

# ***Exterior Security Lighting***

## **Student Guide**

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*Center for Development of Security Excellence*

# ***Lesson 1: Course Introduction***

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## **Introduction**

### ***Welcome***

Every day, on our military installations and within DoD facilities, we protect a wide variety of assets from various types of threats. One way we do this is through the use of exterior security lighting to deter and detect intruders. In this course, you will learn about the different types of exterior security lighting. You will also learn about the components that comprise exterior security lighting and how exterior security lighting is used to protect valuable assets.

### ***Objective***

Here is the course objective:

- Determine the minimum requirements for planning, designing, implementing and maintaining elements of exterior security lighting that will enhance DoD facilities

## ***Lesson 2: What Is Exterior Security Lighting?***

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### **Introduction**

#### ***Objectives***

In this lesson, we'll explore what exterior security lighting is and what its physical components are as well as the types of exterior security lighting that exist.

Here are the lesson objectives:

- Define the purpose of exterior security lighting
- List the physical components of exterior security lighting
- List the types of exterior security lighting

### **Purpose**

#### ***Overview***

On DoD installations and facilities, we use exterior security lighting to illuminate sensitive areas such as piers and docks, vital buildings, and storage areas. By illuminating these areas, exterior security lighting aids us in deterring and detecting intruders.

#### ***Deter***

Exterior security lighting serves as a psychological deterrent to discourage intruders from attempting to enter areas. In tandem with other security measures such as fencing, guards, and access control systems, exterior security lighting should be placed on boundaries and approaches to installations and facilities and on specific areas and structures within a property's general boundaries. Low level lighting must be used on security forces to minimize their visibility to intruders.

#### ***Detect***

Exterior security lighting should allow security forces to detect unauthorized persons approaching an area or attempting malicious acts within an area. Low-level lighting allows security forces to see for long distances and creates contrasts so they can identify outlines of silhouettes, and it minimizes the visibility of security forces to intruders. In addition, low level lighting does not blind security forces with glare or impede the use of automated monitoring systems such as closed circuit television (CCTV) systems.

Using broad lighted areas allows security forces and others to see intruders in and around an installation or facility. Creating stripes on walls with lighting provides recognizable breaks in outlines or silhouettes, which is also helpful to security forces. The volume and intensity of

lighting can improve visibility of intruders but will vary depending on the types of surfaces to be illuminated.

## Physical Components of Lighting

### ***Light Fixture***

A light fixture, also referred to technically as a luminaire, is the complete lighting unit designed to distribute the light, position and protect the light sources, and connect the light sources to the power supply. A light fixture consists of a lamp, a ballast, and a lens.

#### **Ballast**

A ballast is a device used with an electric discharge light source to obtain the necessary circuit conditions of voltage, current, and waveform for starting and operating. The ballast ensures the lamp stays lit by managing the distribution of energy throughout the fixture.

#### **Lamp**

The lamp produces optical radiation. The lamp is also referred to as light source, bulb or tube. In this course, we will refer to this component as the lamp.

#### **Lens**

A lens is a glass or plastic element used in a light fixture to change the direction and control the distribution of light rays.

## Types of Lighting

### ***Overview***

There are four types of exterior security lighting used by DoD installations and facilities:

- Continuous
- Standby
- Emergency
- Portable

#### **Continuous Lighting**

Continuous lighting is the most common type of lighting and consists of a series of fixed lights arranged to flood a given area continuously with overlapping cones of light during hours of darkness. The advantage of using overlapping cones of light is if a single lamp fails, the area will still remain lit.

There are three methods of continuous lighting: glare projection, controlled lighting, and surface lighting.

- With glare projection, lamps are mounted on poles inside the protected area and directed outward to make it difficult to see inside the area. Guards are protected by being kept in comparative darkness and are able to observe an area without being seen by intruders.
- With controlled lighting, lamps are mounted on high poles and shine down and out. This lighting is most effective when it limits the width of the lighted strip outside the perimeter, such as along highways.
- With surface lighting, lamps are mounted at ground surface and shine in and up onto the surface of a building or structure. This lighting illuminates the face of a building and assists the security force by elongating or exaggerating the shadow of an intruder who approaches a building.

### **Standby Lighting**

With standby lighting, light fixtures are not continuously lit. Instead they are triggered automatically by a sensor or manually turned on when suspicious activity is detected or suspected by the security force or alarm systems.

### **Emergency Lighting**

Emergency lighting is used when there is a power failure or other situation that renders the normal lighting system inoperative. It can be powered by an installed or portable generator or a battery.

### **Portable Lighting**

Portable lighting consists of manually operated, movable searchlights that may be lit during hours of darkness or only as needed, such as at construction sites.

## **Review Activities**

### ***Review Activity 1***

Why is exterior security lighting necessary on DoD installations and facilities?

*Select all that apply. Then check your answers in the Answer Key at the end of this Student Guide.*

- To illuminate sensitive areas or structures such as pier and dock areas, vital buildings and storage areas that are under observation
- To discourage or deter intruders from attempting unauthorized entry

- To facilitate the detection of unauthorized persons entering or attempting malicious acts within an area

### **Review Activity 2**

Question 1 of 3. Which component in a light fixture changes the direction and controls the distribution of light rays?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Luminaire
- Ballast
- Lamp
- Lens

Question 2 of 3. Which component in a light fixture is used with an electric discharge light source to obtain the necessary circuit conditions of voltage, current, and waveform for starting and operating?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Luminaire
- Ballast
- Lamp
- Lens

Question 3 of 3. What is the technical term for a light fixture?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Luminaire
- Ballast
- Lamp
- Lens

**Review Activity 3**

Question 1 of 3. Which type of lighting should you use at a construction site on a DoD installation or facility?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Continuous lighting – Glare projection
- Continuous lighting – Controlled lighting
- Continuous lighting – Surface lighting
- Standby lighting
- Emergency lighting
- Portable lighting

Question 2 of 3. Which type of lighting should you use to keep security forces in relative darkness?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Continuous lighting – Glare projection
- Continuous lighting – Controlled lighting
- Continuous lighting – Surface lighting
- Standby lighting
- Emergency lighting
- Portable lighting

Question 3 of 3. Which type of lighting is triggered manually or automatically when suspicious activity is detected or suspected by the security force or alarm systems?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Continuous lighting – Glare projection
- Continuous lighting – Controlled lighting
- Continuous lighting – Surface lighting
- Standby lighting
- Emergency lighting
- Portable lighting

## ***Lesson 3: Planning Considerations***

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### **Introduction**

#### ***Objectives***

In this lesson, we'll explore the policy guidance and planning considerations for the use of exterior security lighting on DoD installations and facilities.

Here are the lesson objectives:

- Recall the policy guidance for the use of exterior security lighting
- Identify the planning considerations for the use of exterior security lighting

#### ***DoD Requirements for Exterior Lighting***

Here are some policies that may help you with your planning considerations with exterior security lighting:

- DoD Manual (DoDM) 5100.76, Physical Security of Sensitive Conventional Arms, Ammunition, and Explosives (AA&E)
  - Provides the minimum standards and criteria for the physical security, including exterior security lighting, of DoD sensitive conventional AA&E
- Unified Facilities Criteria (UFC) 3-530-01, Interior and Exterior Lighting Systems and Controls
  - Meets the current standard of practice for the Illuminating Engineering Society (IES) of North America and addresses general lighting requirements for DoD facilities
- UFC 4-022-01, Security Engineering: Entry Control Facilities/Access Control Points
  - Provides requirements for the design of entry control facilities and access control points for DoD installations and contains a section specifically about exterior security lighting

#### ***Overview of Planning Considerations***

When planning for exterior security lighting on DoD installations and facilities, there are many factors to consider. These include considerations concerning light fixtures, such as the placement of the fixtures as well as replacing worn or inefficient fixtures, lamps, and costs related to exterior security lighting as well as a few other considerations that don't fit neatly into these three categories.



## Light Fixture Considerations

### ***Placement of Light Fixtures***

In planning security lighting, you must consider several factors about the placement and positioning of light fixtures. These factors include:

- Illuminance
- Height of the light fixture
- Direct glare
- Light trespass
- Light uniformity

### **Illuminance**

Illuminance is the amount of light falling on a surface. Horizontal illuminance refers to the amount of light falling on a horizontal surface, such as the ground. Vertical illuminance refers to the amount of light falling on a vertical surface, such as a wall or a sign. The most effective surfaces to light are walls and building facades. Vertical illuminance is more important than horizontal illuminance in many security applications. For example, vertical illuminance on people's faces is important for identification at security checkpoints. Newer commercially-made light meters measure illuminance in units of lux. Older model commercially-made light meters measure illuminance in units of foot candles. One foot candle equals lux multiplied by 10.76.

*NOTE: The information in the box below will not be on the test but is included here as additional information that may provide useful background and insight.*

One lux is the illuminance at the same point at a distance of 1 meter from the source. One foot candle is an English measurement and is the illuminance at a point on a surface that is one foot from and perpendicular to a uniform point source of one candela.

Refer to the job aid in Appendix B of this student guide to review examples of illuminance level recommendations for specific areas.

### **Light Fixture Height**

The height of a light fixture is important to consider. Light fixtures can be mounted on the ground, on buildings, or on poles. Increased pole heights allow the use of higher-wattage, more efficient lamps.

### **Direct Glare**

You probably know what it feels like when you are driving at night and oncoming drivers forget to turn off their bright lights. You feel momentarily blinded. This is a common

example of direct glare. Direct glare is caused by excessive light entering the eye from a bright light source. The potential for direct glare exists anytime one can see a light source. With direct glare, the eye has a harder time seeing contrast and details, which can be a problem for security forces when they can't see contrast and details of intruders. Effective use of indirect light minimizes the negative effects of direct glare.

### **Light Trespass**

Light trespass occurs when light from one area spills over into an adjoining area. Light trespass can cause interference with the security of the adjoining area. There are several ways to minimize light trespass. First, use only shielded light fixtures for area lighting. When unshielded light fixtures such as wall packs and decorative light fixtures are used at low mounting heights, reduce the light source brightness to that of a 4200 lumen light source, which is similar to a 55 watt induction light source, or less. Next, avoid over lighting areas. The reflected light can result in complaints from the adjoining facility and poor visibility. Dim or turn lighting off when it is not needed. Finally, use motion sensors or timers as much as possible to activate lighting.

### **Light Uniformity**

Light uniformity refers to the consistency of lighting. It is important to prevent spotty lighting to allow security personnel to see ahead and to the sides with an absence of dark areas caused by shadows. Lighting should be brightest in the secure area, with the light gradually less in the areas adjacent to the high-illumination areas.

### ***Light Fixture Replacement***

You should consider replacing light fixtures when certain conditions exist. If the light fixtures are in poor condition, especially those creating hazardous situations, they should be replaced. If there are more energy-efficient light fixtures available but the light fixture is not in poor condition, a cost-benefit analysis is needed. Other reasons to consider replacing light fixtures include when illuminance levels are too low, if the lighting produces glare, or when the light fixture layout produces uneven illumination.

## **Lamp Considerations**

### ***Overview of Lamp Planning Considerations***

In planning security lighting, you must consider several factors about the lamps you select for security lighting. Lamps should be as efficient as possible to save costs and energy. This is referred to as lamp efficacy. Color rendition allows security personnel to identify colors accurately and confidently. Lamps should also have effective luminance levels. Luminance refers to the brightness of a light or how bright we perceive a light reflected off of a surface.

You should have provisions, processes, and procedures in place for rapid lamp replacement in the event that a lamp burns out. Lamps must be compatible with the light fixture in which

they are being used. The strike or warm-up time of a lamp is the time it takes for the lamp to light when it is first turned on. The restrike time of a lamp is the time it takes to relight the lamp after a power interruption.

### Lamp Efficacy

Lamp efficacy or efficiency refers to the amount of light produced by a light source for every watt of energy. Lamp efficacy is measured in output of light, or lumens, compared to power input, or watts. The lamp output is expressed in lumens per watt. The higher the efficacy number, the more efficient the lamp. Lamp efficiency degrades over time. The amount of energy consumed remains constant while the light output slowly reduces. This is called lamp lumen depreciation. The most energy efficient technologies are solid state lighting (SSL) light-emitting diode (LED) and induction lighting systems.

*NOTE: The information in the box below will not be on the test but is included here as additional information that may provide useful background and insight.*

Luminous efficacy of a source of light is the quotient of the total luminous flux emitted to the total light source power input. It is expressed in lumens per watt.

### Color Rendition

An important lamp consideration is color rendition, which allows security personnel to identify colors accurately and confidently. Color rendition is determined by the lamp's spectral power distribution and illuminance level and is measured by the color rendition index (CRI). Natural daylight and incandescent lighting have the maximum CRI value of 100. The closer a lamp's CRI rating is to 100, the more it resembles daylight and is able to show true colors of an object to the human eye. In these images, notice which one has good color rendition and which does not.



## Cost Considerations

### Overview of Cost Considerations

When designing exterior lighting systems on DoD installations and facilities, you must always consider the costs involved. Use the most efficient and lowest-wattage lamps to reduce energy use and costs. Minimizing energy consumption results in lower utility bills for the installation or facility. Also by using more efficient technologies, you will reduce maintenance costs in fewer lamp replacements. You must also consider other costs you

might not readily think of, such as the maintenance costs of cleaning fixtures. With new technologies, you will also need to weigh the costs of operating older lamps and fixtures versus replacing them with new technologies.

## Other Considerations

### ***Before Installation***

Besides the more obvious lamp and cost considerations, there are some other equally important but less obvious factors you should consider when designing your exterior lighting systems.

The design should provide for simplicity and economy in system maintenance and should require a minimum of shutdowns for routine repairs, cleaning, and lamp replacement. It is necessary in some instances to install a duplicate wiring system.

You should plan protection for your lighting systems. For example, since bulbs are a favorite target for vandals, they can be protected from damage by installing wire mesh or some other substantial material that would not restrict the light beam.

Other considerations include having a manual override provision during a blackout, including photoelectric controls, which may be desirable during peacetime, but less desirable during a mandatory blackout. You should also consider the effects of local weather conditions on lighting systems.

Wiring, circuits and grounding requirements should be arranged so that failure of any one lamp shall not leave a large portion of the perimeter line or a major segment of a critical or vulnerable position in darkness.

Connection should be such that fluctuating or erratic voltages in the primary power source caused by overloads, industrial accidents, and or other incidents should not disrupt the security lighting system.

Under many circumstances, the primary power source for facilities is the public utility, so facilities and security management should focus on the point at which the power feeder lines enter their property. These lines should be located underground, or in the case of overhead wiring, inside the perimeter to minimize the potential for vandalism to the lines and reduce the effects from adverse weather conditions.

Regardless of the positioning and protection of these feeder lines, an alternate source of power should be available to supply the lighting system in the event of interruptions or failure.

You must also think about lighting requirements for adjoining properties and activities and the requirements for all of your electronic security systems, such as closed circuit television (CCTV) systems.

### ***After Installation***

Once the lighting system has been installed, you should keep it working as efficiently as possible by developing a cost effective and practical strategy to replace bulbs, fixtures and other lighting components.

Plan periodic inspections of all electrical circuits to replace or repair worn parts, tighten connections, and check insulation. Also implement a planned maintenance program to keep fixtures clean, properly aimed and in working order, for example, by changing the bulbs before the burn out date.

## **Review Activities**

### ***Review Activity 1***

Which policy document should you consult for specific lighting requirements for areas containing DoD sensitive conventional AA&E?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- DoDM 5100.76, Physical Security of Sensitive Conventional Arms, Ammunition and Explosives (AA&E)
- UFC 3-530-01, Interior and Exterior Lighting Systems and Controls
- UFC 4-022-01, Security Engineering: Entry Control Facilities/Access Control Points

### ***Review Activity 2***

Question 1 of 3. Your installation is adjacent to a housing complex. Which of the following would you most likely take into consideration when planning security lighting on the perimeter of your installation to avoid negatively impacting the adjacent housing complex?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Color rendition
- Direct glare
- Light trespass
- Vertical illuminance
- Horizontal illuminance

Question 2 of 3. Which of these factors allows security personnel to identify colors accurately?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Color rendition
- Direct glare
- Light trespass
- Vertical illuminance
- Horizontal illuminance

Question 3 of 3. Which of these considerations do you think would be most important in ensuring security forces can clearly see the identification of visitors at checkpoints in the evening hours?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Color rendition
- Direct glare
- Light trespass
- Vertical illuminance
- Horizontal illuminance

### **Review Activity 3**

Besides the more obvious lamp and cost considerations, what other factors should you consider when designing your exterior lighting systems?

*Select all that apply. Then check your answers in the Answer Key at the end of this Student Guide.*

- Design for simplicity and economy in system maintenance
- Provide protection for lighting fixtures
- Local weather conditions
- Wiring and grounding requirements
- Alternate power supply for emergencies

## ***Lesson 4: Types of Light Fixtures and Lamps***

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### **Introduction**

#### ***Objectives***

In this lesson, we'll explore the types of light fixtures and lamps used in exterior security lighting.

Here are the lesson objectives:

- List the types of light fixtures used in exterior security lighting and determine their purposes
- Review different types of lamps used in exterior security lighting and recognize their purposes

### **Light Fixtures**

#### ***Overview***

Exterior security lighting serves various purposes, so there are several types of light fixtures for each of these purposes. They are:

- Cut-off
- Refractor
- Low-mounted site lighting
- Post-top
- High-mast lighting
- Floodlight or projector
- Building-mounted

Refer to the job aid in Appendix C of this student guide to review a complete matrix of the types of light fixtures and their uses. Let's take a closer look at each type.

#### ***Cut-off Light Fixtures***

Cut-off light fixtures are used where control of light trespass and direct glare is important. Cut-off lighting is used to reduce direct glare in lighting medium-to-large areas often in parking lots next to residential areas. The pole heights for this type of lighting vary from 30 to 50 feet.

### ***Refractor Light Fixtures***

Refractor light fixtures are used where light trespass and glare control are less important. They are used on highways, streets, and general areas. Pole heights are 50 feet and higher.

### ***Low-mounted Site Lighting***

Low-mounted site lighting provides low-level, glare-free lighting for small areas. This type of lighting is used on buildings where aesthetic appeal is needed. Pole heights for low-mounted site lighting are 4 feet and under.

### ***Post-top Light Fixtures***

Post-top light fixtures come in two types: controlled and uncontrolled. Controlled post-top fixtures provide low-to-medium wattage light for medium-to-small areas and pedestrian walkways. Uncontrolled post-top fixtures provide 360 degrees of low-wattage light distribution for decorative purposes in the same areas as the controlled post-top light fixtures. Pole heights for both controlled and uncontrolled post-top fixtures range from 4 to 10 feet.

### ***High-mast Lighting***

High-mast lighting is used to illuminate an area with high wattage and good glare control. Light fixtures are mounted in a fixed orientation at the top of a high mast. High-mast lighting is used for large areas such as railroad yards, large parking lots, industrial yards, and highway interchanges. Pole heights range from 60 to 150 feet.

### ***Floodlight***

There are two types of floodlight or projector light fixtures: full cut-off and no cut-off.

Full cut-off floodlight and projector light fixtures provide medium-to-high wattage lighting that controls glare and light trespass with louvers and hoods. Full cut-off floodlights are used for airport aprons where planes are parked and areas adjacent to residential neighborhoods. Pole heights can go up to 50 feet.

No cut-off floodlight and projector light fixtures also provide medium-to-high wattage lighting but with a tight symmetrical beam that does not provide light trespass control. No cut-off floodlights are used for buildings, sporting venues, and area lighting where light trespass is not a concern. Mounting heights are dictated by the height of buildings and for sporting venues, pole heights range from 60 to 150 feet.

### ***Building-mounted Lighting***

There are two types of building-mounted light fixtures: cut-off type and refractor type.

The cut-off type of building-mounted light fixtures provides low-wattage lighting with a tighter beam control and low brightness to control light trespass and glare. These light fixtures are



used on all types of buildings and the mounting heights are dictated by the building heights and the desired area of lighting coverage.

The refractor type of building-mounted light fixtures also provides low-wattage lighting but produces a wide-beam distribution of light where the glare may be objectionable. These light fixtures are used for general lighting of buildings and the mounting height depends on the building height.

## Lamps

### **Overview**

As with light fixtures, there also are various types of lamps that are used for different purposes. They are:

- Incandescent
- Fluorescent
- Tungsten-halogen
- High-intensity discharge
- Low-pressure sodium
- Solid state lighting
- Induction

Refer to the job aid in Appendix C of this student guide to review a complete matrix of the types of lamps and their uses. Let's take a closer look at each type.

### ***Incandescent Lamps***

Incandescent lamps generate light when an electric current heats a tungsten filament wire so that it glows or incandesces. These lamps emit light that is referred to as standard for daylight which means the light emitted is closest to natural daylight. Incandescent lamps have good color rendition so they are used in both exterior and interior locations where color recognition and human appearance are important, such as at security checkpoints.

These lamps range from 15 to 1,500 watts and their initial lumens per watt range from 8 to 24. The average rated life for incandescent lamps is 750 to 3,500 hours.

### ***Fluorescent Lamps***

Fluorescent lamps generate light when an electric arc excites the gas in the tube. Mercury in the gas emits ultraviolet radiation causing the phosphor coating of the lamp to glow, or fluoresce. The glowing phosphors create white-colored light. Like incandescent lamps, fluorescent lamps have good color rendition so they are used in both exterior and interior locations where color recognition and human appearance are important.

These lamps range from 4 to 215 watts and their initial lumens per watt range from 14 to 95. The average rated life for fluorescent lamps is 6,000 to over 20,000 hours. Fluorescent lamps require a ballast as well as special lamp holders in order to operate.

### ***Tungsten-halogen Lamps***

Like incandescent lamps, tungsten-halogen lamps emit light when a tungsten filament is heated sufficiently to emit light. The difference between the two is in the composition of the glass envelope and the gas inside the envelope. Tungsten-halogen lamps emit a white light which has good color rendition so they are used in both exterior and interior locations where color recognition and human appearance are important.

These lamps range from 20 to 1,875 watts and their initial lumens per watt range from 10 to 30. The average rated life for tungsten-halogen lamps is 950 to 6,000 hours.

### ***High-intensity Discharge Lamp***

A high-intensity discharge (HID) lamp is an electric discharge light source in which the light producing arc is stabilized by lamp wall temperature. There are three types of HID lamps:

- Metal halide
- High-pressure sodium
- Mercury vapor

#### **Metal Halide**

Metal halide lamps are HID lamps in which the major portion of light is produced by radiation of metal halides, which are compounds comprised of metals and halogens, and their products of dissociation, possibly in combination with metallic vapors. Metal halide lamps emit light with a color closest to daylight. These lamps have good color rendition so they are used in both exterior and interior locations where color recognition and human appearance are important, such as with closed circuit television (CCTV) systems.

These lamps range from 70 to 2,000 watts and their initial lumens per watt range from 69 to 115. The average rated life for metal halide lamps is 5,000 to 20,000 hours.

#### **High-Pressure Sodium**

High-pressure sodium (HPS) are HID lamps in which light is produced by radiation from sodium vapor. HPS lamps emit light with a color of golden-white to yellow. The color rendition of these lamps makes reds appear brown. HPS lamps are used in exterior locations. However, do not use HPS lamps for new exterior applications or existing applications unless under special circumstances such as where existing conditions and continuity of source type make it necessary.

These lamps range from 35 to 1,000 watts and their initial lumens per watt range from 51 to 130. The average rated life for HPS lamps is 7,500 to over 24,000 hours.

### **Mercury Vapor**

Mercury vapor lamps are a type of HID lamp in which the major portion of the light is produced by radiation from mercury. However, according to UFC 3-530-01, do not use mercury vapor lamps.

### **Low-pressure Sodium Lamps**

Like HPS lamps, low-pressure sodium (LPS) lamps emit light produced by radiation from sodium vapors. LPS lamps emit light that is yellowish, so the color rendition of these lamps makes all colors appear as shades of yellow-grey. LPS lamps are used in exterior locations. However, do not use LPS lamps except for unique applications such as sea turtle nesting areas.

These lamps range from 18 to 180 watts and their initial lumens per watt range from 62 to 150. The average rated life for LPS lamps is 12,000 to 18,000 hours.

### **Solid State Lighting**

Solid State Lighting (SSL) lamps generate light through electroluminescence rather than filaments or gas discharge. Electroluminescence occurs when voltage is applied to negatively charged semiconductors causing electrons to combine and create a unit of light, or photon. In simpler terms, an LED is a chemical chip embedded in a plastic capsule.

*Electroluminescence occurs when voltage is applied to negatively charged semiconductors causing electrons to combine and create a unit of light, or photon.*

There are three types of SSL lamps:

- Light emitting diodes (LEDs)
- Organic light emitting diodes (OLEDs)
- Polymer light emitting diodes (PLEDs)

LED lights emit light that is not inherently white but near monochromatic and can be tuned to any color appearance. SSL lamps have good color rendition. These lamps are used in exterior locations, and they are more energy efficient than HID lamps.

The wattage of these lamps is equivalent to a 60 watt incandescent lamp and their initial lumens per watt are 120. The average rated life for SSL lamps is 50,000 hours or more.

## ***Induction Lighting***

Induction lighting is technology that uses an electric current to induce an electromagnetic field within the phosphor coated lamp. No filaments are used. Induction lighting emits light that is white, and the color rendition of these lamps is good. Induction lighting is used in exterior locations. It has instant on/off operation and is very energy efficient.

These lamps range from 40 to 300 watts and their initial lumens per watt are 90. The average rated life for induction lighting is over 100,000 hours.

## **Review Activities**

### ***Review Activity 1***

Question 1 of 3. Which type of light fixture should be used to light an airplane apron?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Cut-off
- Refractor
- Post-top
- High-mast lighting
- Floodlight or projector, full cut-off

Question 2 of 3. Which type of light fixture should be used to light large areas such as railroad yards and large parking lots?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Cut-off
- Refractor
- Post-top
- High-mast lighting
- Floodlight or projector, full cut-off

Question 3 of 3. Which type of light fixture should be used to light pedestrian walkways?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Cut-off
- Refractor

- Post-top
- High-mast lighting
- Floodlight or projector, full cut-off

### **Review Activity 2**

Question 1 of 3. Which type of lamps can be used in exterior locations and are more energy efficient than HID lamps?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Fluorescent
- High-intensity discharge (HID)
- Low-pressure sodium (LPS)
- Solid state lighting (SSL)
- Induction

Question 2 of 3. What kind of lamps are metal halide and mercury vapor lamps?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Fluorescent
- High-intensity discharge (HID)
- Low-pressure sodium (LPS)
- Solid state lighting (SSL)
- Induction

Question 3 of 3. Which lamp has an average rated life of over 100,000 hours, which is by far the highest?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Fluorescent
- High-intensity discharge (HID)
- Low-pressure sodium (LPS)
- Solid state lighting (SSL)
- Induction

## ***Lesson 5: Requirements for Outdoor Areas***

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### **Introduction**

#### ***Objective***

In this lesson, we'll explore exterior security lighting requirements for various outdoor areas on a DoD installation.

Here is the lesson objective:

- Determine the appropriate types of exterior security lighting for a given outdoor area

### **DoD Installation Requirements**

#### ***Requirements by Area***

Let's take a look at the various areas on this installation to see the lighting requirements for each of the following areas:

- Buildings
- Housing areas
- Perimeter fencing
- Pedestrian walkways
- Roads
- Open storage spaces
- Docks
- Restricted areas
- Arms, ammunition, and explosives storage areas
- Aircraft aprons
- Vehicle and pedestrian access control points

#### **Buildings**

Building entrances and exits require building-mounted, fully-shielded, or cutoff light fixtures and fluorescent or light emitting diode (LED) lamps.

#### **Housing Areas**

Housing areas require either building-mounted or pole-mounted light fixtures. LED or fluorescent lamps should be used with building-mounted fixtures. LED, induction, fluorescent, or metal halide lamps should be used with pole-mounted light fixtures.

## Perimeter Fencing

Perimeter fencing requires controlled post-top light fixtures, pole-mounted floodlight light fixtures, aimed away from the perimeter, or area light fixtures located opposite the fencing. LED, induction, or metal halide lamps should be used with these light fixtures. Different types of lighting are required based on the type of perimeter fencing.

For isolated fence perimeters, which are fence lines that have clear zones of 100 feet or more on both sides of the fence, use glare projection lighting to keep patrol routes unlit. Only patrol units use this area.

For semi-isolated fence perimeters, which are fence lines where approach areas are clear of obstruction for 60 to 100 feet outside of the fence, use controlled lighting to keep patrol routes in relative darkness. The general public and installation personnel rarely use these areas.

For non-isolated fence perimeters, which are fence lines immediately adjacent to operating areas on an installation or public thoroughfares, use controlled lighting. The width of the lighted strip depends on the clear zones inside and outside the fence. The general public and installation personnel may move freely in these areas so it may not be practical to keep the patrol area in the dark.

*NOTE: The information in the box below will not be on the test but is included here as additional information that may provide useful background and insight.*

*Isolated fence perimeters have 100 foot clear zones on both sides of fence. Semi-isolated fence perimeters have 60-100 foot clear zone outside fence. Non-isolated fence perimeters have fence lines next to operating areas of the installation or next to public thoroughfares.*

## Pedestrian Walkways

Pedestrian walkways require pole-mounted light fixtures with LED, induction, or fluorescent lamps. Plazas require pole-mounted, building mounted, or accent light fixtures. For pole-mounted light fixtures, use LED, induction, high output fluorescent, or coated metal halide lamps. For building-mounted light fixtures, use LED or compact fluorescent lamps. Finally, for accent lights, use LED, compact fluorescent, or metal halide lamps.

## Roads

Roads, streets, and driveways require pole-mounted light fixtures with LED, induction, or metal halide lamps.

## Open Storage Spaces

In open storage spaces, such as parking lots, motor pools, railroad sidings, and material storage areas, place light fixtures to allow adequate distribution of light in aisles, passageways, and recesses to eliminate shadowed areas where unauthorized persons

could hide. Open storage spaces require pole-mounted light fixtures with LED, induction, or metal halide lamps.

### **Docks**

Docks, piers, and marinas require pole-mounted high-mast, fully-shielded, light fixtures with LED or metal halide lamps.

For sensitive environments, such as wildlife habitat or nesting areas, use low-pressure sodium, or LPS, lamps or approved monochromatic LEDs.

Illuminate water approaches extending to 100 feet from the pier to at least 0.5 foot-candles, or 5 lux, and decks on open piers to at least 1 foot-candle, or 10 lux.

Illuminate area beneath the pier floor with small-wattage floodlights on the piling.

Minimize obstructions to pier and wharf operations by coordinating quantity, height, and location of poles and by utilizing movable lighting.

### **Restricted Areas**

Restricted areas require fully-shielded pole-mounted or area light fixtures with LED, induction, or metal halide lamps, or fully-shielded, building-mounted or area light fixtures with LED, induction, metal halide, or compact fluorescent lamps.

### **Arms, Ammunition, and Explosives Storage Areas**

Arms, ammunition, and explosives (AA&E) storage areas require fully-shielded canopy-mounted or area light fixtures with LED, induction, or metal halide lamps. To ensure that guards are able to see illegal acts such as forced entry or unauthorized removal of arms, illumination must be a minimum of 0.2 foot-candles, or 2 lux, measured on the horizontal plane at ground level.

In Security Risk Category (SRC) I and II storage areas, exterior building and door lighting must be sufficient to allow detection of unauthorized activity. Install exterior light switches so that they are only accessible to individuals with authorized access.

### **Aircraft Apron**

Aircraft aprons require pole-mounted, adjustable apron light fixtures with internal and external louvers. With these fixtures, use LED, induction or metal halide lamps.

### **Access Control Points**

Access control points (ACPs) require a variety of lighting types for drivers and pedestrians and for security personnel to see vehicles and pedestrians approaching, verify credentials and inspect vehicles.



Vehicle and pedestrian approach zones require fully-shielded pole-mounted or roadway light fixtures with LED, induction, or metal halide lamps.

Vehicle access zones require cutoff lights in the canopy with LED, induction, fluorescent, or metal halide lamps; indirect uplights or downlights in the canopy with LED, fluorescent, or metal halide lamps; and surface-mounted low brightness light fixtures with LED or fluorescent lamps.

Gatehouses require low-level interior illumination to enable guards to see approaching pedestrians and vehicles.

Under vehicle inspections require ground-mounted uplights with LED lamps.

Semi-active and inactive entrances should have the same degree of continuous lighting as the remainder of the perimeter and stand-by lighting when the entrance becomes active.

## Review Activities

### ***Review Activity 1***

What types of lighting are used in building entrances and exits?

*Select all that apply. Then check your answers in the Answer Key at the end of this Student Guide.*

- Building-mounted, fully shielded light fixtures
- LED lamps
- Metal halide lamps
- Fluorescent lamps
- Cutoff light fixtures
- Pole-mounted, high-mast, fully shielded light fixtures

### ***Review Activity 2***

Which type of pole-mounted lighting is appropriate for a housing area?

*Select all that apply. Then check your answers in the Answer Key at the end of this Student Guide.*

- Pole-mounted, high-mast, fully shielded light fixtures
- Pole-mounted LED lamps
- Pole-mounted fluorescent lamps
- Pole-mounted induction
- Pole-mounted metal halide lamps

**Review Activity 3**

Perimeter fencing required different types of lighting. Match the description with the appropriate type.

*Question 1 of 3. Use glare project lighting to keep patrol units unlit.*

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Isolated
- Semi-Isolated
- Non-Isolated

*Question 2 of 3. Use controlled lighting to keep patrol routes in relative darkness.*

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Isolated
- Semi-Isolated
- Non-Isolated

*Question 3 of 3. Use controlled lighting. The width of the light strip depends on the clear zones inside and outside the fence.*

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Isolated
- Semi-Isolated
- Non-Isolated

**Review Activity 4**

Which combination best reflects the lighting that should be used for pedestrian walkways?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Canopy-mounted, fully shielded or area light fixtures with LED, induction or metal halide lamps
- Cutoff lights in canopy with LED, induction, fluorescent, or metal halide lamps
- Pole-mounted, high-mast, fully shielded light fixtures with LED or metal halide lamps
- Pole-mounted light fixtures with LED, induction, or fluorescent lamps

**Review Activity 5**

Which combination best reflects the lighting that should be used for roads, streets, and driveways?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Canopy-mounted, fully shielded or area light fixtures with LED, induction or metal halide lamps
- Pole-mounted light fixtures with LED, induction, or metal halide lamps
- Pole-mounted, high-mast, fully shielded light fixtures with LED or metal halide lamps
- Ground-mounted uplights with LED lamps

**Review Activity 6**

Which combination best reflects the lighting that should be used for open storage spaces?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Cutoff lights in canopy with LED, induction, fluorescent, or metal halide lamps
- Pole-mounted, high-mast, fully shielded light fixtures with LED or metal halide lamps
- Ground-mounted uplights with LED lamps
- Pole-mounted light fixtures with LED, induction, or metal halide lamps

**Review Activity 7**

Which combination best reflects the lighting that should be used on docks, piers and marinas?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Pole-mounted, high-mast, fully shielded light fixtures with LED or metal halide lamps
- Canopy-mounted, fully shielded or area light fixtures with LED, induction or metal halide lamps
- Cutoff lights in canopy with LED, induction, fluorescent, or metal halide lamps
- Ground-mounted uplights with LED lamps

**Review Activity 8**

Which combination best reflects the lighting that should be used for restricted areas?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Canopy-mounted, fully shielded or area light fixtures with LED, induction or metal halide lamps
- Cutoff lights in canopy with LED, induction, fluorescent, or metal halide lamps
- Building-mounted with LED, induction, metal halide, or compact fluorescent lamps
- Ground-mounted uplights with LED lamps

**Review Activity 9**

Which combination best reflects the lighting that should be used for AA&E storage areas?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Pole-mounted, light fixtures with LED, induction, or fluorescent lamps
- Ground-mounted uplights with LED lamps
- Pole-mounted, high-mast, fully shielded light fixtures with LED, induction, or fluorescent lamps are used for pedestrian walkways
- Canopy-mounted, fully shielded or area light fixtures with LED, induction or metal halide lamps

**Review Activity 10**

What types of lighting are required for aircraft aprons?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Pole-mounted, high-mast, fully shielded light fixtures
- Pole-mounted, adjustable apron light fixtures with internal and external louvers
- Cutoff light fixtures
- Building-mounted, fully shielded light fixtures

**Review Activity 11**

What are the different types of access control points requiring unique lighting requirements?

*Select all that apply. Then check your answers in the Answer Key at the end of this Student Guide.*

- Vehicle and pedestrian approach zones
- Vehicle access zones
- Gatehouses
- Under vehicle inspections
- Semi-active and inactive entrances

## ***Lesson 6: Course Conclusion***

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### **Conclusion**

#### ***Summary***

In this course, you learned about the exterior security lighting we use to protect our military installations and DoD facilities. You learned about what you must consider when planning exterior security lighting systems, the different types of light fixtures and lamps and their appropriate uses, and what is required or most appropriate for specific outdoor areas.

#### ***Objectives***

Congratulations! You have completed the *Exterior Security Lighting* course.

You should now be able to perform the listed activity.

- Determine the minimum requirements for planning, designing, implementing and maintaining elements of exterior security lighting that will enhance DoD facilities

To receive course credit, you must take the *Exterior Security Lighting* examination. Please use the Security Training, Education, and Professionalization Portal (STEPP) to register for the online exam.

## Appendix A: Answer Key

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### Lesson 2 Review Activities

#### Review Activity 1

Why is exterior security lighting necessary on DoD installations and facilities?

- To illuminate sensitive areas or structures such as pier and dock areas, vital buildings and storage areas that are under observation (correct response)
- To discourage or deter intruders from attempting unauthorized entry (correct response)
- To facilitate the detection of unauthorized persons entering or attempting malicious acts within an area (correct response)

**Feedback:** All of these are reasons to have exterior security lighting on DoD installations and facilities.

#### Review Activity 2

Question 1 of 3. Which component in a light fixture changes the direction and controls the distribution of light rays?

- Luminaire
- Ballast
- Lamp
- Lens (correct response)

**Feedback:** The lens changes the direction and controls the distribution of light rays.

Question 2 of 3. Which component in a light fixture is used with an electric discharge light source to obtain the necessary circuit conditions of voltage, current, and waveform for starting and operating?

- Luminaire
- Ballast (correct response)
- Lamp
- Lens

**Feedback:** The ballast is used with an electric discharge light source to obtain the necessary circuit conditions of voltage, current, and waveform for starting and operating.

Question 3 of 3. What is the technical term for a light fixture?

- Luminaire (correct response)
- Ballast
- Lamp
- Lens

**Feedback:** *Luminaire is a common technical term for light fixture.*

### **Review Activity 3**

Question 1 of 3. Which type of lighting should you use at a construction site on a DoD installation or facility?

- Continuous lighting – Glare projection
- Continuous lighting – Controlled lighting
- Continuous lighting – Surface lighting
- Standby lighting
- Emergency lighting
- Portable lighting (correct response)

**Feedback:** *Portable lighting consists of manually operated, movable searchlights and can be lit as needed, such as to illuminate a construction site.*

Question 2 of 3. Which type of lighting should you use to keep security forces in relative darkness?

- Continuous lighting – Glare projection (correct response)
- Continuous lighting – Controlled lighting
- Continuous lighting – Surface lighting
- Standby lighting
- Emergency lighting
- Portable lighting

**Feedback:** *Glare projection is a method of continuous lighting that keeps security forces in relative darkness while illuminating intruders.*

Question 3 of 3. Which type of lighting is triggered manually or automatically when suspicious activity is detected or suspected by the security force or alarm systems?

- Continuous lighting – Glare projection
- Continuous lighting – Controlled lighting



- Continuous lighting – Surface lighting
- Standby lighting (correct response)
- Emergency lighting
- Portable lighting

**Feedback:** *With standby lighting, light fixtures are not continuously lit, but are triggered automatically by a sensor or manually turned on when suspicious activity is detected or suspected by the security force or alarm systems.*

## Lesson 3 Review Activities

### Review Activity 1

Which policy document should you consult for specific lighting requirements for areas containing DoD sensitive conventional AA&E?

- DoDM 5100.76, Physical Security of Sensitive Conventional Arms, Ammunition and Explosives (AA&E) (correct response)
- UFC 3-530-01, Interior and Exterior Lighting Systems and Controls
- UFC 4-022-01, Security Engineering: Entry Control Facilities/Access Control Points

**Feedback:** DoDM 5100.76 provides specific lighting requirements for areas containing DoD sensitive conventional AA&E.

### Review Activity 2

Question 1 of 3. Your installation is adjacent to a housing complex. Which of the following would you most likely take into consideration when planning security lighting on the perimeter of your installation to avoid negatively impacting the adjacent housing complex?

- Color rendition
- Direct glare
- Light trespass (correct response)
- Vertical illuminance
- Horizontal illuminance

**Feedback:** Light trespass occurs when light from one area spills over into an adjoining area.

Question 2 of 3. Which of these factors allows security personnel to identify colors accurately?

- Color rendition (correct response)
- Direct glare
- Light trespass
- Vertical illuminance
- Horizontal illuminance

**Feedback:** Color rendition allows security personnel to identify colors accurately. Natural daylight and incandescent lighting have a maximum color rendition index (CRI) value of 100. The closer a lamp's CRI rating is to 100, the better its ability to show true colors to the human eye.

Question 3 of 3. Which of these considerations do you think would be most important in ensuring security forces can clearly see the identification of visitors at checkpoints in the evening hours?

- Color rendition
- Direct glare
- Light trespass
- Vertical illuminance (correct response)
- Horizontal illuminance

**Feedback:** *Vertical illuminance is usually more important than horizontal illuminance. It is especially important to have vertical illuminance on people's faces for identification at security checkpoints.*

### **Review Activity 3**

Besides the more obvious lamp and cost considerations, what other factors should you consider when designing your exterior lighting systems?

*Select all that apply. Then check your answers in the Answer Key at the end of this Student Guide.*

- Design for simplicity and economy in system maintenance (correct response)
- Provide protection for lighting fixtures (correct response)
- Local weather conditions (correct response)
- Wiring and grounding requirements (correct response)
- Alternate power supply for emergencies (correct response)

**Feedback:** *These are all factors you should consider when designing your exterior lighting system.*

## **Lesson 4 Review Activities**

### **Review Activity 1**

Question 1 of 3. Which type of light fixture should be used to light an airplane apron?

- Cut-off
- Refractor
- Post-top
- High-mast lighting
- Floodlight or projector, full cut-off (correct response)

**Feedback:** Floodlight or projector, full cut-off, light fixtures are used to light airport aprons and areas adjacent to residential neighborhoods.

Question 2 of 3. Which type of light fixture should be used to light large areas such as railroad yards and large parking lots?

- Cut-off
- Refractor
- Post-top
- High-mast lighting (correct response)
- Floodlight or projector, full cut-off

**Feedback:** High-mast lighting is used to light large areas such as railroad yards, large parking lots, industrial yards, and highway interchanges.

Question 3 of 3. Which type of light fixture should be used to light pedestrian walkways?

- Cut-off
- Refractor
- Post-top (correct response)
- High-mast lighting
- Floodlight or projector, full cut-off

**Feedback:** Post-top light fixtures are used to light pedestrian walkways and pole heights range from 4 to 10 feet.

## **Review Activity 2**

Question 1 of 3. Which type of lamps can be used in exterior locations and are more energy efficient than HID lamps?

- Fluorescent
- High-intensity discharge (HID)
- Low-pressure sodium (LPS)
- Solid state lighting (SSL) (correct response)
- Induction

**Feedback:** Solid state lighting, also referred to as LED lights, can be used in exterior locations and are more energy efficient than HID lamps.

Question 2 of 3. What kind of lamps are metal halide and mercury vapor lamps?

- Fluorescent

- High-intensity discharge (HID) (correct response)
- Low-pressure sodium (LPS)
- Solid state lighting (SSL)
- Induction

**Feedback:** Metal halide and mercury vapor are both HID lamps. Metal halide lamps can be used in both exterior and interior locations where color recognition and human appearance are important, such as with CCTV systems. Mercury vapor lamps should never be used.

Question 3 of 3. Which lamp has an average rated life of over 100,000 hours, which is by far the highest?

- Fluorescent
- High-intensity discharge (HID)
- Low-pressure sodium (LPS)
- Solid state lighting (SSL)
- Induction (correct response)

**Feedback:** The average rated life for induction lighting is over 100,000 hours.

## Lesson 5 Review Activities

### Review Activity 1

What types of lighting are used in building entrances and exits?

Select all that apply. Then check your answers in the Answer Key at the end of this Student Guide.

- Building-mounted, fully shielded light fixtures (correct response)
- LED lamps (correct response)
- Metal halide lamps
- Fluorescent lamps (correct response)
- Cutoff light fixtures (correct response)
- Pole-mounted, high-mast, fully shielded light fixtures

**Feedback:** Building entrances and exits require building-mounted, fully shielded light fixtures, cutoff light fixtures, fluorescent lamps, and LED lamps.

## Review Activity 2

Which type of pole-mounted lighting is appropriate for a housing area?

Select all that apply. Then check your answers in the Answer Key at the end of this Student Guide.

- Pole-mounted, high-mast, fully shielded light fixtures
- Pole-mounted LED lamps (correct response)
- Pole-mounted fluorescent lamps (correct response)
- Pole-mounted induction (correct response)
- Pole-mounted metal halide lamps (correct response)

**Feedback:** Housing areas require either building-mounted or pole-mounted lighting. If they choose to use pole-mounted lighting, they should have LED, induction, fluorescent, or metal halide lamps.

## Review Activity 3

Perimeter fencing required different types of lighting. Match the description with the appropriate type.

Question 1 of 3. Use glare project lighting to keep patrol units unlit.

Select the best response. Check your answer in the Answer Key at the end of this Student Guide.

- Isolated (correct response)
- Semi-Isolated
- Non-Isolated

**Feedback:** For isolated fence perimeters, which are fence lines that have clear zones of 100 feet or more on both sides of the fence, use glare projection lighting to keep patrol routes unlit. Only patrol units use this area.

Question 2 of 3. Use controlled lighting to keep patrol routes in relative darkness.

Select the best response. Check your answer in the Answer Key at the end of this Student Guide.

- Isolated
- Semi-Isolated (correct response)
- Non-Isolated

**Feedback:** For semi-isolated fence perimeters, which are fence lines where approach areas are clear of obstructions for 60 to 100 feet outside of the fence, use controlled lighting to keep patrol routes in relative darkness. The general public and installation personnel rarely use these areas.

Question 3 of 3. Use controlled lighting. The width of the light strip depends on the clear zones inside and outside the fence.

Select the best response. Check your answer in the Answer Key at the end of this Student Guide.

- Isolated
- Semi-Isolated
- Non-Isolated (correct response)

**Feedback:** For non-isolated fence perimeters, which are fence lines immediately adjacent to operating areas on an installation or public thoroughfares, use controlled lighting. The width of the lighted strip depends on the clear zones inside and outside the fence. The general public and installation personnel may move freely in these areas so it may not be practical to keep patrol area in the dark

#### **Review Activity 4**

Which combination best reflects the lighting that should be used for pedestrian walkways?

Select the best response. Check your answer in the Answer Key at the end of this Student Guide.

- Canopy-mounted, fully shielded or area light fixtures with LED, induction or metal halide lamps
- Cutoff lights in canopy with LED, induction, fluorescent, or metal halide lamps
- Pole-mounted, high-mast, fully shielded light fixtures with LED or metal halide lamps
- Pole-mounted light fixtures with LED, induction, or fluorescent lamps (correct response)

**Feedback:** Pole-mounted light fixtures with LED, induction, or fluorescent lamps are used for pedestrian walkways.

**Review Activity 5**

Which combination best reflects the lighting that should be used for roads, streets, and driveways?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Canopy-mounted, fully shielded or area light fixtures with LED, induction or metal halide lamps
- Pole-mounted light fixtures with LED, induction, or metal halide lamps (correct response)
- Pole-mounted, high-mast, fully shielded light fixtures with LED or metal halide lamps
- Ground-mounted uplights with LED lamps

**Feedback:** *Roads, streets, and driveways require pole-mounted light fixtures with LED, induction, or metal halide lamps.*

**Review Activity 6**

Which combination best reflects the lighting that should be used for open storage spaces?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Cutoff lights in canopy with LED, induction, fluorescent, or metal halide lamps
- Pole-mounted, high-mast, fully shielded light fixtures with LED or metal halide lamps
- Ground-mounted uplights with LED lamps
- Pole-mounted light fixtures with LED, induction, or metal halide lamps (correct response)

**Feedback:** *Open storage spaces require pole-mounted light fixtures with LED induction, or metal halide lamps.*

**Review Activity 7**

Which combination best reflects the lighting that should be used on docks, piers and marinas?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Pole-mounted, high-mast, fully shielded light fixtures with LED or metal halide lamps (correct response)



- Canopy-mounted, fully shielded or area light fixtures with LED, induction or metal halide lamps
- Cutoff lights in canopy with LED, induction, fluorescent, or metal halide lamps
- Ground-mounted uplights with LED lamps

**Feedback:** Pole-mounted, high-mast, fully shielded light fixtures with LED or metal halide lamps are used on docks, piers and marinas.

### **Review Activity 8**

Which combination best reflects the lighting that should be used for restricted areas?

Select the best response. Check your answer in the Answer Key at the end of this Student Guide.

- Canopy-mounted, fully shielded or area light fixtures with LED, induction or metal halide lamps
- Cutoff lights in canopy with LED, induction, fluorescent, or metal halide lamps
- Building-mounted with LED, induction, metal halide, or compact fluorescent lamps (correct response)
- Ground-mounted uplights with LED lamps

**Feedback:** Restricted areas require fully-shielded pole-mounted or area light fixtures with LED, induction, or metal halide lamps, or fully-shielded, building-mounted or area light fixtures with LED, induction, metal halide, or compact fluorescent lamps.

### **Review Activity 9**

Which combination best reflects the lighting that should be used for AA&E storage areas?

Select the best response. Check your answer in the Answer Key at the end of this Student Guide.

- Pole-mounted, light fixtures with LED, induction, or fluorescent lamps
- Ground-mounted uplights with LED lamps
- Pole-mounted, high-mast, fully shielded light fixtures with LED, induction, or fluorescent lamps are used for pedestrian walkways
- Canopy-mounted, fully shielded or area light fixtures with LED, induction or metal halide lamps (correct response)

**Feedback:** Canopy-mounted, fully shielded or area light fixtures with LED, induction or metal halide lamps are used for AA&E storage areas.

**Review Activity 10**

What types of lighting are required for aircraft aprons?

*Select the best response. Check your answer in the Answer Key at the end of this Student Guide.*

- Pole-mounted, high-mast, fully shielded light fixtures
- Pole-mounted, adjustable apron light fixtures with internal and external louvers (correct response)
- Cutoff light fixtures
- Building-mounted, fully shielded light fixtures

**Feedback:** *Aircraft aprons require pole-mounted, adjustable apron light fixtures with internal and external louvers. With these fixtures, use LED, induction or metal halide lamps.*

**Review Activity 11**

What are the different types of access control points requiring unique lighting requirements?

*Select all that apply. Then check your answers in the Answer Key at the end of this Student Guide.*

- Vehicle and pedestrian approach zones (correct response)
- Vehicle access zones (correct response)
- Gatehouses (correct response)
- Under vehicle inspections (correct response)
- Semi-active and inactive entrances (correct response)

**Feedback:** *These are all access control points with unique lighting requirements.*

## Appendix B: Job Aid: Illuminance Levels

This job aid provides the recommended horizontal illuminance levels for specific outdoor areas. Illuminance is the amount of light falling on a surface and is measured in foot-candles (unit of measurement used by older light meters) or lux (unit of measurement used by newer light meters).

### Access Control Point (ACP)

Area	Foot-Candles	Lux
Approach Zone Nighttime	1	10
Response Zone Task Surface	10-20	100-200
Response Zone Roadway	3	30
Parking and Roadways	3	32
Access Zone	1	10
Search Areas (vehicle and ID checking)	10	100
Under Vehicle Inspection	10	100
Vital Locations or Structures	5	53
Building Surrounds	1	10
Pedestrian Entry	2	20

### Buildings Floodlighted

Bright Surroundings	Foot-Candles	Lux
Light Surfaces	15	161
Medium-light Surfaces	20	215
Medium-dark Surfaces	30	322
Dark Surfaces	10	538

Dark Surroundings	Foot-Candles	Lux
Light Surfaces	5	53
Medium-light Surfaces	10	107
Medium-dark Surfaces	15	161
Dark Surfaces	20	215

<b>Dark Surroundings</b>	<b>Foot-Candles</b>	<b>Lux</b>
Gates and Doors	2	21
Office Space	50	538

<b>Self-parking (other than ACP)</b>	<b>Foot-Candles</b>	<b>Lux</b>
Self-parking	1	10
Attendant Parking	2	21
Covered Parking	5	53

<b>Rail Yards, Marshaling, and Loading Areas</b>	<b>Foot-Candles</b>	<b>Lux</b>
Loading and Unloading Platforms	20	215
Freight Car Interiors	10	107
Lumber Yards	1	10

### **Perimeter/Restricted Area/Magazines**

<b>Controlled</b>	<b>Foot-Candles</b>	<b>Lux</b>
Single Fence Line	0.2-4	2-40
Restricted Area	0.2-5	2-50
Magazines	0.2-5	2-50

<b>Ship Yards</b>	<b>Foot-Candles</b>	<b>Lux</b>
General Work Areas	3-5	30-50
Ways	10	107
Fabrication Areas	30	322

<b>Storage Yards</b>	<b>Foot-Candles</b>	<b>Lux</b>
Active	20	215
Inactive	1	10

## Appendix C: Job Aid: Lamp Types

This job aid provides the characteristics and uses of different types of lamps for exterior security lighting.

Type of Lamp	Wattage Range	Initial Lumens Per Watt	Average Rated Life (Hours)	Color of Light	Color Rendition	Used for
Incandescent	15–1,500	8–24	750–3,500	Standard for daylight	Good	Exterior and interior locations where color recognition and human appearance are important
Fluorescent	4–215	14–95	6,000–20,000+	White	Good	Exterior and interior locations where color recognition and human appearance are important
Tungsten-Halogen	20–1,875	10–30	950–6,000	White	Good	Exterior and interior locations where color recognition and human appearance are important
High-Intensity Discharge (HID) Lamp: Metal Halide	70–2,000	69–115	5,000–20,000	Closest to daylight	Good	Exterior and interior locations where color recognition and human appearance are important
HID Lamp: High-Pressure Sodium (HPS)	35–1,000	51–130	7,500–24,000+	Golden-white to yellow	Reds appear brown	Exterior locations, but do NOT use for new exterior applications; may be used under special circumstances in existing applications
HID Lamp: Mercury Vapor	n/a	n/a	n/a	n/a	n/a	Do NOT use this type of lamp.
Low-Pressure Sodium (LPS)	18–180	62–150	12,000–18,000	Yellowish	All colors appear yellow-grey	Exterior locations, but do NOT use except in unique applications such as sea turtle nesting areas

## Appendix D: Job Aid: Light Fixtures Types

This job aid provides the characteristics and uses of different types of light fixtures for exterior security lighting.

Type of Light Fixture	Purpose	Pole Heights	Where Used
Cut-off	Used to control glare and light trespass	30-50 feet	In medium-to-large areas such as parking lots next to residential areas
Refractor	Used where glare and light trespass are less important	50 feet and higher	On highways, streets, and general areas
Low-mounted site lighting	Used to control glare and for aesthetic appeal	4 feet and under	In small areas and on buildings
Post-top, controlled	Provides low-to-medium wattage lighting	4-10 feet	In medium-to-small areas and on pedestrian walkways
Post-top, uncontrolled	Provides 360 degrees of low-wattage lighting for decorative purposes	4-10 feet	In medium-to-small areas and on pedestrian walkways
High-mast lighting	Provides high wattage lighting with good glare control	6-150 feet	In large areas such as railroad yards, large parking lots, industrial yards, and highway interchanges
Floodlight or projector, full cutoff	Provides medium-to-high wattage lighting with good glare and light trespass control	Up to 50 feet	On airport aprons and areas adjacent to residential areas

Type of Light Fixture	Purpose	Pole Heights	Where Used
Floodlight or projector, no cutoff	Provides medium-to-high wattage lighting with a tight symmetrical beam and has no light trespass control	60-150 feet (dictated by height of buildings)	On buildings and in sporting venues and for area lighting where light trespass is not a concern
Building-mounted, cutoff type	Provides low-wattage lighting with good glare and light trespass control	Dictated by building heights and desired area coverage	All types of buildings
Building-mounted, refractor type	Provides low-wattage lighting with a wide beam distribution and no glare control	Dictated by building heights	General lighting of buildings