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## Roadway Lighting Design

**Course Number:** EE-02-405

**PDH:** 7

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## Module 1: Purpose of Lighting

### Learning Objectives

By the end of this section, you will be able to:

- **Evaluate** the safety benefits of roadway lighting using crash reduction statistics.
- **Select** appropriate primary reference documents for lighting design and criteria.
- **Identify** the core objectives of FHWA-funded roadway lighting projects beyond basic illumination.

*Executive Summary:* Roadway lighting is a critical visual aid and proven safety countermeasure that can reduce nighttime fatal crashes by up to 60%, addressing a fatality rate that is three times higher than daytime rates relative to vehicle miles traveled.

### Design Guidance Fundamentals

This course provides essential guidance for lighting designers and government officials regarding the **design and application** of roadway lighting. While not a detailed design guide, it serves as a primary resource for **Professional Engineers** to evaluate the needs, benefits, and applicable standards for roadway systems.

### Primary Industry References

Always consult the latest versions of documents from these organizations for specific lighting levels and configurations:

- **AASHTO:** American Association of State Highway and Transportation Officials.
- **IES:** Illuminating Engineering Society.
- **CIE:** Commission Internationale de l'Eclairage.

### Core Discussion Areas

1. **Policy and Guidance:** FHWA recommendations and funding evaluation.
2. **Basic Terms and Concepts:** Technical descriptions of significant project terms.
3. **Warranting Criteria:** Methods to determine if lighting is technically justified.
4. **Lighting Impacts:** Control and mitigation of environmental and operational impacts.
5. **Application Considerations:** Supplemental information to standard reference documents.
6. **Other Systems and Issues:** External elements impacting the road user.

## Purpose of Roadway and Street Lighting

Driving and walking are inherently less safe in darkness due to the **reduced visibility** of pedestrians and hazards. Although fatal crash totals may appear similar between day and night, the data reveals a severe disparity when adjusted for volume.

## The Nighttime Safety Gap

- Only **25 percent** of vehicle-miles traveled (VMT) occur at night.
- The nighttime fatality rate is **three times** the daytime rate.
- Lighting increases sight distance and makes roadside obstacles more noticeable to drivers.

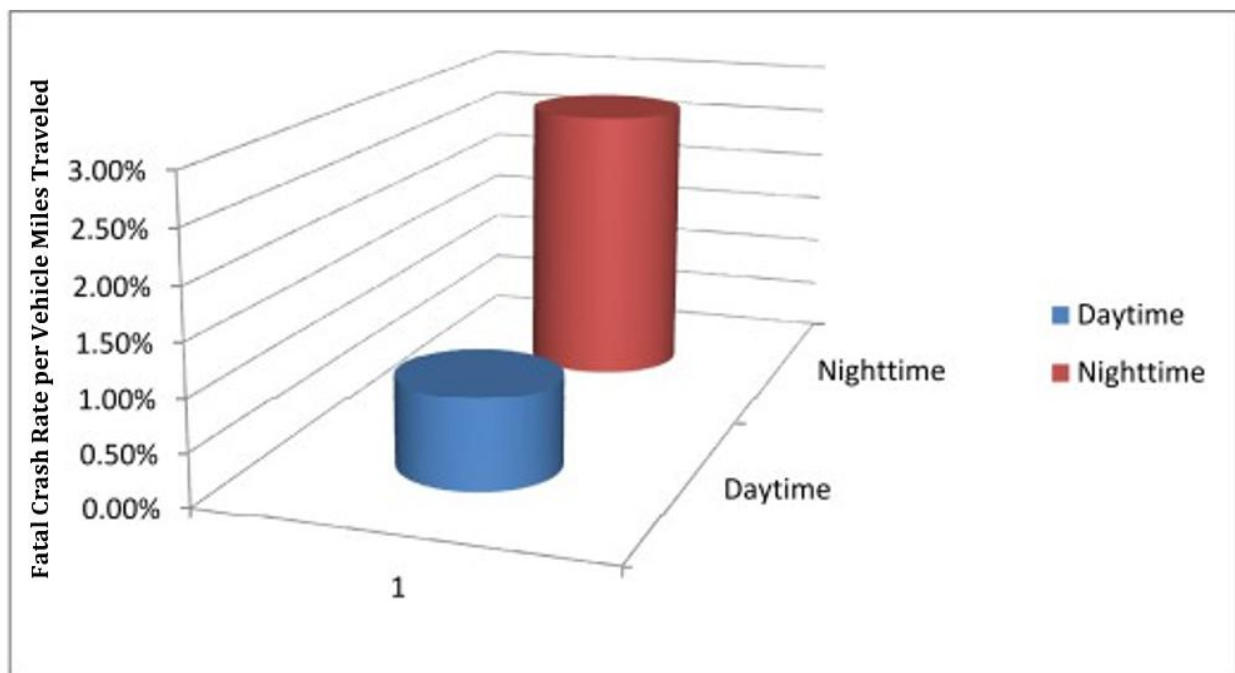


Figure 1a - Fatal Crash Rates per VMT for Day and Night (2019 FARS and NHTS data)

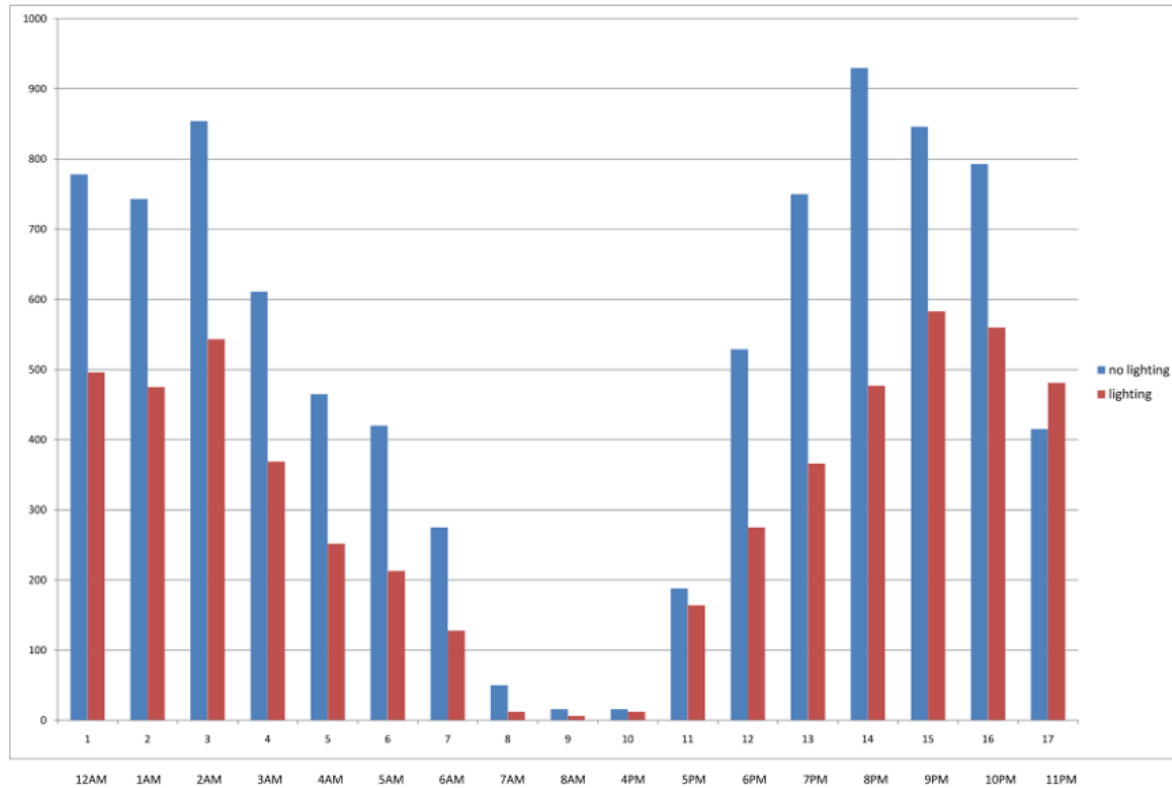


Figure 1b - Fatal Crashes during Darkness by Lighting Condition (2019 FARS data)

## Documented Safety Countermeasures

Lighting acts as a proven safety countermeasure with the following reported benefits:

- **International Scan:** 20% to 30% reduction in total crashes.
- **Signalized Intersections:** 50% reduction in nighttime crashes and 43% reduction in fatal crashes.
- **Personal Security:** Safeguards pedestrians, bicyclists, and transit users by eliminating deep shadows that make commercial activities uncomfortable or unsafe.

## Key Research Findings

The FHWA CMF Clearinghouse highlights several critical studies on the efficacy of roadway lighting:

Researcher	Key Finding
Elvik and Vaa (2004)	64% reduction in fatal crashes; 28% reduction in injury crashes.
Wanvik (2009)	45% reduction in pedestrian injury crashes; 50% reduction in freeway injury crashes.
Lipinski and Wortman (1976)	45% reduction in night crash rates at rural at-grade intersections.
Walker and Roberts (1976)	52% reduction in nighttime crashes at 47 intersections.
Minnesota LRRB (2006)	44% of rural intersections showed crash reduction after installation.



**💡 Design Tip:** Beyond traffic safety, you must prioritize minimum acceptable illumination levels to safeguard personal security for non-motorized users, as darkness directly correlates with a reduction in bicycling and transit comfort.

**⚠️ Safety Constraint:** You must use the latest versions of AASHTO, IES, and CIE documents for all design projects to ensure compliance with current safety criteria and recommendations.

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### *Checkpoint Quiz*

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**1. According to vehicle-miles traveled (VMT) data, how does the nighttime fatality rate compare to the daytime rate?**

- a) It is roughly equal.
- b) It is twice as high.
- c) It is three times as high.
- d) It is four times as high.

**Answer:** (c). While total fatalities may be similar, only 25% of driving occurs at night, making the rate significantly higher.

**2. A study of rural at-grade intersections by Lipinski and Wortman (1976) demonstrated what percentage reduction in night crash rates following lighting installation?**

- a) 35%
- b) 45%
- c) 52%
- d) 64%

**Answer:** (b). Their research specifically looked at rural intersections and found this marked improvement in safety.

## Module 2: Federal Guidance and Recommendations Regarding Roadway Lighting

### Learning Objectives

By the end of this section, you will be able to:

- **Evaluate** the documentation required for FHWA funding eligibility for roadway lighting projects.
- **Identify** specific roadway conditions and features that warrant lighting based on safety and user-group recommendations.
- **Select** appropriate maintenance and design criteria for older drivers, railroad crossings, and specialized roadway segments like crosswalks and roundabouts.

*Executive Summary:* Successful federal funding and implementation of roadway lighting projects require a comprehensive warrant analysis, adherence to established design standards (AASHTO/IES), and a legally binding maintenance plan that ensures long-term system performance and safety for all road users, including vulnerable populations like older drivers.

### Determination of Lighting Need

The FHWA administers funding for State roadway lighting projects under **Section 148 of Title 23** (Highway Safety Improvement Program). These projects are also eligible for an increased Federal share under 23 U.S.C. 120(c).

To support a funding application, applicants must include:

- **Warrant Analysis:** Demonstrating that lighting is a technically warranted safety feature.
- **Project Criteria Document:** Confirming that design criteria from AASHTO or the IES will be met.
- **Maintenance Plan and MOU:** Outlining long-term system upkeep.
- **Safety Analysis:** A study showing lighting is a cost-effective safety alternative, potentially utilizing the **AASHTO Highway Safety Manual (HSM)**.

### Crash Modification Factors (CMFs)

CMFs quantify the expected change in crash frequency resulting from specific roadway improvements.

- **Nighttime Injury Crashes:** Research indicates a CMF of **0.72** for installing lighting on previously unlit roads, representing a **28% reduction** in injury crashes.
- **Calculation:** Expected Crashes with Lighting = (Current Crashes) x (CMF).



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