APTA STANDARDS DEVELOPMENT PROGRAM

STANDARD

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Vehicle Inspection and Maintenance (VIM) Working Group

Low-Location Exit Path Marking

Abstract: This standard contains minimum requirements for a low-location emergency path marking system for rail transit vehicles using passive means (non-electrically powered illumination) of marking the exit path(s) to safety.

Keywords: emergency exit, exit path, low-location exit path mar king (LLEPM) system

Summary: APTA rail transit systems members have expressed a commitment to increase the effectiveness of safety devices and features present on rail transit vehicles, not only for the passengers but for the operators and emergency personnel. This standard was developed to establish minimum requirements for LLEPM intended to provide visual guidance for passengers and rail transit vehicle operators to locate and operate primary exits during conditions of low light or darkness when the emergency lighting system has failed or when smoke conditions obscure overhead emergency lighting. This document principally addresses the design and use of passive-type markings due to their lower costs and maintenance requirements compared with an active marking design. However, if a rail transit system wishes to install an active marking system over a passive system, this standard does not preclude it from doing so.

Scope and purpose: This standard applies to rail transit systems that are procuring new vehicles, retrofitting existing vehicles or overhauling existing vehicles. It provides guidance to rail transit systems in specifying minimum required equipment and minimum required performance measures for low-location emergency path markings. An effective systems approach uses this standard, as well as APTA RT-S-VIM-020-10, "Emergency Lighting System Design for Rail Transit Vehicles," and APTA RT-S-VIM-021-10, "Emergency Signage for Rail Transit Vehicles," to provide a means for passengers and rail transit vehicle operators to locate, reach and operate emergency exits to facilitate their safe evacuation in an emergency. Agencies and car builders should carefully consider the options available to meet the emergency evacuation requirements presented in these three standards.

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Introduction

This introduction is not part of APTA RT-VIM-S-022-10, Rev. 1"Low-Location Emergency Path Marking for Rail Transit Vehicles."

This standard represents a common viewpoint of those parties concerned with its provisions, namely transit operating/planning agencies, rail transit systems, manufacturers, consultants, engineers and general interest groups. The application of any standards or recommended practices contained herein is voluntary. In some cases, federal and/or state regulations govern portions of a rail transit system's operations. In those cases, the government regulations take precedence over this standard. APTA recognizes that for certain applications, the standards or recommended practices, as implemented by individual rail transit systems, may be either more or less restrictive than those given in this document.

APTA recommends the use of this document by:

- individuals or organizations that operate rail transit systems;
- individuals or organizations that contract with others for the operation of rail transit systems; and
- individuals or organizations that influence how rail transit systems are operated (including but not limited to consultants, designers and contractors).

Note on alternate practices

Individual rail transit systems may modify the practices in this standard to accommodate their specific equipment and mode of operation. APTA recognizes that some rail transit systems may have unique operating environments that make strict compliance with every provision of this standard impossible. As a result, certain rail transit systems may need to implement the standards and practices herein in ways that are more or less restrictive than this document prescribes. A rail transit system may develop alternates to APTA standards so long as the alternates are based on a safe operating history and are described and documented in the system's safety program plan (or another document that is referenced in the system safety program plan). Documentation of alternate practices shall:

- identify the specific APTA rail transit safety standard requirements that cannot be met;
- state why each of these requirements cannot be met;
- describe the alternate methods used; and
- describe and substantiate how the alternate methods do not compromise safety and provide a level of safety equivalent to the practices in the APTA safety standard (operating histories or hazard analysis findings may be used to substantiate this claim).

Low-Location Exit Path Marking for Rail Transit Vehicles

1. General system requirements

The low-level exit path marking (LLEPM) system shall be designed to identify the location of primary door exits and the exit path to be used to reach such doors by passengers and rail transit personnel under conditions of darkness when normal and emergency sources of illumination are obscured by smoke or are inoperative.

1.1 Visual identity and recognition

The LLEPM system shall be conspicuous (i.e., clearly recognizable/distinguishable), or become conspicuous within low-location areas, immediately and automatically upon loss of power for normal lighting, under the minimum general emergency light illumination levels as specified in APTA RT-S-020-10, "Emergency Lighting System Design for Rail Transit Vehicles." The LLEPM system shall be installed with consideration for useful field of view (UFOV) to enable vehicle occupants to make positive visual identification of the exit path and primary door exits without undue hesitation, delay or confusion.

At a minimum, the LLEPM system shall have three components:

- primary door exit signs
- primary door exit marking/delineators
- exit path marking/delineators

The LLEPM system shall operate independently of the car's normal and emergency lighting systems for 90 minutes aft.er loss of power for normal lighting and in accordance with the prevailing NFPA guidelines.

1.2 Multilingual signs

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

2. System design requirements

The LLEPM system shall include the following:

- an exit sign at each primary door exit, visible from a low location (i.e., extending from the floor upward to 4 ft. [1.23 m]), and a horizontal distance of 6 ft. (1.93 m) from the exit along the exit path
- markings along the perimeter of the door or door frame visible from a low location (i.e., extending from the floor upward to 4 ft. [1.23 m]) and a horizontal distance of 6 ft. (1.93 m) from the exit along the exit path
- markings on or around the door's operating handle
- markings/delineators indicating a path from all aisle seating and compartment locations in the rail car to all the car's primary exits

In cars with only one designated primary door exit, additional measures shall be taken to provide emergency opening instructions for the secured primary exit or to direct passengers to an alternative door exit and/or emergency window exit. Rail transit systems shall provide information regarding alternative exits by posting the information inside the car and may also use onboard announcements, station signs, public service announcements or seat drops. If passengers are directed to an alternative door exit, then emergency instructions for opening that exit shall be posted at that exit location as specified in Section 2.1.1,1, "Low-location signs."

LLEPM signs shall comply with the text, color and respective illuminance or luminance requirements specified in APTA RT-S-VIM-021-10, "Emergency Signage for Rail Transit Vehicles."

LLEPM sign/marking component illumination or luminance levels, as applicable, shall be verified in accordance with Section 3 and tested, maintained and repaired in accordance with Section 6.

The physical characteristics of high performance photoluninescent (HPPL) materials have an impact on their visibility and thus the performance criteria and installation location within various rail car configurations. It is important that HPPL material be installed in locations and orientations that provide maximum exposure to adequate charging light.

2.1 Location

2.1.1 Door exits

2.1.1.1 Low-location signs

Each primary door exit or designated alternative door exit shall be clearly marked with an exit sign.

Each exit sign shall be located on or immediately adjacent to each door and placed between 6 and 18 in. (45.7 cm) above the floor.

2.1.1.2 Marking/delineators

Each primary door exit or designated alternative door exit shall be clearly marked/delineated with HPPL marking/delineator material placed in close proximity to or on the primary door exit.

A minimum of 1 in. (2.54 cm) wide strips shall be applied to the extent practicable to both sides of the interior of each primary door exit or door frame and shall extend from the floor to a minimum height of 12 in. (30.5 cm) above the floor. If unable to extend HPPL material from the floor directly, then the marking/delineator may start at the lowest location possible (within 6 in. [15.2 cm] of the floor) and extend at least 12 in. (30.5 cm) vertically from that point. If this is not possible, then sufficient HPPL material shall be placed on the door, door frame or adjoining wall between the floor and an 18-in. vertical limit, so that the total area is at least 12 $in.^2$ (77 cm^2) on both sides. Additional material placed above 18 in. off the floor is permitted, but it does not count toward this requirement.

In addition, each primary or, at the option of the rail transit system, secondary door exit handle, latch or operating button shall be identified with HPPL material as specified in APTA RT-S-VIM-021-10, "Emergency Signage for Rail Transit Vehicles."

2.1.2 Exit path marking/delineators

The location of the exit path shall be marked using passive HPPL marking/delineators.

The marking/delineator components shall be positioned so as to identify an exit path to all primary exits that is clearly visible and easily recognizable from any seat or area in the rail car, when normal lighting and emergency lighting are unavailable in conditions of darkness and/or smoke.

The marking/delineator components shall be located on the floor or no higher than 18 in. (45.7 cm) on the seat assembly, or walls/partitions of aisles, passageways or stairways, above the plane of the floor or the nearest stair tread.

Changes in the direction of the exit path shall be indicated by the LLEPM. This indication must be placed within 4 in. (10.2 cm) of the corner in the exit path.

The width of each marking/delineator strip for aisles, passageways and interior stairways shall not be less than 1 in. (2.5 cm) wide and shall be applied either as a continuous or an intermittent strip.

If intermittent strips are used, then they shall be placed on both sides of the aisle, passageway or stairway and on the floor or no higher than 18 in. Where practicable, any gaps on either side of the aisle, passageway or stairway shall be staggered.

2.1.2.1 Aisles and passageways

HPPL marking/delineator material shall be applied continuously on the floor or no higher than 18 in., to at least one side or down the middle of the aisle/passageway, or intermittently on both sides of the aisle/passageway, to provide a conspicuous delineation of the exit path to a person standing in the aisle/passageway.

The width of marking/delineator strips may consist of multiple parallel strips (multi-strip), as long as the sum of the widths of the multiple strips is equal to or exceeds the 1 in. (2.5 cm) wide strip and the light output (luminous intensity) per unit length of the multiple strips exceeds that of the single 1 in. (2.5 cm) wide strip marking placement.

Intermittent marking/delineator strips shall total a minimum of 6 in. (15.2 cm) in length for every 42-in. (106.7 cm) segment of exit path.

2.1.2.2 Interior stairways

In all interior stairways, HPPL marking/delineator material shall be applied, either as a continuous strip on the walls of both sides of the stairs, or as intermittent strips applied to the riser or tread of each step.

If the HPPL marking/delineator material is applied to the interior stairway walls, then the marking shall be applied as a continuous strip, to the extent practicable, extending from the lowest to the highest step.

If the HPPL marking/delineator material is applied to the stairway treads, then a strip of material at least 1 in. (2.5 cm) wide shall extend, to the extent practicable, across the full width of each tread near the step nosing.

One of the following two methods is acceptable if the marking/delineator placement provides a clear and conspicuous visual delineation of the exit path to a person standing at the top and bottom landings:

- 1 in. (2.5 cm) wide L-shaped marking/delineators shall be installed on both sides of each tread nearest to the wall.
- Materials shall be applied to the step risers that consist of a minimum 2 in. (5.2 cm) wide strip or two 1 in. (2.5 cm) wide strips that extend, to the extent practicable, across the full width of the riser and are placed at the lower half of the riser.

2.2 Materials

HPPL strip marking/delineator material used for LLEPM components shall be capable of providing a minimum luminance level of 7.5 mcd/m^2, measured 1.5 hours aft.er normal power has ceased.

2.3 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**.

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 (6500 K)
0.9 (9.7)	Warm-white LED (4700 K)
1.0 (10.8)	Cool-white fluorescent (4000 to 4500 K)
1.5 (16.1)	Warm-white fluorescent (3000 to 3500 K)
3.5 (37.7)	Incandescent (2900 K)

These illuminance values shall be measured with a light meter with cosine correction accurate to 3 percent or better and with the sensor placed flat against the surface of the sign/marking/delineator.

HPPL materials certified by an independent test laboratory to meet **Table 1** with the lower amount of charging light are permitted for use in the interior stairway, 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 for high-performance photo luminescent material 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**.

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.

Luminaires 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.

3. Evaluation measurements and tests

To verify that the LLEPM system component design complies with Section 2.2, a qualification test shall be conducted on at least one representative car of each LLEPM layout operated by the rail transit system in accordance with this section.

Rail transit systems shall confirm that LLEPM system components comply with the minimum required illumination or luminance criteria, as applicable, for the specified duration.

Some of these tests may exceed what a rail transit system is qualified and authorized to perform. In such cases, it would be appropriate for the qualification testing to be performed by a third party.

3.1 Material luminance

Manufacturer/supplier-provided independent laboratory-certified test results 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, aft.er 1.5 hours, when tested according to the provisions of ASTM E2073-02, "Standard Test Method for Photopic Luminance of Photoluminescent (Phosphorescent) Markings," with the following three modifications:

- **Section 8.3, Activation:** The HPPL material shall be activated with a fluorescent lamp of 40 W or less that provides no more than 1 fc of illumination as measured on the material surface.
- **Section 8.4, Luminance:** The photopic luminance of all specimens of the HPPL material shall be measured with a luminance meter as described in Section 5.2 of ASTM E2073, a minimum of 1.5 hours aft.er activation has ceased.
- **Section 9.1.12, Luminance in mcd/m^2:** The test report shall include a luminance measurement 1.5 hours aft.er activation has ceased.

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

The manufacturer shall have an independent laboratory recertify the performance of the material at a maximum time period of five years from the date of the last certification.

3.2 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 Section 2.3, as applicable. This requirement applies to each representative car 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., working at night with cars parked away from bright yard lights; locating cars in a dark, windowless shop or car wash; masking windows and vestibules with roofing paper, flooring paper or similar opaque materials; or draping cars with opaque tarpaulins).

If light diffusers are used on the light fixtures, then the measurements shall be made with the light diffusers in place.

3.3 Record-keeping

Rail transit systems shall retain a copy of the car manufacturer/supplier-provided certified independent laboratory test report results showing that the illuminance or luminance measurements, as appropriate, on the active area of the signage/marking/delineator component comply with the criteria specified in Section 2.2 or 2.3, as applicable, of this standard. Such records shall be kept until all cars with those components are retired.

Rail transit systems shall retain a copy of the illuminance test plan(s) and test results until the next periodic test is conducted on a representative car, or until all cars of that type are retired.

4. System reliability

All LLEPM system components shall be designed so that the exit path remains conspicuous, notwithstanding the failure of any single HPPL material segment.

5. Operating conditions

All LLEPM systems shall be designed to operate under the conditions typically found in rail transit vehicles.

6. Inspection and maintenance

6.1 Daily inspections

Rail transit systems that conduct daily inspections shall visually inspect all LLEPM system components during those inspections to determine that signs/markings/delineators are present and conspicuous, and that signs and instructions are legible.

6.2 Periodic inspections

Rail transit systems shall conduct periodic inspections to verify that all LLEPM system components are present and functioning as intended.

6.3 Defect reporting, repair and record-keeping

Illegible, broken, damaged, missing or non-functioning components of LLEPM systems, including the normal and emergency power systems, shall be corrected and documented in accordance with established local transit system procedures and OEM recommendations.

Related APTA standards

APTA RT-S-VIM-020-08 Rev 1, *"Emergency Lighting System Design for Rail Transit Vehicles"*
APTA RT-S-VIM-021-10 Rev 1, *"Emergency Signage for Rail Transit Vehicles"*

Reference

ASTM International, ASTM E2073-02, "Standard Test Method for Photopic Luminance of Photoluminescent (Phosphorescent) Markings," 2002. http://www.astm.org/Standards/E2073.htm.

Definitions

aisle: A path through a vehicle that is not bordered by walls, such as the path through the center of a rail transit car with rows of seats on each side.

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

candela: A unit of luminous intensity in both the SI and English measurement systems. One candela is 1 lumen per steradian (lm/sr). It is similar to the obsolete unit called the candle.

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 a 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, whereas higher color temperatures are associated with bluish (or cool) color sources.

exit path: The path or corridor through a rail transit car that provides the preferred path of evacuation from the car.

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

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 millicandela per square meter (7.5 mcd/m^2), for 1.5 hours aft.er 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 to 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.

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

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 head-end power, main car battery, auxiliary power and/or wayside power are unavailable.

lighting, emergency: A 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.

lighting, normal: A lighting mode available when the car is in operation with the normal power system.

low location: An area of the rail car defined by a volume that includes the entire area of the floor, and which extends upward to a horizontal plane 4 ft. (1.22 m) high.

lumen: The international unit of luminous flux, or the rate of flow of light.

luminaire (light fixture): A device to produce, control and distribute light. A complete unit 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 electrical power to the lamp(s).

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 millicandela per square meter (mcd/m^2). (1 fl = 3.426 cd/m^2 or 3426 mcd/ m^2.)

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.

lux: The international unit of illuminance (1 lux = 0.0929 fc).

marking/delineator: A noticeable sign, symbol, line or trace.

passageway: A path through a vehicle that is bordered by walls to allow a passenger or crew member the ability to move from one location to another.

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

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

primary exit: The normal (preferred) door exit point used by passengers and crew members to egress from the affected car in an emergency.

rail transit car: A passenger-carrying rail vehicle.

secondary exit: An exit point used by passengers and crew to egress from the affected car and/or train in an emergency if the primary exit is not available or safe.

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

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.

useful field of view (UFOV): 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 information that can be extracted from a glance.

Abbreviations and acronyms

ADA	Americans with Disabilities Act
ASTM	ASTM International (formerly the American Society for Testing and Materials)
EL	electroluminescence
fc	foot-candle
fl	foot-lambert
HPPL	high-performance photoluminescent
LED	light-emitting diode
LLEPM	low-level emergency path marking
lm	lumen
mcd	millicandela
NATSA	North American Transit Services Association
NFPA	National Fire Protection Association
OEM	original equipment manufacturer
PL	photoluminescent
SI	Système International d'unités
sr	steradian
UFOV	useful field of view

Summary of document changes

- Document title corrected and changed from Low-Level Emergency Path Marking to Low-Level Exit Path Making. Also removed for Rail Transit in the title.
- Section 1.1: Changed "1.5 hours" to "90 minutes" and added "and in accordance with the prevailing NFPA guidelines."
- Section 3: Added, "Some of these tests may exceed what a rail transit system is qualified and authorized to perform. In such cases, it would be appropriate for the qualification testing to be performed by a third party."
- Section 3.1: Added, "The manufacturer shall have an independent laboratory recertify the performance of the material at a maximum time period of five years from the date of the last certification."
- Section 3.3: Substituted "the illuminance test plan(s)" for "approved illuminance test plan(s)" in the second paragraph.
- Section 6.0: Added "Inspection" to the title of this section.

Document history

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First Published	-	-	-	-	June 6, 2010
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