the interior location of emergency exit windows be conspicuously marked by luminescent material. Instructions for their use are also required at or near such door exits and windows. These regulations also require that doors and windows intended for rescue access be marked with retroreflective material on the exterior and have operational instructions posted. The FRA issued regulations in 1999 that require emergency lighting for new equipment.

This American Public Transportation Association (APTA) standard was originally developed to provide guidance for meeting the FRA regulations and specifies the minimum visual information necessary to facilitate egress of passengers and train crewmembers from passenger rail cars and emergency responder access to cars under various types of emergency situations that require the last-resort measure of car evacuation.

An effective systems approach uses this standard, as well as APTA standards *APTA PR-E-S-013-99, Rev. 1, Standard for Emergency Lighting System Design for Passenger Cars,* and *APTA PR-PS-S-004-98, Rev. 2, Standard for Low-Location Exit Path Marking,* to provide a means for passengers and train crewmembers to locate, reach, and operate emergency exits and rescue access points to facilitate their safe evacuation of in an emergency. Each railroad and car builder should carefully consider the options available to meet emergency evacuation requirements presented in these three standards.

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[1] National Transportation Safety Board (NTSB). Collision and Derailment of a Maryland Rail Commuter MARC Train 286 and National Railroad Passenger Railroad (Amtrak) Train 29 Near Silver Spring, Maryland on February 16, 1996. Report No. NTSB/RAR-97/02. Adopted July 3, 1997.

Revision 1 of this standard included:

1) revisions to the Introduction;
2) revisions to the Scope in Section 1 Overview;
3) addition of the APTA emergency lighting standard (*APTA PR-E-S-013-99)* and other references to Section 2 References;
4) renumbering of the Bibliography to Section 3;
5) renumbering of Sections 3 Definitions and 4 Emergency Egress/Access Signage to Sections 4 and 5;
6) addition and revision of certain definitions in renumbered Section 4; and
7) modifications to renumbered Section 5 that include: revisions to increase the size, spacing, and stroke-to-width ratio of sign letters; revision of sign color, contrast, and legibility requirements; revision to require the use of High-Performance Photoluminescent Material (HPPL), if photoluminescent material is used for the interior door and emergency exit window signs and marking; and the inclusion of an ASTM test method reference for exterior signage / marking retroreflectivity.

Revision 2 of this standard included:

1) revision of Introduction;
2) addition of a Table of Contents;
3) reorganization of Scope in Section 1 Overview;
4) addition of two 49 CFR citations in Section 2 References;
5) relocation of the Bibliography from Section 3 to a new Annex A;
6) renumbering of Section 4 Definitions to Section 3;
7) renumbering of section headings and related text information formerly in Section 5 under two separate major headings: 4 General system requirements and 5 Design requirements;
8) renumbering of the remaining subheadings accordingly. (This reorganization and revision was consistent with the reorganization and revision of those similar sections in the related *APTA PR-PS-S-004-99, Rev.1, Standard for Low-Location Exit Path Marking*.);
9) an ASTM standard containing retroreflective material performance criteria was cited in Section 5;
10) a bibliography was added as an Annex A; and
11) three new Annexes B-D were added that provide guidance to railroads for evaluating HPPL material performance.

Revision 3 of this standard includes extensive modifications to facilitate the incorporation of the standard by reference by the FRA in 49 CFR, Part 238 (See explanation in next paragraph.). In addition to the revision of the Introduction, these modifications include:

1) revision of Overview, Purpose, and Scope in Section 1;
2) addition and revision of definitions in Section 3;

3) reorganization and extensive revision of Section 5 Design Requirements that also addresses grandfathering of certain signs / markings;

4) deletion of Section 6 Material Safety;

5) relocation and revision of provisions for exterior signage / markings and instructions, formerly in Section 5, to a new Section 6 and revision of the retroreflectivity criteria;

6) transfer and revision of light meter requirements and HPPL laboratory tests and charging light test provisions that were formerly in Annex B to a new Section 7 Evaluation measurements and tests;

7) revision and renumbering of former Sections 6-8 to sections 8-10; and

8) revisions to former Section 9 (renumbered 10) Maintenance to include additional and revised daily and periodic tests, and clarified defect reporting, repair, and recordkeeping.

In addition as part of Revision 3, the annexes were revised:

1) the technical considerations information formerly in Annex D was revised and relocated to Annex B;

2) HPPL test laboratory information in Annex C was revised and relocated to Annex D; and

3) three new Annexes have been added that contain guidance for measuring HPPL charging light illuminance (Annex C); automatic testing of emergency sign systems that use independent power sources (Annex D) and representative sampling (Annex F).

When FRA issued the final rule addressing Passenger Equipment Safety Standards in 1999, it identified various issues for future rulemaking, including those to be addressed following the completion of additional research, the gathering of additional operating experience, or the development of industry standards, or all three. Passenger rail equipment emergency signage / marking is one such issue. APTA proposed to the Railroad Safety Advisory Committee (RSAC) Passenger Safety Working Group / Emergency Preparedness Task Force that this APTA emergency signage standard be incorporated by reference into 49 CFR, Part 238. Accordingly, APTA has worked with the FRA, railroads, car manufacturers and suppliers, labor organizations, passenger organizations**,** and NTSB, as part of the FRA RSAC process, to prepare this revision of this standard in order to address the NTSB recommendation and to facilitate incorporation by reference of the standard into the FRA regulations. The RSAC Task Force had little difficulty reaching consensus on the revisions as they apply to new equipment. However, the debate on how to handle existing equipment proved to be more difficult.

The modifications comprising Revision 3 of this standard will affect equipment currently in service and / or new equipment in the following ways:

- The option to use accelerated compliance with this standard as a remedy for failure to meet the Emergency Light Levels required by *APTA PR-E-S-013-99, Standard for Emergency Lighting System Design for Passenger Cars* has been eliminated.

- The Scope has been revised to clarify that the standard does not apply to tourist, scenic, historic, excursion operations, or private rail cars. See Section 1.1.

- The purpose of the standard has been revised to require tests to validate the design of the emergency sign / marking system. See Section 1.2.

- Several definitions have been added, including: auxiliary power system, car, color temperature, dual mode, foot-candle, head-end power, independent power source, emergency lighting, normal lighting, luminaire, luminous intensity, and representative car/area. These additional definitions are necessary to clearly define requirements contained in the standard. See Section 3.1.

- The definition of HPPL material has been changed. Railroads and manufacturers requested this change to eliminate the need for more than one type of HPPL product to comply with the requirements in this standard. After Revision 3 of this standard takes effect, railroads will have to procure material capable of HPPL performance when subjected to a lower level of charging light. See Section 3.1.13.

- When a door is locked, secured or otherwise inoperative, passengers must be directed to an alternative exit or operating instructions must be provided to open the inoperative door. See Section 5.1.1.1.

- Additional signs / markings are required for the emergency / manual door release controls. See Section 5.1.1.2.

- Door exit control locator signs must be highlighted with outline stripping or an area wide pad of HPPL material. See Section 5.1.1.3.

- The terminology used to describe active signage / marking systems has been changed to allow newer technology actively powered marking /delineator components. See Section 5.4.1.1.1.

- Because fluorescent light sources are much more effective for charging HPPL material, fluorescent charging light sources are used as the basis for charging requirements. Different charging light levels are required when using different light sources (e.g., higher light levels are required when using incandescent lighting). See Sections 5.4.2.2 and 5.6, including Tables 1 and 2.

- The specifications for the light meter required to confirm charging light levels have been revised and moved to the body of the standard. This means railroads / suppliers may be required to buy new meters or adapters. See Sections 5.4.2.2, 5.6, 7, and Annex C.

- For passenger cars ordered before April 7, 2008, and placed in service before January 1, 2012, all end and side doors leading to the exterior of the car must be marked by electrically powered or HPPL or dual mode signs / markings. In addition, this also means that, for passenger cars ordered before January 1, 2007, and placed in service before January 1, 2009, beginning on January 1, 2012, all newly installed or replacement end and side door signs shall use HPPL material or electrically powered sign fixtures with an independent power source. See Section 5.5.1.

- Electrically powered independent power sources or HPPL material or dual mode must be used for emergency signs / markings for all end and side doors leading to the exterior of the car in all passenger cars ordered on or after April 7, 2008, or placed in service for the first time on or after January 1, 2011.

- Batteries that are used as independent power sources shall have automatic self-diagnostic modules designed to perform discharge tests.
- A requirement to mark side door locations that do not have independently powered emergency lights with additional HPPL material by January 1, 2009 has been added. See Section 5.5.2.
- As of April 7, 2008, all passive signs / marking must achieve HPPL performance or be specifically grandfathered. See Section 5.6.
- Zinc sulfide signs in cars currently in service must be replaced and existing stocks of zinc sulfide signs are no longer acceptable for installation as replacement signs because they do not meet HPPL performance.
- Existing stocks of non-zinc sulfide photoluminescent material held in inventory as of April 7, 2008, can only be installed as allowed by Section 5.6.
- Instructions for emergency rescue access windows intended for removal by emergency responders must be placed on or near each such window. Location of the instructions solely at the midpoint as well as the ends of the car is no longer permitted. See Section 6.1.2.
- Retroreflective emergency roof access locator signs / marking and instructions must be used on all cars equipped with roof hatches or roof structural soft spots. See Section 6.1.3.
- Additional requirements for protective coatings and color contrast of exterior retroreflective signs / markings have been added. See Section 6.3.
- Requirements have been added to the body of the standard for illuminance / luminance measurements and tests to verify that passenger car designs comply with this standard. These requirements were developed from material contained in the Annexes of Revision 2 of the Standard. Revision 3 makes them mandatory. See Section 7.
- For equipment placed in service before January 1, 2008, if a verification of compliance test on a representative car signage / marking layout has not already been completed, as required by Section 7, it must be completed by December 31, 2008. See Section 7.1.
- For new equipment, a verification of compliance test on a representative car / area, as required by Section 7, must be completed before the car is put into revenue operating service. See Section 7.1.
- A requirement to keep records of the illuminance/luminance measurements and tests made to verify initial designs has been added. See Section 7.3.
- Requirements for material safety contained in Section 6 of Revision 2 of this standard have been deleted for Revision 3.
- More detail has been added to the System Reliability Requirements. See Section 8.
- For new passenger cars, a requirement for independent power sources to operate in all orientations as of January 1, 2011 has been added. See Section 9.
- Extensive revisions have been made and detail has been added to the periodic tests and inspection requirements. See Section 10.

- Testing of a representative sampling of cars comprising the fleet operated by the railroad must be done at an interval not to exceed 8 years, to verify that the performance of the emergency signs remains in compliance with this standard. See Section 10.2.1.2.
- Defect recording, repair, and record keeping requirements have been clarified and included in a separate new Section 11.
- All of the Informative Annexes in Revision 2 of this standard have been extensively revised and reorganized and new annexes containing new guidance information have been added.

## Participants

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 original *Standard for Emergency Signage for Egress/Access of Passenger Rail Equipmen*t:

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## Contents

# APTA PR-PS-S-002-98, Rev. 3 Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment

## 1. Overview

Historically, certain passenger rail car accidents and incidents have required the emergency evacuation of passengers and/or train crewmembers.

This standard requires that each passenger rail car have interior emergency signage to assist passengers and train crewmembers in locating and operating emergency exits in order to safely evacuate from the rail car or train, and exterior signage to assist emergency responders in locating and operating emergency access points, during an emergency situation that warrants immediate passenger rail car or train evacuation.

Passenger railroads recognize that, in the majority of emergencies, the safest place for passengers and crew is on the train. Should evacuation from a particular car be required, the safest course of action for passengers and crew is normally to move into an adjacent car. This avoids or minimizes the hazards inherent with evacuating passengers onto the railroad right-of-way.

APTA designed this standard to offer flexibility in application, as well as to achieve the desired goal of facilitating passenger and crew egress from potentially life threatening situations in passenger rail cars. Individual railroads have the responsibility to design, install and maintain emergency signage system that is compatible with their internal safety policies for emergency evacuation, while complying with the performance criteria specified in this standard.

### 1.1 Scope

This standard applies to all passenger rail cars that operate on the general railroad system in the United States. This standard does not apply to tourist, scenic, historic, excursion operations, or private rail cars.

Revision 3 of this standard takes effect April 7, 2008, unless otherwise specified (see Sections 5 and 7).

This standard contains requirements for signs, markings, and instructions for emergency exits and rescue access points. This standard is an integral component of a systems approach to facilitate the ability of passengers and train crewmembers to locate, reach, and operate emergency exits and emergency responders to gain access into the car to promote safe evacuation from a rail car or train in the event of an emergency. The other required components of this systems approach are emergency lighting and low location exit path marking (LLEPM), which are described in the following APTA standards:

*APTA PR-E-S-013-99, Rev. 1, Standard for Emergency Lighting System Design for Passenger Cars* [2]*;* and

*APTA PR-PS-S-004-99, Rev. 2, Standard for Low-Location Exit Path Marking.*

### 1.2 Purpose

This standard specifies minimum requirements for the design and selection of the physical characteristics, informational content, and placement of all interior emergency exit and exterior rescue access signs / markings and instructions. This standard also requires tests to validate the design.

Complementary emergency systems provide emergency lighting and low-location exit path markings to locate, operate, and reach emergency exits and are covered in separate APTA standards.

## 2. References

This standard shall be used in conjunction with the applicable sections of the following publications. When the following publications are superseded, the revision shall apply.

ANSI/ASQC Z1.9-1993, Sampling Procedures and Tables for Inspection by Variables.

APTA PR-E-RP-007-98, Standard for Storage Batteries and Battery Compartments.

APTA PR-E-RP-012-99, Recommended Practice for Normal Lighting System Design for Passenger Rail Equipment.

APTA PR-CS-S-012-02, Standard for Passenger Car Door Systems for New and Rebuilt Passenger Cars.

APTA PR-E-S-013-99, Rev. 1, Standard for Emergency Lighting System Design for Passenger Cars.

APTA PR-IM-S-001-98, Rev. 1, Standard for Passenger Rail Equipment Battery System Periodic Inspection and Maintenance.

APTA PR-IM-S-005-98, Rev. 2, Standard for Passenger Compartment Periodic Inspection and Maintenance.

APTA PR-IM-S-007-98, Rev. 1, Standard for Passenger Car Exterior Periodic Inspection and Maintenance.

APTA PR-IM-S-008-98, Rev. 1, Standard for Passenger Car Electrical Periodic Inspection and Maintenance.

APTA PR-IM-S-013-99, Rev. 1, Standard for Passenger Car Periodic Inspection and Maintenance.

[2] For references in Italics, see Section 2 of this standard.

APTA-PR-PS-S-001-98, Standard for Passenger Railroad Emergency Communications.

APTA-PR-PS-S-004-99, Rev. 2, Standard for Low-Location Exit Path Marking.

ASTM D-4956-07 1$^{e}$, Standard Specification for Retroreflective Sheeting for Traffic Control.

ASTM E-810-03, Standard Test Method for SIA of Retroreflective Sheeting.

ASTM E-2073-07, Standard Test Method for Photopic Luminance of Photoluminescent (Phosphorescent) Markings.

49 CFR, Part 223, Safety Glazing Standards.

49 CFR Part 238, Passenger Equipment Safety Standards.

49 CFR, Part 239, Passenger Train Emergency Preparedness.

FRA, Emergency Order Number 20, Notices 1 and 2.

National Transportation Safety Board Recommendations to Federal Railroad Administration, FRA R-97-16 and R-97-17.

# 3. Definitions, abbreviations, and acronyms

## 3.1 Definitions

For the purposes of this standard, the following terms and definitions apply:

**3.1.1 active illumination:** Illumination that is generated by electrical energy.

**3.1.2 auxiliary power system:** An on-board source of electrical power (e.g., alternator / generator / car battery) typically used under normal operating conditions to supply such functions as lighting, air conditioning, etc.

**3.1.3 candela: (cd):** Unit of luminous intensity in both SI and English measurement systems. One candela is 1lumen per steradian (lm/sr). It is almost exactly equal to the obsolete unit called the candle.

**3.1.4 car:** A passenger-carrying rail vehicle.

**3.1.5 color temperature:** a numerical descriptor of the hue of a light source. It is expressed in terms of degrees on the Kelvin scale, and refers to the temperature of black-body radiator that produces light of the same hue as the source specified. Low color temperatures correspond to reddish sources, such as, candle flames or incandescent lamps. Higher color temperatures are associated with cool-white fluorescent lamps, blue sky and several types of new lighting technology.

**3.1.6 dual-mode:** Utilizing a combination of active (electrically powered) and passive (PL) light sources.

**3.1.7 electroluminescence (EL):** Luminescence resulting from the application of an alternating electrical current to phosphor.

**3.1.8 emergency exit locator signs:** Conspicuous emergency marking/signage used to identify and/or direct passengers to the nearest emergency exit location(s).

**3.1.9 emergency signage:** Textual and graphic messages designed to assist passengers and train crewmembers in locating and using rail car emergency exits and to assist emergency responders in gaining access to rail cars using doors and windows from the exterior.

**3.1.10 externally illuminated:** The light source is contained outside the sign, device, legend, marking, or path that is illuminated, e.g., a non-photoluminescent sign with a light source shining on its surface. This source may be designed to provide dedicated illumination for a specific location or general emergency illumination. Fluorescent or incandescent lamps are typically used.

**3.1.11 foot-candle:** A unit of illuminance. One foot-candle is 1lumen per square foot ($Lm/ft^2$). In the international system (SI), the units of illuminance are lux (1 fc = 10.76 lux).

**3.1.12 head-end power (HEP):** A system by which electrical power is provided to railroad vehicles from a central source via a trainline system. The source of power can be a locomotive or a power car (Wayside supply from catenary, third rail, or trackside can also be transformed into HEP as it passes through the power system). HEP is used under normal operating conditions to provide electrical power to the passenger equipment systems, such as "normal" lighting. In the United States, 480 VAC, 3-phase systems are most common.

**3.1.13 high-performance photoluminescent (HPPL) material:** A photoluminescent material that is capable of emitting light at a very high rate and for an extended period of time. For this standard, the minimum luminance value for HPPL is 7.5 milli-candela per square meter (7.5 $mcd/m^2$), for 1.5 hours after removal of the charging light source. Unless otherwise permitted in this standard, the charging light source is specified as a fluorescent lamp with a color temperature of 4000-4500°K that provides an illuminance of no more than 1 fc on the test sample for a duration of no more than 1 hour.

**3.1.14 HPPL material -former:** An HPPL material that is capable of emitting light at a high rate and for an extended period of time. For this standard, the minimum luminance value for HPPL is 7.5 milli-candela per square meter (7.5 $mcd/m^2$), for 1.5 hours after removal of the charging light source. Unless otherwise permitted in this standard, the charging light source is specified as a fluorescent lamp with a color temperature of 4000-4500°K that provides an illuminance of no more than 5 fc on the test sample for a duration of no more than 1 hour.

**3.1.15 icon:** A sign or representation that stands for an object by virtue of a resemblance or analogy to it.

**3.1.16 illuminance:** The amount of light (luminous flux) falling on a specific unit surface area (e.g., 1square foot). English units are foot-candles (fc) or lumens per sq. foot ($Lm/ft^2$). International units (SI) are lumen per sq. meter ($Lm/m^2$) or lux (lx). One fc equals 10.76 lux.

**3.1.17 independent power source:** A sealed battery or other energy storage device located within the car body designed to power one or more emergency light fixtures or other devices when the normal HEP, main car battery, auxiliary power, and/or wayside power are unavailable.

**3.1.18 internally illuminated:** The light source is contained inside the sign, device, or legend that is illuminated**,** e.g., a light fixture with the word "EXIT" printed on the diffuser. The light source is typically incandescent, fluorescent, EL, or LED.

**3.1.19 lighting, emergency:** Lighting mode that is available whenever power for the normal lighting is unavailable. The main car battery or one or more independent power sources can be used to supply the power to operate the fixtures that provide emergency lighting.

**3.1.20 lighting, normal:** Lighting mode that is available when the car is in operation with the normal power system.

**3.1.21 luminance:** The amount of light reflected from a unit area or surface or the amount of light emitted from a surface, e.g., EL or LED material. English units are foot-lamberts (fl). International units (SI) are candela per square meter (cd/ $m^2$) (also called "nits") and milli-candela per square meter (mcd/$m^2$). (1 fl = 3.426 cd/$m^2$ or 3426 mcd/ $m^2$.)

**3.1.22 luminescence:** The emission of light other than incandescent, as in phosphorescence or fluorescence by processes that derive energy from essentially non-thermal sources through excitation by radiation.

**3.1.23 luminous intensity:** The luminous flux per unit solid angle in the direction measured. Expressed in candelas or lumens per steradian.

**3.1.24 luminaire (light fixture):** A device to produce, control, and distribute light. A complete unit typically consisting of one or more lamps, sockets to hold and protect the lamps, optical devices to direct the light, and circuitry to provide the required electric power to the lamp(s).

**3.1.25 luminance contrast:** Refers to the relationship or difference between the object and its immediate background, defined by the ratio:

$$\frac{L_1 - L_2}{L_1}$$

Where: $L_1$ = luminance of background

$L_2$ = luminance of the object in question (e.g., lettering, pictogram, symbol)

**3.1.26 marking / delineator:** A visible notice, sign, symbol, line or trace.

**3.1.27 passive illumination:** Illumination that is generated without the use of direct electrical energy.

**3.1.28 pictogram / pictograph:** A pictorial sign or symbol.

**NOTE 1--** Both words share the same meaning. For the purposes of this standard, the term "pictogram" will be used.

**3.1.29 photoluminescent (PL) material:** Material having the property of emitting light that continues for a length of time after excitation by visible or invisible light has been removed (i.e., self-illuminating).

**3.1.30 reflectance factor:** The ratio of the luminous flux reflected by a surface to the luminous flux it receives.

**3.1.31 representative car / area:** A car / area that shares the relevant characteristics as the car(s) / area(s) it represents (i.e., same signage / marking layout, and charging light system for passive systems or light fixtures and power system for electrically powered systems).

**3.1.32 retroreflective material:** A material that is capable of reflecting light rays back to the light source.

**3.1.33 sign:** A display board, poster, placard, or marking / delineator using text and/or graphics to convey information or direction.

**3.1.34 symbol:** A letter, figure, other character, arrow**,** or mark or any combination thereof used for designating something else by association, resemblance or convention.

**3.1.35 spatial average:** The average of all samples taken in the vicinity of a specific location. The area of a spatial average varies. For a stairway, it comprises only the area of the stair step (s). For an aisle, the entire length of the aisle is included.

**3.1.36 useful field of view (UFOV):** Useful field of view refers to the sensory, perceptual and attentional processes that address the ability to attend to one's surroundings, detect information and identify that which demands action. In terms of behavior, UFOV includes that information which can be extracted from a glance.

## 3.2 Abbreviations and acronyms

| | |
|---|---|
| ADA | Americans with Disabilities Act |
| APTA | American Public Transportation Association |
| ASTM | ASTM International (American Society for Testing and Materials) |
| CFR | Code of Federal Regulations |
| CIE | Commission Internationale de l'Eclairage (International Commission On Illumination) |
| EL | Electroluminescent |
| FRA | Federal Railroad Administration |
| HEP | Head-end power |
| HPPL | High performance photoluminescent |
| LED | Light emitting diode |
| NTSB | National Transportation Safety Board |
| PL | Photoluminescent |
| PRESS | Passenger Rail Equipment Safety Standards |
| SIA | Specific intensity per unit area |
| UFOV | Useful field of view |
| UL | Underwriters' Laboratories |

# 4. General system requirements

Emergency signs / markings shall be designed to provide evacuation guidance for passengers and train crewmembers and rescue access guidance for emergency responders.

## 4.1 Visual identity and recognition

All emergency exit and rescue access signage / marking systems shall contain brief and quickly understandable information, with consideration for useful field of view (UFOV). That is, emergency exit signage / marking systems shall enable passengers and/or train crewmembers to make positive identification of emergency exits. Rescue access signage / marking systems shall enable emergency responders to make positive identification of rescue access points without undue hesitation, delay, or confusion. Signs / markings and instructions shall utilize, to the extent practical, commonly recognized/used information symbols, icons, graphics, and pictograms, as well as standardized color, contrast, content, and placement.

Each interior emergency exit sign and emergency exit locator sign shall be conspicuous (i.e., clearly recognizable / distinguishable) or become conspicuous to passengers and train crewmembers immediately and automatically upon the loss of power for normal lighting, from a minimum distance of 5 feet (1.52 m). Each sign / marking shall remain conspicuous under the minimum general emergency light illumination levels as specified in *APTA PR-E-S-013-99, Rev. 1, Standard for Emergency Lighting System Design for Passenger Cars* as well as under total darkness should the emergency lighting systems fail. The signs / markings shall operate independently of the car's normal and emergency lighting systems, if applicable (see Section 5.5.1), for a minimum of 1 or 1.5 hours, as applicable (see Sections 3.1.14, 5.5.1, and 5.6), after loss of all power for normal lighting. An emergency exit locator sign shall be located in close proximity of each emergency exit and shall work in conjunction with the emergency exit sign, except as noted in Sections 5.1.1.2 and 5.1.2.1. The location of the sign, directional arrow(s), or wording shall guide passengers and train crewmembers to the emergency exit route (see Section 5.1).

Each emergency rescue access sign / marking shall be conspicuous on the exterior of the car (see Section 6).

## 4.2 Multilingual signs

At a minimum, any words included in emergency exit /rescue access signage shall be in English. However, when system-specific determinations are made or are otherwise mandated by local, municipal, state, or other regulations, signage / instructions shall be written in designated language(s), in addition to English.

# 5. Design requirements - interior

Emergency exit and evacuation information placed within the interior of the car body shall, at a minimum, consist of the following signs / markings / instructions:

- Door exit signs / markings and instructions;
- Door exit locator signs / markings, if necessary (see Section 5.1.1.2);

- Door exit control locator signs / markings;
- Emergency window exit locator signs / markings, if necessary (see Section 5.1.2.1); and
- Emergency window exit signs / marking and instructions.

## 5.1 Location

### 5.1.1 Door exits

#### 5.1.1.1 Door signs / markings

Each vestibule door, end-frame door, and side door leading to the exterior that is intended for emergency egress shall be identified by a sign / marking that contains the wording "EXIT," "EMERGENCY EXIT," or other similar wording in capital letters.

Each sign shall be located on the door or door glazing, or in the immediate proximity. The center of the sign shall be located on the upper half of the door / car, and shall be conspicuous. See Sections 5.4.2.2 and 7.1.2.2.

When a door designated as an exit is locked, secured or otherwise inoperative, additional measures shall be taken to provide emergency opening instructions for the door exit or direct passengers to an alternative door exit and/or emergency window exit. At a minimum, railroads shall provide such safety awareness information to passengers and may comply by using one or more of the following methods: on-board announcements, laminated wallet cards, ticket envelopes, timetables, station signs or video monitors, public service announcements, or seat drops. A railroad shall take the following additional safety awareness measures, where applicable:

- **Alternative Door Exit:** If passengers are directed to an alternative door exit, and the method for opening the alternative door exit is not obvious, emergency instructions for opening that exit shall be posted at that exit location.
- **Routinely Locked or Secured Door Designated as an Exit:** If a railroad routinely locks or secures a door designated as an exit (*e.g.*, the outermost end door in a train), the railroad shall also post information regarding one or more alternative exits inside the car (*e.g.*, on car bulkhead signs, seatback decals, or seat cards).

If a door designated as an exit is not available for use as an exit and the car in which it is located is continuing in passenger service pursuant to 49 CFR § 238.305(d), a railroad shall provide written notice to the train crew of the non-complying condition and prominently display a notice on the defective door indicating that the door is defective, as required by 49 CFR § 238.305 (c) (10).

**NOTE 2--** HPPL signs/markings installed in shadowed locations should be avoided, to the extent practicable.

### 5.1.1.2 Door exit locator signs / markings

If a door exit is not within sight of any seat or standee location (e.g. visibly blocked by a bulkhead or divider), a door locator sign shall be provided to enable passengers and train crewmembers in those areas to identify the location of such door exit.

The locator(s) sign shall consist of brief text, graphic arrow(s), or symbol(s) that are placed on bulkheads, dividers, seat frames / pockets, armrests, luggage racks, ceilings, etc., to direct passengers towards the nearest door that can be used for emergency egress.

### 5.1.1.3 Door exit control locator signs / markings

Each door exit handle, latch, or operating button shall be marked with HPPL material using one of the following methods:

1) Outline stripping that is no less than 1-inch (2.54 cm) wide to the extent practicable around the perimeter of the opening device, or

2) Area wide pad that is applied to the door or doorframe directly behind the handle or latch with either of the following dimensions:

   - For equipment ordered before April 7, 2008, and placed in service before January 1, 2011, no less than 6 square inches (39 $cm^2$).
   - For equipment ordered on or after April 7, 2008, or placed in service for the first time after January 1, 2011, no less than 16 square inches (103 $cm^2$).

In addition, for each door equipped with a separate manual override device for a power-operated door intended for emergency egress shall be marked with a sign / marking containing the words “Emergency Door Control,” “Manual Door Control,” or other similar wording. These signs / markings shall be placed at the manual door control or at an appropriate location in its immediate proximity.

If it is not obvious where the manual override device is located relative to the door handle, latch or operating button, a door control locator sign shall be posted. The manual door control locator sign(s) / marking(s) shall consist of brief text, graphic arrow(s), or symbol(s) to direct passengers / crewmembers from the door control to the location of the manual door override.

### 5.1.1.4 Instructions

If the method for opening a door intended for exit is not obvious, operating instructions shall be posted at that door’s control or in its immediate vicinity.

Operating instructions shall be posted at or near each manual override device for a door intended for emergency egress.

### 5.1.2 Emergency window exits

#### 5.1.2.1 Exit locator signs / markings

Emergency exit locator signs / markings directing passengers / crewmembers to the nearest emergency window exit location(s) shall be provided. The signage / marking shall use the words "EMERGENCY EXIT," or similar wording. This signage / marking may take the form of:

- Signage / marking on walls;
- Signage / markings on light fixtures located above the emergency window exit; and / or
- Signage / markings located on the ceiling, window or seat frames / armrests.

One sign / marking may serve more than one emergency window exit if the sign / marking can readily identify each such exit. If all of the side windows installed in the passenger compartment of the rail car can be used for emergency egress, locator signs are not required.

An emergency window exit sign may serve as a locator sign if it meets the minimum requirements for a locator sign.

#### 5.1.2.2 Exit signs / marking and instructions

Each interior emergency window exit shall be identified with a sign / marking located on or adjacent to each such window. In addition, instructions, including pictorial diagrams, for opening the window shall be posted on or adjacent to each such window.

Each emergency window exit equipped with a pull handle shall be identified with "EMERGENCY EXIT PULL-HANDLE" marking; either as an integral part of the handle marking, or with instructions / illustrations applied as a decal in the immediate vicinity, or a combination of these.

Locations that are space limited, such as the emergency window pull handle, as well as supplemental operating instructions, shall have the characters as large as feasible for the allotted space. See Note 3 of this standard (Section 5.2).

## 5.2 Letter / sign size

### 5.2.1 Letter size

The letter characters on emergency exit signs and markings and emergency exit locator signs intended to be read by the general public shall have a minimum character height using upper case letters of:

- 1 inch (2.54 cm) on emergency window exit signs and locator signs
- 1½ inches (3.81 cm) on door exit signs and locator signs

In addition, the characters shall have the following characteristics:

- A width-to-height ratio between 3:5 and 1:1;
- A stroke-to-width ratio between 1:4 and 1:6 (i.e., the width of the lines which are combined to produce a letter); and
- Spacing between letters of a minimum of 1/16 the height of the upper case letters.

**NOTE 3--** The letter size and other requirements above are based on compliance with Section 5.3, as well as luminance / illuminance criteria measured at the sign surface, as specified in Section 5.4. Otherwise, signs may not be legible (see also Notes in Section 5.3).

**NOTE 4--** These requirements do not apply to instructional signage / marking.

**NOTE 5--** Raised letter characters may be utilized.

### 5.2.2 Sign size

A minimum sign area of 16 square inches (103 $cm^2$) is required for all end and side door exit signs installed after April 7, 2008.

## 5.3 Color and contrast

Lettering and pictogram(s) utilized on interior emergency exit signage / marking shall be designed to achieve a luminance contrast ratio of not less than 0.5, as measured by a color-corrected photometer.

**NOTE 6--** The recommended color contrast choice for all new and replacement signage is red lettering / graphics on a light PL background preferably with a matte finish, except for those instances where bold contrast with the background on which the sign is placed would not be attainable.

LED-based dual–mode signage / marking components shall use either white or green charging light.

**NOTE 7--** Dual-mode signs with white charging light sources may use red (or green) lettering.

**NOTE 8--** A contrasting border around the outer edge of the sign will also enhance visibility.

**NOTE 9--** The more of the HPPL surface that is visible (i.e. not covered with letters, symbols, etc.), the more conspicuous the resulting sign. Graphics, or heavy text covering the HPPL material, will reduce the light output of the sign letters, and thus conspicuity and legibility of the signs, even though the HPPL material passes the tests required in Section 7.

## 5.4 Illuminance / luminance criteria

Sign / marking component illumination or luminance levels, as applicable, shall be initially verified in accordance with Section 7 and maintained in accordance with Section 10.

The difference between the physical characteristics of electrically powered light sources and HPPL materials has an impact on their visibility and thus the performance criteria and installation location within various rail car configurations. Wherever illumination from the normal lighting system is less than required for charging (see Sections 5.4.2.2 and 5.6), dual-mode sign systems can be used to achieve greater conspicuity. Additional measures for addressing extenuating circumstances are described in Annex B.

### 5.4.1 Active electrically powered systems

The light sources utilized to comply with the criteria required in this section shall be electrically powered (e.g., fluorescent, electroluminescent (EL), incandescent, or light emitting diodes (LED) point sources).

#### 5.4.1.1 Internally illuminated signs / markings

The luminance value of signs / markings using incandescent, fluorescent, or EL point sources shall be at least 1000 mcd/$m^2$, as measured on the sign surface.

**NOTE 10--** Most electroluminescent signs have an initial luminance of more than 20,000 mcd/$m^2$, but they may show substantial luminance degradation (more than 80%) over their service lives. Service life estimates range from 30,000 hours to 100,000 hours (7 to 20 years) for stationary equipment.

For signs / markings installed on or after April 7, 2008, with exposed LEDs that spell out "EXIT," each LED shall have a minimum peak intensity of 35 mcd. For signs using LEDs with a transparent cover or dual mode, the average luminance measured on the surface, when powered, shall be at least 1000 mcd/$m^2$.

#### 5.4.1.2 Externally illuminated signs / markings

Non-HPPL externally illuminated signs / markings shall receive a minimum illuminance level of 5 fc, as measured on the sign / marking surface.

**NOTE 11--** It may be possible to install an independently powered emergency light fixture in a position such that it illuminates an emergency sign / marking.

### 5.4.2 HPPL (Passive)

#### 5.4.2.1 Materials

Signs / marking constructed of HPPL material shall provide a luminance value of at least 7.5 mcd/$m^2$ for either 1 or 1.5 hours, as applicable, after loss of normal power (see Sections 3.1.14, 5.5.1, and 5.6).

#### 5.4.2.2 Charging light

Because the illuminance levels required to provide sufficient charging vary according to the type of light source used, the minimum charging light values, are as specified in Table 1.

These illuminance values shall be measured with a light meter meeting the requirements in Section 7 and with the sensor placed flat against the surface of the sign / marking (see Annex C).

HPPL materials certified by an independent test laboratory to meet Table 1 with the lower amount of charging light are permitted for use at that location as long as the specified amount of light is available.

HPPL signs / markings certified by an independent test laboratory to be capable of meeting the specifications in 3.1.13 that are located in partitioned vestibules / compartments / passageways that are no longer than 5 ft (1.5 m) longitudinally (including partially portioned vestibules) are not subject to the illuminance requirements in Table 1.

Table 1. Minimum Illuminance Values for Charging HPPL Materials

| HPPL Illuminance FC (lux) | TYPE OF LUMINAIRE (Charging Light) |
|---|---|
| 0.8 (8.6) | Cool-white LED (6500º K) |
| 0.9 (9.7) | Warm-white LED (4700º K) |
| 1.0 (10.8) | Cool-white Fluorescent (4000 - 4500ºK) |
| 1.5 (16.1) | Warm-white Fluorescent (3000 - 3500ºK) |
| 3.5 (37.7) | Incandescent (2900 ºK) |

To ensure that the normal lighting system provides an adequate charge to the HPPL system, luminaires (light fixtures) shall be located in the proximity of each HPPL component and oriented to ensure that the HPPL material is adequately exposed to charging light. Section 7 and Annex B contain information that railroads can use to ensure sufficient light is available.

Luminaires (light fixtures) located in the proximity of each HPPL component shall be specified such that their light dispersion patterns provide the above listed minimum illuminance levels at the surface of the component.

**NOTE 12--** Consideration should be given to other illumination requirements for the area, including those for *APTA PR-PS-S-004-99, Rev. 2, Low Location Exit Path Markings* and ADA.

### 5.4.3 Dual-mode systems

Dual-mode systems comprised of active and passive components shall be designed so the HPPL material is adequately charged by an active light source in order to comply with the minimum

luminance criterion of 7.5 mcd/$m^2$, measured after 1 or 1.5 hours, as applicable (see Sections 3.1.14, 3.1.13, and 5.6), after activation lighting has been removed / ceased operating.

## 5.5 Component materials

Interior emergency exit signs / markings complying with Sections 5.2 through 5.3 shall be constructed of active electrically powered light sources, passive HPPL material, dual mode systems, or a combination, as specified in this section.

### 5.5.1 Vestibule, end-frame and side doors

Emergency exit signs / markings shall identify the location of all vestibule, end-frame, and side doors leading to the exterior of the car and intended for emergency egress using:

1) For passenger cars ordered before April 7, 2008, and placed in service before January 1, 2011:
   - HPPL material, including dual-mode (see Note 7), or
   - Electrically powered fixtures with an independent power source that can power the signs for least 1 hour after power for normal lighting ceases.
2) For passenger cars ordered on or after April 7, 2008, or placed in service for the first time on or after January 1, 2011:
   - HPPL material, including dual mode (see Note 7), or
   - Electrically powered fixtures with an independent power source, located in or within each ½ car length, that can power the signs / markings for at least 1.5 hours after power for normal lighting ceases. For electrically powered illuminated signs that use a battery as an independent power source, an automatic self-diagnostic module shall be connected to such power source and installed where its status indicator can be readily observed during the daily inspection (see Annex D).

For passenger cars ordered before April 7, 2008, and placed in service before January 1, 2011, each electrically powered sign / marking that is <u>not</u> dual mode shall have an independent power source that can power the sign / marking in accordance with the requirements above by January 1, 2012.

### 5.5.2 Additional requirements to mark side door exit locations without independently powered emergency lighting

By January 1, 2009, each side door opening intended for emergency egress leading to the exterior of the car, shall be marked with a minimum of 144 square inches (929 $cm^2$) of HPPL material placed no higher than 18 inches (45.7 cm) off the floor, with its lowest point no higher than 6 inches (15.2 cm) off the floor. The marking may be comprised of one or more panels placed either on the door and / or in its immediate vicinity.

**NOTE 13--** A door with two leaves that open for emergency egress is considered a single door opening. Therefore, 144 square inches (930 $cm^2$) of HPPL material is sufficient for that door opening.

To provide some illumination at the floor for passengers and crewmembers as they exit, to the extent practical, the material should not be placed on a door leaf that is intended to open for emergency egress or on the part of a wall or partition that would be covered by a trap door in any position.

Signs and markings used to comply with the LLEPM requirements contained in *APTA PR-PS-S-004, Rev. 2* may be counted towards this requirement to the extent that they meet the criteria noted above (e.g., HPPL door delineators required to meet the LLEPM requirements that are installed on the door 18 inches (45.7 cm) off the floor would count as 36 square inches (232 $cm^2$) of the 144 square inches (930 $cm^2$).

### 5.5.3 Door exit control locator signs / markings

Each door control locator sign / marking shall be constructed of HPPL material.

### 5.5.4 Emergency window exits

All emergency window exit markings shall be constructed of HPPL material.

## 5.6 Grandfathering of PL signs / markings

PL materials that meet the luminance levels of at least 7.5 mc / $m^2$ for at least 1 hour following a charge with the illuminance values in Table 2 are grandfathered. If PL materials certified by an independent laboratory to meet the former definition of HPPL (see Section 3.1.14) are charged with the illuminance levels in the first column of Table 2, such materials are presumed to meet these luminance levels. PL signs / markings installed in cars on or before April 7, 2008, and certified by an independent test laboratory to comply with these PL luminance criteria are grandfathered if any of the following conditions are met:

1) The location where they are installed receives the minimum illuminance listed for the type of luminaire used for charging as specified in Table 2. The illuminance values shall be measured (see Section 7.1.2.2) with a light meter meeting the requirements in Section 7 (See Annex C) and with the sensor placed flat against the surface of the sign / marking.
2) The illuminance values shall be measured with a light meter meeting the requirements in Section 7, except that its cosine error may be as specified in CNS 5119 (see Annex C) and with the sensor placed flat on the floor at any point within a horizontal distance of 3 feet (1 m) of the sign / marking. The illuminance values shall be at least five (5) times greater than the values listed in Table 2.
3) Signs / markings made of materials meeting the former definition of HPPL located in partitioned vestibules / compartments / passageways that are:
    - No longer than 5 ft (1.5 m) longitudinally (including partially partitioned vestibules); or
    - Between 5 ft (1.5 m) and 10 ft (3 m) in length measured longitudinally (including partially partitioned vestibules) that are charged by incandescent luminaires, and have:

- Locator signs in the seating area that comply with Section 5.3, and:
- Dimensions of at least:
  - o 2 inches (5 cm) in letter height, or
  - o 21 square inches (135 $cm^2$) in area.

**NOTE 14--** Some signs / markings may have to be replaced or some illumination levels increased.

If the ambient (normal charging light) illuminance is less than the required criteria specified, railroads can take several actions described in Annex B to increase the charging light levels.

Table 2. Minimum Illuminance Values for Charging HPPL (Former and Current Definitions) Materials – Grandfathering

| ILLUMINANCE VALUE - FC (Lux) | | TYPE OF LUMINAIRE (Charging Light) |
|---|---|---|
| Certified Under Former Definition of HPPL (Section 3.1.14) | Certified Under Current Definition of HPPL (Section 3.1.13) | |
| 1.6 (10.8) | 0.8 (8.6) | Cool-white LED (6500º K) |
| 1.8 (19.4) | 0.9 (9.7) | Warm-white LED (4700º K) |
| 2.0 (21.5) | 1.0 (10.8) | Cool-white Fluorescent (4000 - 4500ºK) |
| 3.0 (32.3) | 1.5 (16.1) | Warm-white Fluorescent (3000 - 3500ºK) |
| 7.0 (75.3) | 3.5 (37.7) | Incandescent (2900 K) |

Existing stocks of PL material held in inventory as of April 7, 2008, that meet the former definition of HPPL may be installed only in locations that qualify under one of the conditions listed above and which are not shadowed by structural elements or other permanent fixtures.

## 6. Design requirements - exterior

Rescue access information for emergency responders placed on the exterior of the car body shall, at a minimum, consist of the following:

- Rescue access door signs / markings and instructions;
- Rescue access door control locator signs / markings and instructions;
- Rescue access window locator signs / markings and instructions; and
- Roof access locator signs / markings and instructions, if applicable.

## 6.1 Location

### 6.1.1 Rescue access doors

#### 6.1.1.1 Door signs / marking

Each door intended for use by emergency responders for rescue access shall be identified with emergency access signs, symbols, or other conspicuous marking consisting of retroreflective material that complies with Sections 6.2 and 6.3.

#### 6.1.1.2 Door control signs / marking and instructions

Each door intended for use by emergency responders for rescue access shall have operating instructions for opening the door from outside the car placed on or immediately adjacent to the door on the car body. If a power door does not function with an integral release mechanism, the instructions shall indicate the location of the exterior manual door control.

Each power door intended for use by emergency responders for rescue access which has a non-integral release mechanism located away from the door, shall have a door control sign / marking placed at the location of this control that provides instructions for emergency operation, either as part of the access sign / marking or as another sign /marking.

Each car equipped with manual doors shall have operating instructions for opening the door from the exterior, either as part of the access sign / marking or as another sign /marking.

### 6.1.2 Rescue access windows

Each rescue access window shall be identified with a unique retroreflective and easily recognizable sign, symbol, or other conspicuous marking that complies with Sections 6.2 and 6.3.

Signs, symbols, or marking shall be placed at the bottom of each such window, on each window, or adjacent to each window, utilizing arrows, where necessary, to clearly designate rescue assess window location. Legible and understandable window-access instructions, including any pictogram / instructions for removing the window, shall be posted at or near each rescue access window.

### 6.1.3 Emergency roof access

The location of each emergency access point provided on the roof of a passenger car shall be clearly marked with retroreflective material of contrasting color that complies with Sections 6.2 and 6.3. Legible and understandable instructions shall be posted at or near each such location.

If emergency roof access is provided by means of a structural weak point:

1) The retroreflective material shall clearly mark the line along which the roof skin shall be cut; and

2) A sign plate with a retroreflective border shall also state:

**CAUTION--DO NOT USE FLAME CUTTING DEVICES.**

**CAUTION--WARN PASSENGERS BEFORE CUTTING.**

**CUT ALONG DASHED LINE TO GAIN ACCESS.**

**ROOF CONSTRUCTION – [STATE RELEVANT DETAILS].**

### 6.2 Color and contrast

Exterior signs / markings shall provide luminance contrast ratio of not less than 0.5, as measured by a color-corrected photometer.

**NOTE 15--** A light background color should be used for the signs / markings along with dark lettering e.g., red or black letters on a white or yellow background), except for those instances where bold contrast with the background on which the sign / marking is place would not be attainable.

**NOTE 16--** Contrasting borders around the outer edge of the sign will also enhance visibility.

### 6.3 Materials

Exterior emergency rescue access locator signs / markings shall be constructed of retroreflective material that conforms to the specifications for Type I material sheeting, as specified in *ASTM D 4956*-07 1$^{e}$, *Standard Specification for Retroreflective Sheeting for Traffic Control*.

In order to maintain optimum retroreflective properties of the base material, any retroreflective markings that have ink or pigment applied shall utilize a translucent or semi-translucent ink, as per the manufacturer's instructions. This may include a UV clear coat to prevent fading. Signs utilizing protective coatings or other materials for the enhancement of sign durability shall meet the retroreflectivity requirements.

## 7. Evaluation measurements and tests

### 7.1 Interior signs / markings

To verify that emergency signage system component design complies with the requirements of Section 5.4, railroads shall ensure that a qualification test is conducted on at least one representative passenger car / area, for each signage system layout, in accordance with this section and Annex C.

For equipment placed in service before January 1, 2008, the car(s) / area(s) shall be randomly selected and this test shall be conducted by December 31, 2008. For equipment placed in service for the first time on or after January 1, 2008, the first car to have the system installed may be tested and this test shall be completed prior to the car's release for operation in revenue service.

The railroads shall confirm that emergency exit signage system components comply with the minimum required illumination or luminance criteria, as applicable, for the specified duration (see Section 5.5.1).

To ensure accurate illuminance measurements including measurements on vertical surfaces at which the angle of incident light is large, the light meter must be designed to take such measurements and possess:

- Basic accuracy: ± 3% of reading ±1 digit or better,
- Resolution: 0.01 fc or better,
- Cosine error: no more than 6%, measured at 50 degrees, and
- Color correction to CIE photopic curve.

Unless the floor measurement value is known to be at least 5 times the value in Table 2, a 6.5 foot (2 m) separation between the sensor head and the display must be used to ensure that the close proximity of the person taking the measurements does not affect the readings.

### 7.1.1 Electrically powered (active) systems

Manufacturer / supplier provided independent laboratory certified test report results shall show that electrically powered components have been photo-metrically tested as appropriate for the type of light source:

1) Luminance for EL markings, and
2) Luminous intensity for point sources and comply with Section 5.4.1.

Railroads shall confirm that the power supply for electrically powered signage components will maintain the operating voltages specified by the sign / marking manufacturer / supplier for at least 1 or 1.5 hours, as applicable (see Section 5.5.1).

To ensure compliance with Section 5.4.1.2, electrically illuminated signs / markings, measurement shall be conducted in accordance with Sections 6.1, 6.2, 6.3.1, and 6.3.2 of *SS APTA PR-E-S-013-99, Rev 1, Standard of Emergency Lighting System Design for Passenger Cars.*

To take the measurement readings, the sensor is placed on the area of the sign / marking surface location where the light is brightest. The observer records the reading(s) using a data collection form (see Annex C).

The sensor and the readout device of the illuminance meter must be held in a manner so that the sensor is not affected by the observer's shadow.

### 7.1.2 HPPL (passive) systems

#### 7.1.2.1 Material luminance

Manufacturer / supplier-provided independent laboratory certified test result reports shall show that all tested samples of passive HPPL material, as used in the finished component configurations (including any cover or protective coating if used, but not including text or graphics) comply with the minimum luminance criterion of 7.5 mcd/$m^2$, after 1.5 hours, when tested according to the provisions of *ASTM E-2073-07, Standard Test Method for Photopic Luminance of Photoluminescent (Phosphorescent) Markings* (www.astm.org), with the following three modifications:

- Section 8.3—Activation: The HPPL material shall be activated with a fluorescent lamp of 40W or less and a color temperature of 4000-4500° K that that provides no more than 1 fc of illumination as measured on the material surface. The activation period shall be for no more than 1 hour.

- Section 8.4—Luminance: The photopic luminance of all specimens of the HPPL material shall be measured with a luminance meter as described in 5.2 (*of ASTM E-2073*), a minimum of 1.5 hours after activation has ceased.

- Section 9.1.12—Luminance in mcd/$m^2$: The test report shall include a luminance measurement 1.5 hours after activation has ceased.

A list of independent test laboratories is contained in Annex E.

The manufacturer / supplier is required to have a minimum of one batch of material for signs / markings of a given type certified. Signs / markings of the same certified type of material can be sold to multiple customers, even with minor changes in text or typography (see Note 9).

### 7.1.2.2 Ambient light charge

To confirm that HPPL emergency sign / marking components are installed in locations that receive adequate charging light, illuminance measurements shall be taken in accordance with Sections 5.4.2.2 or 5.6, as applicable. This requirement applies to each representative car /area tested.

The charging light shall consist only of that provided by the car's normal lighting system. All natural or other external light shall be excluded. Several methods can be used to eliminate ambient light for accurate data collection (e.g., work at night with cars parked away from bright yard lights; locate cars in a dark, windowless shop or carwash; mask windows and vestibules with roofing paper, flooring paper, or similar opaque materials; or drape cars with opaque tarpaulins).

If the ambient light can't be reduced to 0.01 fc, there are two alternative measurements that can be used to meet the requirements in Tables 1 and 2:

1) Measure the ambient light at each location and subtract that value from the value measured with the charging light system operating;
2) If the charging light system is at least twice the required levels in Tables 1 and 2 plus the ambient light reading, consider that the required levels to be met.

To take the measurement readings, the sensor is placed on the area of the HPPL sign / marking surface location where the light is brightest (or on the floor location as permitted in Sections 5.6 and 10). The observer records the reading(s) using a data collection form (see Annex C).

The sensor and the readout device of the illuminance meter should be held in a manner so that they can be read without the observer's shadow affecting the readings. If light diffusers are used on the light fixtures, the measurements shall be made with the light diffusers in place.

If the ambient (normal charging light) illuminance is less than the required criteria specified (see Sections 5.4.2.2 and 5.6), railroads can take several actions described in Annex B to increase the charging light levels.

### 7.2 Exterior signs / markings

Railroads shall ensure that retroreflective material is certified by an independent test laboratory to be in conformance with requirements for Type I sheeting materials, per *ASTM D-4956-05,* as tested in accordance with *ASTM E-810-03, Standard Test Method for SIA* (specific intensity per unit area) *of Retroreflective Sheeting*.

### 7.3 Recordkeeping

Railroads shall retain a copy of the car manufacturer / supplier provided independent laboratory certified test report results showing that the illuminance or luminance measurements, as appropriate, on the active area of the signage / marking component comply with the criteria specified in Section 5.4 or 5.6, as applicable, of this standard. (For HPPL systems, see Annex C.) Such records shall be kept until all cars with those components are retired, transferred, leased, or conveyed to another railroad for use in passenger service. A copy of such records shall be transferred to the accepting railroad along with any such cars.

Railroads shall retain a copy of the railroad-approved illuminance test plan(s) and test results until the next periodic test, or other test specified in Section 10 is conducted on a representative car / area, or until all cars of that type are retired, or are transferred, leased, or conveyed to another railroad. A copy of such records shall be transferred to the accepting railroads along with such car(s).

Railroads shall retain a copy of the certified independent laboratory test report results that certify that the retroreflective material complies with Type I materials per *ASTM D-4956-05* until all cars containing the retroreflective material are retired, or are transferred, leased, or conveyed to another railroad. A copy of such records shall be provided to the accepting railroads along with any car(s) that are transferred, leased, or conveyed.

## 8. System reliability

All emergency signage systems shall be designed so that the signs / markings remain conspicuous, notwithstanding the failure of any single individual sign, material segment, or any single light fixture, or battery or other power source.

**NOTE 17--** Batteries may fail to achieve normal service lives unless measures are taken to prevent their discharge when the signage / marking system is not needed. To avoid this situation, lighting circuits of signage / marking systems that use batteries for independent power sources should be turned off manually or by an automatic (voltage or timer-based) controller (e.g., when the car is not in passenger service). See Annex D for additional guidance.

For passenger cars ordered before April 7, 2008, and placed in service for the first time before January 1, 2011, electrically-powered emergency signs shall continue to function after the standby power and any other stages of load shedding have terminated, so that illumination at the minimum levels are maintained for at least 1 hour after loss of normal power. Effective January

1, 2012, such signs / marking shall also continue to function independently of the main car battery.

For passenger cars ordered on or after April 7, 2008, or placed in service for the first time on or after January 1, 2011, electrically-powered emergency signs / marking shall continue to function independently of the main car battery, so that illumination at the minimum levels are maintained for at least 1.5 hours after loss of normal power.

# 9. Operating conditions

Emergency signs/markings shall be conspicuous under all conditions including build up of dust, dirt, as well as discoloration of the HPPL or light diffuser components.

All emergency signage systems shall be designed to operate without failure under the conditions typically found in passenger rail equipment including expected mechanical vibrations and shock, as well as comply with electromagnetic interference and other criteria in *49 Code of Federal Regulations (CFR) Part 238, Passenger Equipment Safety Standards*, Sections 238.225 and 238.425.

All electrically powered signs / marking components using independent power sources in passenger cars ordered on or after April 7, 2008, or placed in service for the first time on or after January 1, 2011 shall be designed to operate in all equipment orientations and after the initial shock of a collision or derailment resulting in the following individually applied accelerations:

- longitudinal: 8g,
- lateral: 4g, and
- vertical: 4g.

# 10. Maintenance

## 10.1 Daily inspections

Railroads shall visually inspect all emergency signage system components, except those for roof access, during the daily inspections to determine that signs / markings components are present and conspicuous, and that signs and instructions are legible.

## 10.2 Periodic inspections and tests

### 10.2.1 Interior signs / markings

Railroads shall conduct periodic inspections and tests to verify that all emergency signage system components, including power sources, function as intended.

Railroads shall test a representative sample of passenger rail cars / areas, in accordance with Sections 10.2.1.1 and 10.2.1.2, using the procedures in Annex F or other statistically valid documented sampling method.

### 10.2.1.1 Electrically powered (active) systems

Railroads shall ensure that tests and inspections are conducted in conformance with the requirements of *APTA PR-IM-S-008-98, Rev. 1, Standard for Passenger Car Electrical Periodic Inspection and Maintenance; APTA PR-IM-S-001-98, Rev. 1, Standard for Passenger Rail Equipment Battery System Periodic Inspection and Maintenance; APTA PR-IM-S-013-99, Rev. 1, Standard for Passenger Car Periodic Inspection and Maintenanc*e; and *APTA PR-IM-S-005-98, Rev. 2, Standard for Passenger Compartment Periodic Inspection and Maintenance.*

**NOTE 18--** Criteria for acceptable main car battery characteristics are specified in *APTA PR-E-RP-007-98*

After the initial verification tests required by Section 7, railroads shall ensure that periodic tests to confirm that electrical component(s), including the emergency power source, function as intended and comply with Section 5.4, are conducted no less frequently than once every 8 years, with the first test conducted no later than 8 years after the car was placed in service for the first time.

The tests shall verify the minimum illumination / luminance level and duration of all interior emergency signage system components are conducted. Electrically powered components shall be photo-metrically tested as appropriate to the type of light source:

1) Illuminance for externally illuminated signs, and
2) Luminance for EL signs.

If the luminance level of photometrically-tested EL signs, measured in the first two randomly selected representative sample cars / areas is at least 2000 mcd/$m^2$, for the specified duration (see Section 5.5.1), no further testing is required for the cars / areas represented by the sample car / area tested for the periodic cycle.

Other types of light sources do not require photometric testing if the main car battery / independent power source (s) that provides emergency lighting power is designed and maintained to provide the operating voltages to the sign / marking specified by the manufacturer / supplier to comply with Section 5.5.1.

Independent power sources using batteries shall be certified by their manufacturers / suppliers to be capable of maintaining operation of the sign / marking components to which they connected for the specified duration (see Section 5.5.1).

For electrically powered illuminated interior door exit signs that use a battery as an independent power source and have an automatic self-diagnostic module, the module shall perform discharge tests. (See Annex D for additional guidance.)

Each sealed battery shall be replaced at two-year intervals, unless equipped with a controller that automatically prevents unnecessary discharge. If so equipped, the battery-replacement interval shall be in accordance with the manufacturer's specifications, or if not specified, at least every five years.

For electrically powered illuminated interior door exit signs that use capacitors as independent power sources, a functional test shall be conducted as part of the periodic inspection. Due to their long life, the self-diagnostic test and the two-year replacement requirements do not apply to capacitor-based energy storage devices.

#### 10.2.1.2 PL (passive) systems

Railroads shall conduct tests and inspections in conformance with the requirements of *APTA PR-IM-S-005-98, Rev. 2, Standard for Passenger Compartment Periodic Inspection and Maintenance.*

Railroads shall also conduct tests specified in this section to verify that all PL (passive) interior emergency signage system components receive sufficient illuminance from the charging light to provide the required luminance for the required duration (See Sections 5.4.2.2, 5.5.1, and 5.6). Charging light shall be photo-metrically tested as appropriate to the type of light source.

Railroads shall conduct periodic illuminance tests to confirm that PL components receive adequate charging light no less frequently than once every 8 years, with the first test conducted no later than 8 years after the car was placed in service for the first time, for only the following PL-components:

1) HPPL signs/markings placed in areas designed or maintained with normal light levels of less than 5 fc.

2) Grandfathered PL materials, where the sign / marking is placed in an area designed or maintained with normal light levels of less than 10 fc.

If all of the illuminance levels in the first two randomly selected representative sample cars / areas exceed the minimum required to charge the PL components required by this standard by at least a factor of 2, no further testing is required for the cars / areas represented by the sample car / area tested for the periodic inspection cycle.

### 10.2.2 Exterior signs / markings

Railroads shall conduct periodic inspections of the exterior emergency signage system that conform with the requirements of *APTA PR-IM-S-007-98, Rev. 1, Standard for Passenger Car Exterior Periodic Inspection and Maintenance.*

## 10.3 Defect reporting, repair, and recordkeeping

Illegible, broken, damaged, missing, or non-functioning components of either the interior or the exterior emergency signage system, including the normal and emergency power systems, shall be reported and repaired in accordance with railroad procedures that comply with FRA *(49 CFR, Part 238)* defect reporting procedures.

Recordkeeping shall be in accordance with railroad procedures that comply with FRA (*49 CFR, Part 238)* recordkeeping procedures.

## Annex A (informative)

## Bibliography

[B1] ASTM E-808-01, Standard Practice for Describing Retroreflection.

[B2] ASTM E-809-02, Standard Practice for Measuring Photometric Characteristics of Retroreflectors.

[B3] ASTM E-2030-047, Standard Guide for Recommended Uses of Photoluminescent Safety Markings.

[B4] ASTM E-2072-04, Standard Specification for Photoluminescent (Phosphorescent) Safety Markings.

[B5] Deutsche Industrie Norm (DIN) 67510, Parts 1-4: German Standard: Phosphorescent Pigments and Products, January 1992.

[B6] DOT-FRA-ORD-93-24, FRA/Volpe Center, USDOT, Recommended Emergency Preparedness Guidelines for Passenger Trains, December 1993.

[B7] Illuminating Engineering Society (IES), Handbook Reference and Applications, Chapter 29: Emergency, Safety and Security Lighting, 9th edition, 2000.

[B8] International Standards Organization (ISO) 3864-1: 2003, Graphical Symbols—Safety Colours and Safety Signs—Design Principles for Safety Signs Used in Workplaces and Public Areas (First edition 2002, Corrected version 2003).

[B9] ISO 7010: 2002, Graphical Symbols--Safety Colours and Safety Signs—Safety Signs Used in Workplaces and Public Areas. 1st Edition.

[B10] ISO 9186, 2001, Graphical Symbols—Test Methods for Judged Comprehensibility and for Comprehension. 2nd Edition.

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[B13] National Bureau of Standards (NBS), Technical Note 11-80, National Bureau of Standards, Size of Letters Required for Visibility as a Function of Viewing Distance and Observer Visual Acuity, NBS Technical Note 11-80, July 1983.

[B14] NFPA 70, National Electrical Code, 2006.

[B15] NFPA 101, Life Safety Code: Chapter 7, Means of Egress, 2006.

[B16] NFPA 130, Fixed Guideway and Passenger Rail Systems, NFPA, Quincy, MA, 2006.

[B17] UL 924, Standard for Emergency Lighting and Power Equipment—9h Edition—Dated February 24, 2006. Effective date August 24, 2006.

[B18] U.S. Architectural & Transportation Barriers Compliance Board, Commuter Rail Cars and Systems Technical Assistance Manual, Oct. 1992.

[B19] Federal Aviation Administration (FAA). 14 CFR Part 25, Airworthiness Standards, Transport Category Airplanes: Subpart D, Design and Construction, Subsection 25.811: Emergency Exit Marking.

# Annex B (informative)

# HPPL material technical considerations

## B.1 Variables

Five variables that affect the visibility of the HPPL material / component are:

- Location of the material in relation to the activating charging light;
- Illuminance charging levels provided by ambient light;
- Amount of time that the HPPL material component is exposed to light;
- Type of activating light source; and
- Energy-storage efficiency of the HPPL material.

The location of the HPPL material in relation to the activating light source and any objects that cast shadows on the material have a great impact on the illuminance provided by the charging light. Accordingly, HPPL material should not be located in shadowed areas.

Cool-white fluorescent lamps producing an illuminance level of 2 fc have been shown to provide sufficient charging light for materials meeting the former definition of HPPL (see Section 3.1.14) used in passenger rail cars. Adequate charging light for HPPL materials / components is generally available at most locations, except directly under the seats, or if there are overhangs or other obstructions that block light from reaching the material / component. Signs/markings certified according to the former definition of HPPL (see Section 3.1.14) require at least twice as much illuminance as HPPL material (see Section 3.1.13) to deliver the same luminance. HPPL materials certified to the former definition were usually designed with a large safety factor so that they do not actually require 5 times as much light for charging as the HPPL material defined in Section 3.1.13.

Another variable is the available HPPL charging time. The adequate charging time at 1 fc is at least ½ hour from dark storage until departure.

The type of charging light that is used will affect the amount of illumination required to charge the signs / markings adequately. Most of the visible spectrum (red, orange and yellow) of a light source is not useful for charging PL materials. Short-wave length ultraviolet light is the most effective part of the light spectrum for charging PL materials. Photons of longer wavelength do not have enough energy to excite the electrons of the PL material. For example, 1 fc of illumination from a commonly available cool-white fluorescent lamp will provide sufficient illumination to meet the HPPL luminance criterion. However, 1 fc of illumination from commonly available warm-white fluorescent and incandescent lamps will not. If warm-white fluorescent lamps are used, the minimum charging light level must be at least 50% higher. If incandescent lamps are used, the minimum charging light level will be more than three times higher than is sufficient with cool-white fluorescent lamps.

White LED light contains a higher proportion of short-wave light, and is thus somewhat more effective than cool-white fluorescent light for charging. In addition, since LEDs are fundamentally unidirectional light emitters, luminaires that use them must be specifically

designed to disperse light through the use of multiple emitters pointing in different directions, reflectors and/or diffusers. Therefore, it is important that procurement documents explicitly state the illuminance levels required on the surface of the PL signs / markings.

In addition to these five variables, an important consideration is the type of light meter used to measure the charging light illuminance and the placement of the meter sensor in relation to the HPPL material both of which will have an impact on the ability to accurately measure the illuminance level provided by the activating light source. Light meters are designed to respond to light the same as the human eye does and thus measure only the visible light emitted by both the charging source and the PL material. Although invisible ultraviolet light is the most effective part of the light spectrum for charging PL materials, standard light meters do not register the ultraviolet light emitted by the charging light. Moreover, the weighting factor for visible violet and blue light is small. Therefore, light meter readings of charging light can be misleading if the light source is different from the specified cool-white fluorescent source used for certification (i.e., laboratory) testing. See Annex C-for further information relating to light meters.

## B.2 Alternatives to increase charging light output

If, during the interior verification tests or periodic inspections, the normal charging light fails to meet the minimum illuminance criterion using normal lighting, there are several actions that can be taken to increase the charging light levels:

- Check the light fixtures near the test samples to ensure proper working order.
- Clean light fixtures and check to ensure that the diffusers not yellowed with age. Old, dirty fixtures have been measured with less than half the light output of clean ones with new diffusers.
- Check fluorescent tubes to ensure they are not near the ends of their service lives, where light output drops significantly.
- Relocate signs/ markings.
- Replace warm white fluorescent lamps with cool white fluorescent lamps.
- Replace / supplement incandescent luminaires with fluorescent or LED luminaires.
- Replace frosted light diffuser lenses with clear lenses.
- Replace existing fluorescent tubes with those of recent design that provide 10-15% more light for the same wattage rating and double the service life.
- If the charging light performance criterion cannot be met after taking any of the above actions, then either install:
  - PL signs/ markings verified by the manufacturers' / suppliers' independent laboratory certified test result to exceed HPPL requirements sufficiently that they can provide a luminance of 7.5 mcd/$m^2$ after 1 or 1.5 hours, as applicable, after charging with the whatever normal lighting is available at the sign / marking location in question, or
  - Dual-mode or actively illuminated components with an independent power supply.

# Annex C (informative)

# Procedures for measuring charging light illuminance

## C.1 Equipment

Examples of hand-held meters on the market with adequate accuracy and sensitivity for this application, are illustrated in Figure C1:

- Minolta T-10 Illuminance meter and A20 and A21 adapters and LAN cable
- Gigahertz-Optik X9 1 with VL 3704 illuminance detector
- Hagner E4-X digital luxmeter

Other meters that meet the performance specifications listed in Section 7 are also acceptable.

**Illuminance sensors may need recalibration if the meter is dropped. Special care is required to avoid this.** Gigahertz-Optik offers an optional foam rubber shock protector for its sensor.

Railroads with fleets consisting entirely of brightly illuminated cars may forego the use of a meter with precise off-axis response, because high levels of floor illumination can be used to establish that illumination on vertical surfaces is adequate for charging PL signs /markings. Low-cost meters that conform to CNS 5119[3], Class II (which permits unlimited errors for angles of incidence greater than 60º) may be used for floor and arm-rest level measurements of illumination. Because field data have shown that illuminance values on vertical surfaces are at least 20% of the illuminance on adjacent floors, the floor measurements made with inexpensive meters can be used to demonstrate compliance with this standard whenever the values at the floor are five times greater than required illuminance on the surface of the sign/marking in question. Meters for this application are widely available from vendors such as Extech, TES, Tenmars, etc.

Other considerations: The Minolta meter can be set to readout in foot-candles or lux; the other meters readout in lux only. The Minota and Gigahertz-Optik meters have RS-232 data outputs and require an external USB adapter to work with most notebook computers. The Hagner meter has an analog data output and requires an external USB data-acquisition adapter. The Minolta The Minolta meter has a detachable head that can be connected to the meter body with ordinary LAN cable of 6.5 ft (2 m), provided that the optional A20 and A21 adapters are purchased. The other meters have 6.5 ft (2-m) cables permanently attached to the sensor.

## C.2 Timing of readings

Readings should be taken at least 15 minutes after the normal illumination charging light is placed in operation to allow the lamps to reach full output and per Section 7.

[3] CNS 5119 is a standard developed in Taiwan. It is available for viewing in Mandarin at: http://www.cnsonline.com.tw/en/.


**Figure C1. Typical meters for illuminance measurements**


## C.3 Sample illuminance charging light survey form

See next page.

## Signage / marking sample illuminance / charging light survey form

| | | | |
|---|---|---|---|
| RAILROAD PROPERTY: / LOCATION | | | |
| CAR BUILDER: | | | |
| CAR TYPE / SERIES / CONFIGURATION / YEAR: | | | |
| CAR PLATE #: | | | |
| DATE: | | | |
| DATA COLLECTOR'S NAME | | | |
| LIGHT METER USED | | | |
| START TIME: | END TIME: | | |
| All measurements are expressed in foot-candles | | | |
| MEASUREMENTS | | | |
| LOCATIONS | | A-end | B-end |
| End door sign /control / instructions | | | |
| Side door sign, location 1 | | | |
| Side door sign, location 2 | | | |
| Side door sign, location 1 | | | |
| Side door sign, location 2 | | | |
| Window exit locator signs (Describe location) and record measurement at each sign | | Left Side | Right Side |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

## Notes

Use the following to describe the make/model/wattage rating/cleanliness, etc., of the emergency charging light fixtures, etc.

# Annex D (informative)

## Automatic testing of electrically powered signage systems that use batteries as independent power sources

Electrically powered door exit signs using independent power sources have important advantages since they are not vulnerable to loss of the main car battery power supply and/or damage to the main car battery power supply wiring. However, for the independent power supply to the door emergency exit sign system to be reliable and operate when necessary, multiple individual batteries must be periodically tested for each rail car (for cars with only two such batteries, each one must be tested).

Manual testing requires that a worker first determine that all batteries as independent power sources have been connected to a source of charging power for the necessary amount of time to reach full charge. Then, car-by-car, the charging power must be disconnected and the door signage system switched into emergency mode. After the prescribed 1 or 1.5 hour time period for discharge, the worker must then revisit each car and note which door emergency exit sign fixtures are working properly and which are not. While such tests are in progress, other kinds of maintenance work are effectively precluded by the lack of light inside the car.

To avoid the substantial labor costs of conducting periodic discharge tests of these independent power sources, manufacturers of door emergency exit sign systems for buildings have developed self-test modules for their battery ballasts that perform periodic discharge tests automatically. (A discharge test is necessary for independent batteries because they are sealed devices and therefore cannot be tested by the specific-gravity method used for the main car battery.)

These self-test modules display the results of the most recent test by means of a multi-color LED on the light fixture. For a typical fixture, the LED can indicate any of the following conditions:

| **CONDITION** | | **STATUS INDICATION** |
|---|---|---|
| Normal mode | | Steady green |
| Self-testing | | Flashing green |
| Emergency mode | | Off |
| Insufficient charge | | Flashing red / green |
| Battery pack failure | | Single-flash red |
| Emergency lamp failure | | Double-flash red |
| Self-diagnostic module failure | | Triple-flash red |
| Under / over charge | | Quadruple-flash red |

The status indication remains displayed until the next scheduled periodic test or until a repair is performed. Only a momentary observation is required to see that a unit is functioning normally. Only failed components require action by maintenance staff.

Automatic testing offers the important advantage of allowing one worker to determine the condition of every door emergency exit sign in the time it takes to walk the length of an entire train and requires no special preparation. In addition, it is not necessary to turn off normal lighting, so there is no interference with other inspection and maintenance activities.

All of the test modules on the market are microprocessor-based. The frequency and duration of the discharge tests are specified in software. Test modules for the commercial building market perform 5-minute discharge tests at 30-day intervals and 30-minute discharge tests at 6-month intervals.

The economics of automatic testing of independent power sources using batteries are persuasive. Battery packs have an average life of more than six years or about 500 discharge cycles, whichever comes first. However, a small percentage will fail prematurely. The current retail price of an automatic self-test module is about $80 in single units - about equal to the cost of a replaceable battery and substantially less than the cost of a battery ballast with a non-replaceable battery. Compared with replacing all batteries at two-year intervals, use of automatic testers and replacement of batteries at the time of actual failure will be substantially cheaper over the life of the car on a materials-cost basis alone. Additional savings will accrue because of the labor costs avoided from replacing all batteries three or more years before they actually fail.

# Annex E (informative)

# Test laboratories

## E.1 ASTM International (American Society for Testing and Materials)

At the time this document was authorized, the following independent test laboratories could perform the ASTM E-2073 test, as modified in Section 7.1.2.1 of this standard, to measure the luminance of HPPL material.

California Institute of Electronics
and Material Science
2115 Flame Tree Way
Hornet, CA 92545
Tel: 951-929-2659
Contact: Lev Berger
info@CIEMS.com

Gamma Scientific
8581 Aero Drive
San Diego, CA 92123
Tel 858-279-8034
Fax 858-576-9286
Contact: Eric Nelson
www.gamma-sci.com

Hoffman Engineering Corporation
8 Riverbend Drive
P.O. Box 4430
Stamford, CT 06907-0430
Tel: 203-425-8900
Fax: 203-425-8910
Contact: Jim Delancy
www.HoffmanEngineering.com

Intertek ETL Simko
3033 U.S. Route 11
Cortland, NY 13045
Tel: 800-345-3851
Fax: 607-758-6637
Contact: David Ellis
www.ETL.Simko

Underwriters Laboratories, Inc.
1655 Scott Blvd.
Santa Clara, CA 95050
Tel: 408-985-2400
Fax: 408-556-6085
www.ul.com

## E.2 Underwriters' Laboratories (UL)

Underwriters' Laboratories (UL) has issued *UL 924, Standard for Emergency Lighting and Power Equipment* [B17] [4]. *UL 924* includes requirements for lighting, exit signs and fixtures, and battery power supplies for buildings in accordance with *NFPA 70, National Electrical Code* [B14] and *NFPA 101, Life Safety Code* [B15]. The *NFPA Life Safety Code* and *UL 924* requirements now reflect the acceptance of PL signs for use in buildings.

While this APTA standard contains requirements consistent with the general concepts of *UL 924*, the UL tests and performance criteria are not considered to be appropriate to evaluate passenger rail car emergency signage /markings.

[4] The numbers in brackets correspond to those of the bibliography in Annex A.

# Annex F (informative)

# Representative sample sizes – Periodic maintenance

Either of the following two sampling methods is acceptable.

## F.1 ANSI / ASQ

The American National Standards Institute (ANSI) and the American Society for Quality (ASQ) have developed detailed procedures for calculating the size of a representative sample depending on population size, variance, and required levels of statistical confidence. These may be found in *Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming (ANSI / ASQC Z1.9-1993)*. The ANSI / ASQC minimum sample size for a population of up to 8 units is 3 units. Specification of minimum sample sizes for fleets of more than 8 cars requires previous knowledge of the variance in the test parameter of interest. In the absence of such knowledge, a common rule of thumb is to plan to test 15 units and conduct a running analysis of variance as the test proceeds. If the variance among samples is small, it is usually possible to establish 95% confidence with a total of 5-10 samples.

## F.2 Simplified sampling method

A simplified method of conducting the tests consists of the following:

1) Select (5) five representative cars / areas at random.
   - Inspect cars / areas to ensure that there are no defects, such as burned-out lamps, weak batteries, missing or damaged signs / markings.
   - Follow the test preparation procedures described in Section 7.1.
2) Take all measurements as described in Section 7 and Annex C.
3) If all 5 cars / areas comply with the minimum criteria required by Sections 5, 7, and 10, no further action is required.
4) If one or more cars / areas fail to meet minimum criteria:
   - Determine and document the extent and cause of the failure and perform repairs to the car (s) / area(s).
   - Continue taking measurements on cars / areas randomly selected without replacement (not the same cars / areas until at least ten (10) successive cars / areas or all cars / areas comply with all minimum criteria in Sections 5, 7, and 10.
     - If a pattern of failures becomes apparent, (i.e., occurs repeatedly), determine the cause, document, and implement a fleet-wide redesign / repair to correct the defect.
     - Inspection / testing may be interrupted until this repair has been completed.
   - Confirm correction of failure / defect by inspecting / testing a sample of ten repaired cars / areas (or all cars / areas) to verify that they comply with all of the minimum criteria in Sections 5, 7, and 10.
5) Retain records for possible FRA inspection.