APTA STANDARDS DEVELOPMENT PROGRAM
RECOMMENDED PRACTICE
American Public Transportation Association
1300 I Street, NW, Suite 1200 East, Washington, DC 20006

APTA SS-SIS-RP-001-10, Rev. 1
First Published: October 1, 2009
First Revision: September 25, 2020

Transit Infrastructure Security Working Group

Security Lighting for Transit Passenger Facilities

Abstract: This document establishes recommended practices for security lighting systems for transit passenger facilities to enhance the security of people, operations, assets and infrastructure.

Keywords: design, security lighting, transit passenger facilities

Summary: Security lighting may be one of the most cost-effective and universally accepted security measures any organization can use to improve its security posture. Effective security lighting both deters criminal behavior and enhances safety, thereby reducing overall risk. Properly designed and planned security lighting can create a sense of openness and security for passengers. Security lighting aids the ability to observe and monitor movements through the facilities and supports the fundamental principles of Crime Prevention through Environmental Design (CPTED).

Scope and purpose: This recommended practice contains minimum industry best practices. It should be used as a guide for security design reviews, capital improvement projects, retrofit projects, new designs and grant submissions that enhance security of the property. It provides guidance for the application of security lighting systems to reduce risk to people, operations, assets and infrastructure. However, it does not address life and safety emergency lighting, which is described in the References section. Throughout this document, Occupational Safety and Health Administration (OSHA) and Illuminating Engineering Society of North America (IESNA) lighting standards have been applied. Where OSHA foot-candle standards for lighting were higher than IESNA lighting recommendations, the OSHA standards were used. Where IESNA lighting recommendations were higher than OSHA lighting standards, IESNA lighting recommendations were used.

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Introduction

This introduction is not part of APTA SS-SIS-RP-001-10, Rev. 1"Security Lighting for Transit Passenger Facilities."

APTA recommends the use of this document by:

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

Security Lighting for Transit Passenger Facilities

1. Stakeholder considerations

Lighting should be designed to meet the specific needs of users of transit passenger centers, stations, transit facilities and other transit areas (i.e., parking, walkways, internal or underground areas, bus stops and shelters). These stakeholders include passengers, law enforcement, security operations personnel, and facility operations and maintenance staff.

1.1 Passengers

Lighting should provide a sense of personal security for passengers. Waiting passengers should be able to observe activity near the transit facility, such as a person approaching, as well as other passengers within the facility.

1.2 Law enforcement and security operations personnel

Light should be sufficient for law enforcement and security personnel to recognize activities and faces of individuals within the transit facility, directly and through video surveillance. The lighting should permit visibility of the interior and exterior of the facility.

1.3 Facility operations and maintenance staff

Lighting systems should facilitate observation of revenue and nonrevenue critical infrastructure and equipment, ongoing operations, and maintenance.

2. Risk assessment considerations

Transit agencies should evaluate risks and use systemwide and asset-specific risk assessments to inform effective placement of lighting systems to maximize transit security.

2.1 Systemwide assessment

Transit agencies should refer to their security risk assessments to determine the risks to their systems' assets and the surrounding environment. Transit agencies that do not have existing security risk assessments should develop them using current government guidelines.

2.2 Revenue and nonrevenue transit facility risk assessment

To determine specific passenger facility risks, refer to the agency's asset criticality ranking and the security and risk management issues for each specific location being considered. Transit agencies should use a risk-based assessment approach to identify security threats to their transit system. The approach may also evaluate system vulnerabilities to those threats and determine the consequences to people, operations, assets and infrastructure. The results should be used to determine appropriate lighting system requirements for the protection of people, operations, assets and infrastructure.

3. Types of lighting

There are three basic types of security lighting that may be installed at transit facilities: continuous, standby and mobile. **Table 1** lists recommended applications for the different types of security lighting, which are further described in this section. Selection of types of lighting should be based on an agency's risk assessment and lighting plan.

3.1 Continuous lighting

Continuous lighting is the most commonly installed type of security lighting system. Continuous lighting consists of a series of fixed lights arranged to continuously light interior or exterior areas during hours of darkness. Use continuous lighting around a building perimeter, along pedestrian pathways or vehicle approaches, and along property boundaries.

3.2 Standby lighting

Standby lighting is similar in layout and design to continuous lighting, except that the luminaires are not continuously lit and turn on instantly when activated. Standby lighting can be activated either automatically when activity is detected in the area or manually when needed. For passenger facilities, standby lighting should be considered when continuous lighting is desired and power fails.

3.3 Mobile lighting

Mobile lighting is manually operated and moveable. Mobile lighting may supplement continuous or standby lighting. Use mobile lighting at special events and in emergencies during hours of darkness.

TABLE 1
Application of Security Lighting in a Transit Environment

Location of Use	Type of Security Lighting		
	Continuous	Standby	Mobile
Critical infrastructure access point	x	x	
Fare gate or fare zone entry point	x		
Kiosk	x		
Mezzanine	x		
Parking lot (open area)	x		x
Passenger station waiting area	x		
Passenger emergency communications device	x		
Parking structure (covered deck)	x	x	x
Parking structure (roof decks)	x	x	x
Platform (outside canopy)	x		
Platform (under canopy)	x		
Pedestrian pathway	x		x
Restricted area entry/exit	x	x	
Station entrance/exit	x		x
Ticket vending machines	x		
Vehicle approach (kiss-and-ride)	x		
Vehicle staging area (waterborne transit operations)	x		x

4. Lighting application and selection

The application of lighting should be based on the attractiveness of the asset or facility and the value of its contents. Operators may seek to avoid spotlighting what would otherwise be obscure targets (e.g., highlighting storage of reels of copper wire within a maintenance facility or an isolated ventilation shaft).

4.1 Application and selection

Lighting lamp application and selection is an important function of security lighting. Each type of lamp has different characteristics that may be advantageous or undesirable depending on the application and situation. For example, various lamps have a different color characterization that affects human perceptions of color. **Table 2** lists commonly selected lamp types, recommended applications for their use, as well as their advantages and disadvantages. Disposal should be in accordance with industry prescribed methods and local ordinances.

TABLE 2
Lamp Comparisons

Lamp Type	Applications	Advantages	Disadvantages
Incandescent	• Ambient, task or accent lighting • Flood or spot lighting	• Instant "on" • High Color Rendering Index (CRI)	• Not energy efficient

TABLE 2
Lamp Comparisons

Lamp Type	Applications	Advantages	Disadvantages
Halogen (incandescent)	• Ambient, task or accent lighting • Flood or spot lighting	• Instant "on" • High CRI	• Not energy efficient
Fluorescent	• Interior use • Area lighting	• Quick "on" • Energy efficient • Moderate/high CRI • Long life	• Lamp lumen output depreciates with ambient temperature change
Compact fluorescent	• Interior use • Area lighting	• Quick "on" • Energy efficient • Moderate/high CRI	• Lamp lumen output depreciates with ambient temperature change
Metal halide	• Areas or displays where color identification is critical • Parking areas	• Long life • Energy efficient • Moderate/high CRI	• Slow "on" and restrike time • High initial cost
High-pressure sodium	• Roadways, walkways and parking areas	• Long life • Energy efficient	• Slow "on" and restrike time • High initial cost • Low CRI
Low-pressure sodium	• Roadways, walkways and parking areas • Area lighting where color identification is not critical • Typically not used in a security application	• Long life • Energy efficient • Excellent acuity	• Slow "on" and restrike time • Monochromatic • Low CRI • High initial cost
Mercury vapor	• Area lighting where color identification is not critical	• Long life	• Slow "on" and restrike time • Low CRI • Not energy efficient
Inductively coupled electrodeless	• All interior and exterior areas	• Long life • Energy efficient • High CRI	• Size of lamp • Component heat control • High initial cost
Light-emitting diode (LED)	• All interior and exterior areas	• Long life • Energy efficient • Moderate/high CRI	• Component heat control • High initial cost • Use in standby lighting can result in premature failure

4.2 Lamp properties

The capacities, efficiencies, restrike times and CRI are important factors in considering the type of lamp that best fulfills the unique requirements of a transit environment. They should be reviewed and considered along with other security lighting survey information and calculations to determine the best values for an agency. **Table 3** lists factors to consider for each of the commonly used lamps. The values given are approximate and can vary significantly depending on lamp type, wattage, manufacturer, ballasting and operating conditions.

TABLE 3
Lamp Properties

Lamp Type	**Lamp Life** (hours)	**Efficacy** (output lumens to input watts)	**Restrike Time** (minutes to full output)[1]	**CRI** (Color Rendering Index)
Incandescent	750	17	instant	100
Halogen (incandescent)	2500	14	instant	100
Fluorescent	20,000–50,000	80–110	quick-on	75–90
Compact fluorescent	10,000	80–90	quick-on	72–90
Metal halide	12,000–20,000	70–90	up to 15	65–90
High-pressure sodium	24,000–40,000	80–110	1–2	22
Low-pressure sodium	18,000	126	7–15	monochromatic
Mercury vapor	24,000	45	3–7	45
Inductively coupled electrodeless	100,000	75–80	instant	80
Light-emitting diodes (LED)	50,000	60–80	instant	80

1. "Instant" means the lamp will immediately be at full output. "Quick-on" means that the lamp will immediately start and very quickly reach full rated output. The other listings are the amount of time in minutes that the lamp takes to restrike after being extinguished, which includes some lamp cooldown time. If already cool, these lamps will strike immediately but take a minute or several minutes to reach full rated output.

5. Lighting design and planning

5.1 Design basis

Effective security lighting design and planning includes performing a design basis to benchmark the lighting system requirements. A design basis should include the following steps:

- Define the purpose of the lighting system.
- Identify areas requiring installation of or increased illumination.
- Determine the type(s) of security lighting to install in an area.
- Consider system expansion and value engineering options during any design and planning phases.

Other factors that influence the effectiveness of design are light source color, illuminance, uniformity, glare and shadow of the light source. Design should also consider the presence of video surveillance systems that will use the light source and the effects of lighting on the surrounding community and area.

5.2 Light source color

The two factors that comprise light source are color temperature and color rendition. Light source color affects mood and environmental surroundings. The higher the color temperature of a lamp, the more closely it replicates daylight, as demonstrated in **Figure 1**. A basic guideline to estimate the perceived color of a source is the higher the color temperature, the more "cool" the source will appear (e.g., more blue/green in tint). The lower the color temperature, the more "warm" the source will appear (e.g., more red/yellow in tint). Discharge sources (i.e., "white" light sources such as fluorescent and metal halide) will have a color temperature somewhere between 3000 °K and 4500 °K. Color temperature is an important factor in the selection of light sources.

FIGURE 1
Color Temperature Comparison

Metal halide installation
Correlated color temperature: 3700 °K
Color Rendition Index: 70

High-pressure sodium installation
Correlated color temperature: 1900 °K
Color Rendition Index: 22

Color rendition is the ability of a lamp to accurately reproduce the colors seen in an object. It is measured from 0 to 100 on the Color Rendition Index (CRI). The closer to 100 the index number, the closer the lamp output is to natural daylight. The qualities of color rendition characteristics can be influenced by CRI and the spectral distribution of the lamp.

5.3 Illuminance

Illuminance is the concentration of light that falls on a surface. It is measured in foot-candles or lux with a light meter on the horizontal and vertical planes. This document refers to illuminance measurements in foot-candles. Foot-candles can be converted to lux using the following conversion:

1 foot-candle = 10.764 lux
1 lux = 0.0929 foot-candles

Horizontal illuminance does little to aid the visibility of vertical objects, such as signs and keyholes, whereas vertical illuminance in the appropriate lighting levels provides observers the ability to identify people and activities at a distance, especially in enclosed facilities such as parking garages.

5.4 Uniformity ratio

Uniformity is the even distribution of light on a surface. It is measured as a ratio in determining uniformity of the minimum, average and maximum illuminance to an area. The ratios compare average-to-minimum or maximum-to-minimum illuminance. The differences in uniformity ratios aid the eye to view depth when scanning or viewing an area. Uniformity ratios may vary depending upon their application and built environment. Unbalanced uniformity ratios may present shadowing effects. In this recommended practice, the criteria are given in average values and minimum values. The uniformity ratio for E_{avg}/E_{min} can, therefore, be found as the ratio of those two values.

Lighting uniformity can provide balanced lighting of an area and reduce shadowing. For example, a very uniform lighting environment can lack contrast, making the visibility of objects difficult by allowing the foreground and background to blend with little to no contrast. A more non-uniform scene provides greater opportunity that an object will be visible due to its contrast, either against a bright or dark background. For security lighting, however, a non-uniform scene can provide dark areas and shadows that allow for concealment. Therefore, security applications of uniformity of light attempt to walk the fine line between too much or too little non-uniformity.

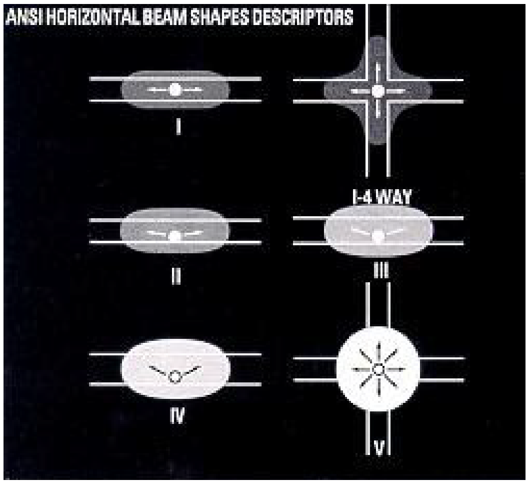
5.5 Lighting distribution

Lighting distribution is the direct area that the light covers. There are five types of lighting distribution patterns, as described in **Table 4** and **Figure 2**. Each application may depend on various factors determined during the design and planning phases of a project and/or indicated in a risk-based security assessment. The selection of the distribution types should be determined by lighting professionals based on the size, shape and location to be illuminated.

TABLE 4
Lighting Distribution Types

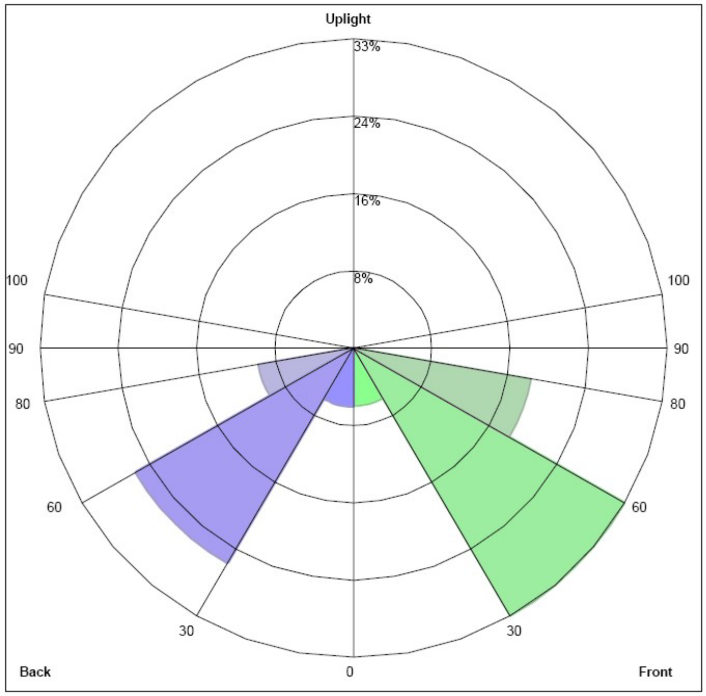
Type	Distribution	Application
I	Very narrow	Walkway, roadways
II	Increasing width	Walkways, roadways
III	Increasing width	Walkways, parking areas
IV	Increasing width	Walkways, roadway
V	Round	Parking areas, perimeter areas near structures, entryways

FIGURE 2
Lighting Distribution Descriptions



In addition to the lighting distribution classification, there is also a luminaire classification system (LCS) that describes how light is emitted from a luminaire. IESNA is the current luminaire classification system, which replaced the old system that described luminaires as either full cutoff, cutoff, semi-cutoff or non-cutoff. IESNA uses an LCS system rating that notes the amount of light distributed from the front, back and upward from the luminaire. These areas are also further subdivided. This new classification system is outlined in IESNA TM-15-07 and depicted in **Figure 3**.

FIGURE 3
Example of LCS Classification Report



LCS Rating: F:6-33-19-1,B:6-26-10-1,U:0-0

Front: Low=6.1%, Medium=32.6%, High=18.7%, Very High=0.1%
Back: Low=6.1%, Medium=26.2%, High=10.0%, Very High=0.2%
Uplight: Low=0.0%, High=0.0%

5.6 Shadows

Shadows reduce the effectiveness of lighting by reducing lighting uniformity and increasing the contrast from darkness to lightness. Because shadows offer areas of concealment for people, objects, animals, etc., they often impart a feeling of being unsafe.

Shadows also impact visibility and safety within stations. The locations of luminaires and their optical design should be based on the need to eliminate shadows on critical surfaces, such as platform edges and stair treads. **Figure 4** demonstrates the value of illuminating shadows along platform edges.

FIGURE 4
Platform Edge Lighting

FIGURE 5
Impact of Glare on Visibility

5.7 Glare

Glare is produced when the intensity of light in a direction on a surface is sufficiently greater than the eye can adapt to. It can reduce the contrast of an object against its background, resulting in difficulty for the eye to perceive depth accurately and to see well. Glare can be hazardous for people with weak or impaired vision. **Figure 5** demonstrates the impact of glare on visibility.

5.8 Photosensors

Transit agencies should consider using photosensors to control the electrical power to the luminaire. These devices initiate the power source to operate only when the ambient light falls below a certain threshold during low-light conditions. Photosensor receptacles are common in roadway, parking lot and area lighting applications where the electric utility provides the lighting system.

Dusk-to-dawn lighting control, commonly incorporating a photocell, ensures that the lighting system is shut off during daylight hours. When luminaires use multiple mounting configurations, some lighting luminaires may be switched off by time clock or manual shutoff switch instead of a photosensor during hours when the illumination is not expected to be used. This strategy can save energy while maintaining a minimal illuminance for security purposes.

5.9 Landscape impacts to lighting

Landscape selection should ensure that light distribution will not be obstructed by the foliage of trees, shrubs or other vegetation as it matures or as seasons change. **Figure 6** provides an example of the impact landscape can have on lighting. The images are of the same pedestrian location during the winter and summer months.

FIGURE 6
Impact of Vegetation on Lighting Systems

The presence of the leaves on the tree reduces the average vertical illuminance by more than 60 percent. During hours of darkness, pole-mounted luminaires should be clearly visible from a distance away from the pole of 2.5 to 3 times their height to ensure area lighting coverage. If the line of sight to the luminaire cannot be clearly seen during the full blossom of the canopy, the tree or shrub branches obscuring the view should be removed by pruning. This action is also referred to as "limb up." Trees, shrubs and other vegetation should be pruned to prevent interference with light distribution patterns and to eliminate shadows. Designs that include decorative landscaping at transit facilities should be planned with the full understanding of density, height and breadth of the landscape as it grows to full maturity.

6. Energy and environmental considerations

6.1 Energy conservation

Energy consumption depends on the lamp type, ballast, luminaire, number of luminaires required and control strategy. Older lighting installations replaced by highly efficient lighting systems can translate to cost savings.

6.2 Environmental considerations

Light pollution, uplight, sky glow, light trespass and glare are lighting issues caused when light penetrates areas unintended for lighting. This can affect the living environment of neighboring properties. There are also national organizations concerned with preserving visibility of the night sky. Careful planning and effective designs can reduce and control the effects of unintended lighting on the environment.

The IESNA provides guidelines for the limitation of light trespass, which are included in IESNA TM-11-00, *Light Trespass: Research, Results, and Recommendations*. Depending on the type of area where the facility is located, vertical illumination limits at the property line are recommended. The areas are classified into the following zones:

- **E1:** Areas with intrinsically dark landscapes
- **E2:** Areas of low ambient brightness
- **E3:** Areas of medium ambient brightness
- **E4:** Areas of high ambient brightness

Lighting levels from TM-11 are recommended in **Table 5**. For the purpose of this document, these levels are given as a goal. Security lighting levels should meet the recommendation contained in Section 7 of this recommended practice.

TABLE 5
Light Trespass Limits from IESNA TM-11-00

Environmental Zone	Pre-Curfew Limitations[1]	Post-Curfew Limitations[1]
E1	0.10	0.00[2]
E2	0.30	0.10
E3	0.80	0.30
E4	1.50	0.60

1. Foot-candle values on a plane perpendicular to the line of sight to the luminaire(s).
2. Where safety and security are issues, nighttime lighting is needed. Such lighting should meet IESNA recommendations for the particular property being lighted. Lighting should be designed, however, to minimize light trespass.

6.3 Other environmental hazardous material considerations

Agencies should use the accepted practices for the proper disposal of lighting lamps and fixtures that are considered hazardous material.

7. Recommended illumination levels for facility locations

The recommended illumination levels listed below are applicable for underground, elevated and exterior space lighting criterion. Most of the values given are the minimum required for typical operations and functional activities in which security is a primary element. In some areas, such as pedestrian walkways and parking lots, the values are higher than typical functional values for these types of uses in order to provide adequate illumination for system and customer security.

For unoccupied building interiors with only security personnel present, 1.0 maintained foot-candles with an average-to-minimum uniformity of not greater than 6:1 are generally sufficient for patrol officers. In many cases, the part of the normal lighting system connected to emergency circuits meeting the levels prescribed in NFPA 101, Life Safety Code, is also used to provide nighttime security lighting.

The values given in **Tables 6** are initial and maintained values for exterior areas but are applicable for underground, elevated and exterior space lighting criterion. The maintained values are the lowest in-service value the lighting system will reach before it is serviced (relamped or cleaned). The initial values are given only as a guide for initial design consideration. The actual required initial values will depend on the expected maintenance of the lighting system, as well as the lamp and luminaire used. For example, if a lighting system is designed with a lamp that has only a small amount of lumen depreciation throughout its life, the luminaire used is well-constructed against dirt infiltration, group relamping will be performed, and cleaning is done on a regular basis, then the initial value (and therefore, the capital cost) of the lighting system may be lower. If, however, the lamp and luminaire are more prone to lumen and dirt depreciation, spot relamping will be used, and cleaning will be irregular or nonexistent, then a higher initial value may be required.

While average foot-candle (fc) illumination should always be the goal for area lighting listed below, the illumination criteria provided recommends minimum horizontal values and, for some areas, minimum vertical values. These values are the minimum point at any location in the defined area. For pedestrian areas, it is the minimum point in both directions along the path of travel. The uniformity for these areas is obtained from the table using the ratio of the average maintained foot-candles to the minimum maintained foot-candles.

TABLE 6
Lighting Levels (Foot-Candles) for Exterior Transit Facility Locations

Area	Average Foot-Candle Illumination Level		Minimum Foot-Candle Illumination Level	
	Maintained	**Initial**	**Maintained**	**Initial**
Open parking lots (employee parking)	3	4	1 horizontal 0.5 vertical	1.4 horizontal 0.7 vertical
Parking garage (employee parking)	6	9	1.5 horizontal 0.8 vertical	2.2 horizontal 1.2 vertical
General exterior (storage yards, equipment areas or container terminals where some material loss is acceptable)	0.5	0.8	0.1	0.15
General exterior (storage yards, equipment areas, or container terminals where no material loss is acceptable)	1.7	2.5	1	1.5
Maintenance facilities (general area, task lighting higher)	2	3	0.7	1.0
Service and inspection facilities (general area, task lighting higher)	2	3	0.7	1.0
Backup power station	2 horizontal 5 vertical	3 horizontal 8 vertical	0.7 horizontal	1.0 horizontal
Fuel farm and generators (during use)	20	30	5	8
Alternative fuel storage facilities	2	3	0.7	1.0
Switches, signals and interlockings	2 horizontal 5 vertical	3 horizontal 8 vertical	0.7 horizontal	1.0 horizontal
Electrification substations	2 horizontal 5 vertical	3 horizontal 8 vertical	0.7 horizontal	1.0 horizontal
Wayside support and maintenance facilities, train control towers, communication rooms and signal bungalows	2	3	0.7	1.0

Table 7 provides initial and maintained values for maritime transit facility locations.

TABLE 7
Lighting Levels (Foot-Candles) for Maritime Transit Facility Locations

Area	Average Foot-Candle Illumination Level		Minimum Foot-Candle Illumination Level	
	Maintained	Initial	Maintained	Initial
Berth	5	8	1.5	0.9
Customer service area	20	26	6	4.6
Dock	5	8	1.5	0.9
Facility entrances/exits	3	5	1	0.6
Gangways	10	16	3	1.9
Pier	5	8	1.5	0.9
Vehicle lanes	2	3.5	0.6	0.4
Vehicle loading/unloading	3	5	1	0.6
Waiting area	10	13	3	2.3
Wharf	5	8	1.5	0.9

8. Security lighting survey

8.1 Approach

To ensure that the basic principles of security lighting are understood and applied, a security lighting survey should be performed on a periodic basis, or when there are changes to the built environment. First transit agencies should review their current security assessment results to analyze identified threats and determine the potential hazards against people, operations and assets. Then transit agencies should complete a design basis in order to do the following:

- Establish the purpose of the lighting system.
- Identify areas requiring installation of illumination or increased illumination.
- Determine the type(s) of security lighting to install in a specific area.
- Consider value engineering options during any design and planning phases.

Finally, the transit agency should perform a comprehensive security lighting system survey that includes lighting measurements and a review of operational procedures.

8.2 Lighting measurements and system maintenance/repairs

As a function of the security lighting survey, lighting measurements should be taken and analyzed, using UL-certified equipment and proper manufacturers' calibration, to determine the current lighting levels throughout the different transit property areas. The status of scheduled maintenance and necessary repair of identified damages should be noted as part of the survey. The measurements should be recorded in foot-candles.

8.3 Security lighting survey procedures

Table 8 provides recommended procedures for completing a security lighting survey. To record the results of a security lighting survey, an example of a lighting survey field report form is listed in Appendix B.

TABLE 8
Lighting Survey Procedures[1]

Procedures	Purpose
Review lighting plans and drawings	Verify lighting designs and any system modifications.
Review lamp/light maintenance	Verify schedule of luminaires and lamp maintenance.
Identify power source	Identify primary and secondary power sources.
Inspect luminaires and connections	Identify frayed or worn wiring or damaged connections.
Select equipment (light meter and compass)	Capture lighting calculations with a light meter measuring device. Ensure light meter is functioning and calibrated. Identify the cardinal directions (north, south, east and west).
Select a typical test time at night	Avoid full or no moon conditions, snow on the ground, overcast, stormy, or rainy nights. Survey should be performed during hours of darkness.
Orient the property	Identify the cardinal directions (north, south, east and west) and mark them on a plan or sketch.
Lay out the area	Identify test points and determine spacing of measurements between test points.
Determine height	Identify primary and secondary measurement heights.
Take reading at ground (primary)	Capture and analyze lighting level at (ground) primary height level (horizontal plane).
Take reading at height (secondary)	Capture and analyze lighting level at secondary height level (1.5 m [5 ft] vertical plane).
Look for trouble	Note other site problems that may influence additional threats to property.
Note off-site conditions	Make notation of off-site conditions. Adjacent properties may have installed high light levels or glare-intensive sources, which may impact the visibility on the surveyed site.
Note other security systems	Make notation of type and location of security system elements such as video surveillance cameras, emergency telephones, “blue light” stations, etc., and their general configuration as it relates to the lighting system.

1. Lamp “burn-in” of a minimum of 100 hours per lamp should be performed before lighting measurements are taken to ensure the most stable lumen output.

9. Inspection, maintenance and repairs

The optimum operational effectiveness of a lighting system can be limited by the performance or nonperformance of inspections, maintenance and repairs. Mounting heights often require special equipment to access the luminaires, increasing maintenance costs and risk. Easily replaced lamps, ballasts and other optical components can reduce labor costs. Ease of maintenance is also a safety issue, because the less time a person works on maintaining a lighting system, the less risk there is for an accident to occur. Group relamping rather than spot relamping may also help control maintenance costs.

A clean luminaire is essential for best performance. Poorly aligned, poorly fitted or damaged luminaire components, such as gaskets, housing covers, lenses, etc., can allow dirt or water to penetrate, which can reduce illuminance and increase maintenance or operating costs over the life of the system.

Lighting system issues, maintenance and inspection should be performed periodically based on fixture condition and the environment. However, if there is a history of vandalism or extreme conditions, then maintenance and inspections should be performed more often. Security lighting system repairs should be performed without delay. For optimum security lighting system performance, follow manufacturers' recommended best practices for inspection, maintenance and repair.

Related APTA standards

SS-SIS-RP-002-08, "CCTV Camera Coverage and Field of View Criteria for Passenger Facilities"
SS-SEM-RP-004-08, "Security and Emergency Management Aspects of Special Event Service"
n/a, "Security Placement of Bus Stops"

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Definitions

ballast: A magnetic or electronic device used to control the starting and operation of discharge lamps.

brightness: The intensity of the sensation from which light is seen by the human eye.

color rendition: The ability of a lamp to reproduce accurately the colors seen in an object.

Color Rendering Index (CRI): A measure from 0 to 100 of how closely a lamp renders colors of objects compared with a standard source. Daylight is considered the standard source of light for the purpose of this recommended practice. The higher the Color Rendering Index, the more natural the appearance of the source and the richer the colors appear.

contrast: The relationship between the brightness of an object and its immediate background.

correlated color temperature (CCT): The measure of the “warmth” or “coolness” of a light.

efficacy: The ratio of light output (in lumens) to input power (in watts), expressed as lumens per watt.

emergency communications device: Equipment and or technology installed at locations open to the traveling public or passengers and intended to communicate the need for assistance, help or another type of emergency or alarm to transportation staff or area first responders (telephone, alarm button or panel, intelligent video device, or other GPS or non-GPS communications device).

flare: A situation created when a light source overwhelms a video surveillance system sensor, making the image unusable.

foot-candle (fc): A unit of measure of illuminance; 1 fc is equal to 1 lumen cast per square foot of surface, and 1 fc is equal to 10.764 lx.

glare: A visual sensation caused by excessive and uncontrolled brightness.

high-intensity discharge (HID) lighting: An electric lamp that produces light directly from an arc discharge under high pressure. Metal halide, high-pressure sodium, low-pressure sodium and mercury vapor are examples of types of high-intensity discharge lamps.

horizontal illuminance (Eh): The measure of brightness from a light source, usually measured in foot-candles or lumens, through a horizontal position on a horizontal surface.

Illuminating Engineering Society of North America (IESNA): The recognized technical authority on illumination.

illuminance (E): The total amount of visible light landing on a surface from all directions above the surface.

instant: The lamp will immediately be at full output.

lamp: Electrical light sources often referred to as bulbs.

light-emitting diodes (LEDs): Diodes (electronic components that let electricity pass in only one direction) that emit visible light when electricity is applied, much like a light bulb.

light meter: Electrical device that measures light in foot-candles or lux.

light trespass: Illumination cast to area where it is not wanted, such as an adjacent property.

luminance: The luminous intensity of a surface in a given direction per unit area of that surface as viewed from that direction; often incorrectly referred to as brightness.

lumen: The quantity of luminous flux emitted within a unit solid angle by a point source with one candela intensity in all directions.

lux (lx): The metric standard unit of measure for illuminance, lumens per square meter (lm/m^2); 10.764 lx is equal to 1 fc.

nonrevenue transit facility: A non-publicly accessible transit facility or the non-publicly accessible portion of a mixed revenue/nonrevenue facility, i.e., operations control centers, maintenance facilities, bus vehicle storage yards, rail vehicle storage yards, traction power substations, communication rooms, train control rooms, emergency fan plants, elevator rooms, passenger station ancillary rooms, and other similar facilities.

photosensor: An electronic device used to automatically turn lights on and off based on the amount of ambient light near the cell.

quick-on: The lamp will immediately start and very quickly reach full rated output.

relamp: Replace light bulb.

sky glow: The result of natural or artificial light sources increasing the night sky brightness. Sky glow varies greatly depending on weather conditions, the quantity of dust/particles in the air, and the amount of light directed skyward. It is considered light pollution.

time clock: An electronic device used to automatically turn lights on and off on a predetermined schedule.

revenue transit facility: A publicly accessible transit facility or the publicly accessible portion of a mixed revenue/nonrevenue facility, i.e., passenger stations and terminals.

transitional lighting: Illumination levels that gradually increase or decrease between brightly illuminated and dark areas.

uplight: Light directed upward from the source, whether from luminaires or reflected light from the ground or other surfaces. Uplight can increase sky glow.

uniformity ratio (UR): The maximum or average illuminance across an area. The uniformity ratio may be expressed as a ratio of average to minimum, or it may be expressed as a ratio of maximum to minimum level of illumination for a given area.

vertical illuminance (Ev): The total amount of visible light landing on a vertical surface from all directions.

Abbreviations and acronyms

ANSI	American National Standards Institute
CCT	correlated color temperature
CFL	compact fluorescent lamp

CPTED crime prevention through environmental design
CRI Color Rendering Index
E illuminance
Eh horizontal illuminance
Ev vertical illuminance
fc foot-candles
HID high-intensity discharge
IESNA Illuminating Engineering Society of North America
LCS luminaire classification system
LED light-emitting diode
LPW lumens per watt
lx lux
NATSA North American Transportation Services Association
NEC National Electric Code
NFPA National Fire Protection Association
NLPIP National Lighting Product Information Program
OSHA Occupational Health and Safety Administration
TCRP Transit Cooperative Research Program
UR uniformity ratio

Summary of document changes

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Document history

Document Version	Working Group Vote	Public Comment/ Technical Oversight	Rail CEO Approval	Policy & Planning Approval	Publish Date
First published	—	—	—	—	Oct. 1, 2009
First revision	May 7, 2020	Jun 6, 2020	Jun. 22, 2020	Aug. 20, 2020	Sept. 25, 2020
Second revision	—	—	—	—	—

Appendix A: General security lighting considerations

1. Lighting patterns should overlap so no area is dependent on a single luminaire and to eliminate dark spaces, corners and shadows.
2. Security lighting layout and the maintenance, inspection and repair protocols should be considered as part of risk assessments.
3. Illuminate objects, people and spaces to allow observation and identification.
4. Protect lighting by installing protective covers over lamps, and place lamps on poles out of the reach of passengers.
5. Use photosensors to automatically control lighting operations.
6. Provide primary, auxiliary or redundant power sources to lighting.
7. Landscape design, fences and other facility features should not obstruct lighting. Trees and other landscaping should be coordinated with the lighting system and pruned to permit illumination below the canopy.
8. Illuminate all vehicle and pedestrian entrances in parking facilities.
9. Building doorways should be individually illuminated to reduce or eliminate shadows that may be cast by other light sources.
10. Reduce light pollution, sky glow, light trespass and glare.
11. Lighting should be reliable, easy to maintain, able to withstand the elements and protected from vandalism.
12. Protective lighting should be installed to protect areas and critical infrastructures, such as communications and power systems.

Appendix B: Lighting survey field report form

The following is an example of a lighting survey field report form, which can be used in present form or modified as necessary.

LIGHTING SURVEY FIELD REPORT

< Distance 1 >

< Distance 2

Cardinal Direction

	Date:	Time:	Location:
	Distance 1:	Spacing 1:	
	Distance 2:	Spacing 2:	
	Pole Height:		
	Fixture Type:	Lamp Type:	Wattage:
	Meter Type:	Date Calibrated:	
	Weather Conditions:		
	Readings: Fc ( )		

	Primary (Ground)	North	South	East	West	Secondary (Vertical)

Lighting survey field report form explanations

Issue	**Explanation**
Area	use the blank area to draw or sketch the area being surveyed
Cardinal Direction	enter the direction of north with an arrow
Date	date of survey
Time	times of survey
Location	name or location of survey sight, e.g., parking lot, building, etc.
Distance 1 & 2	distances of the area being surveyed
Space 1 & 2	distances between poles or other objects
Pole Height	height of light poles
Fixture Type	luminaires type
Lamp Type	lamp type
Meter Type	lighting calibration meter type being used
Date Calibrated	date of recent calibration
Weather Conditions	condition at lighting survey sight during survey (temp, moonlight, overcast, clouds)
Readings	check foot-candles
Reading	at ground level (horizontal plane)
Cardinal Direction	check appropriate reading direction block
Secondary Reading	at approximately 5 ft. from ground (vertical plane)

Appendix C: Lighting system checklist

Use this checklist to confirm you have considered the relevant sections in this document.

Lighting Issue	Document Section	Reviewed
Stakeholder considerations		
Passengers		
Law enforcement and security operations personnel		
Facility operations and maintenance staff		
Risk assessment considerations		
Systemwide assessment		
Revenue and nonrevenue transit facility risk assessment		
Types of lighting		
Continuous lighting		
Standby lighting		
Mobile lighting		
Lighting application and selection		
Application and selection		
Lamp properties		
Lighting design and planning		
Design basis		
Light source color		
Illuminance		
Uniformity ratio		
Lighting distribution		
Shadows		
Glare		
Photosensors and time clocks		
Landscape and impacts to lighting		
Energy and environmental		
Energy conservation		
Environmental considerations		
Other environmental hazardous material considerations		
Recommended illumination levels for various facility locations		
Security lighting survey		
Approach		
Lighting measurements and system maintenance/repairs		
Security lighting survey procedures		
Inspection, maintenance and repair		
General security lighting considerations		
Lighting survey field report		

