FHWA - Safety in Roadway Lighting

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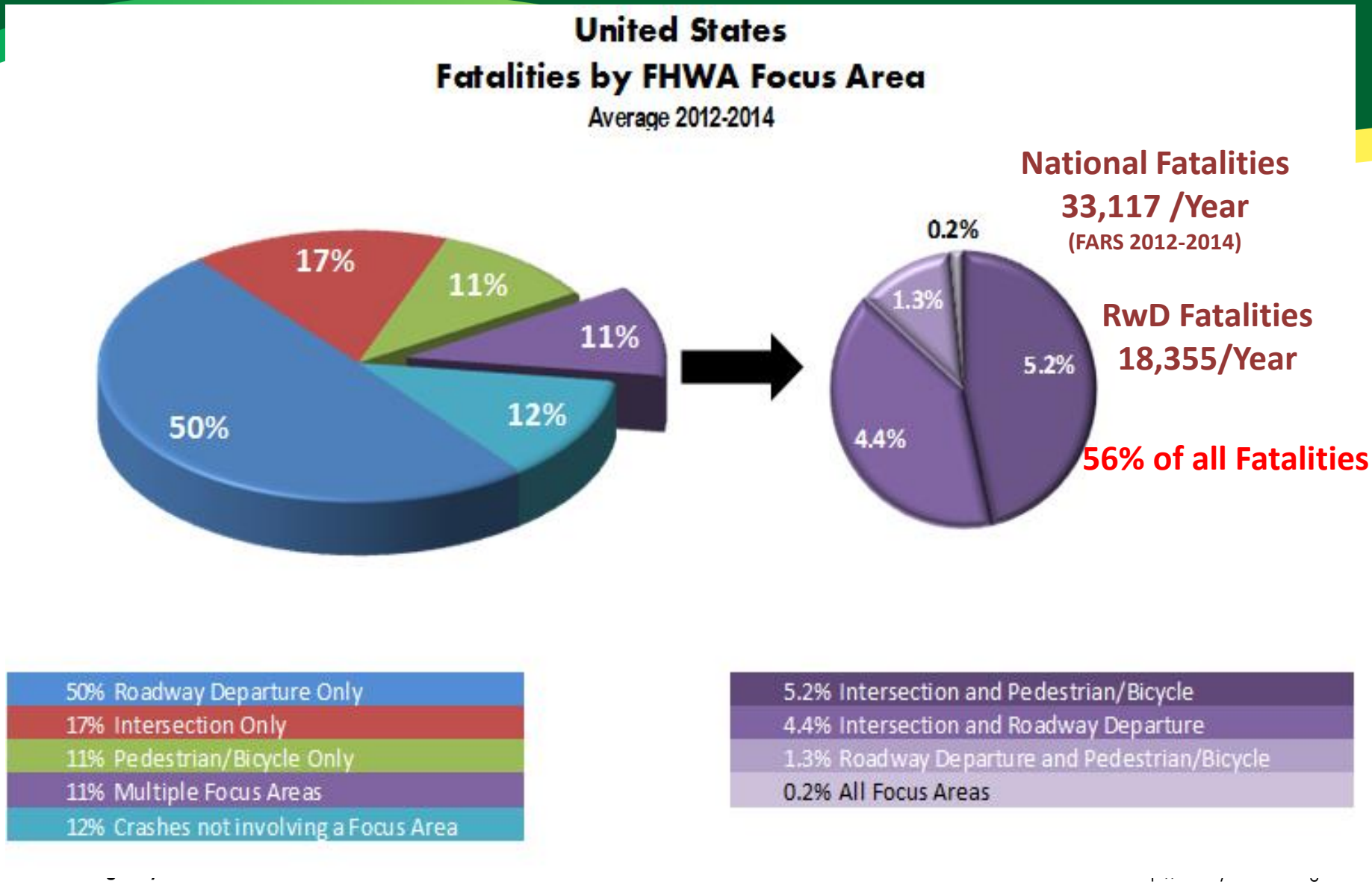
Joseph Cheung P.E.
FHWA – Office of Safety

U.S. Department of Transportation
Federal Highway Administration

Safe Roads for a Safer Future
Investment in roadway safety saves lives
http://safety.fhwa.dot.gov

Fatalities breakdown by crash types



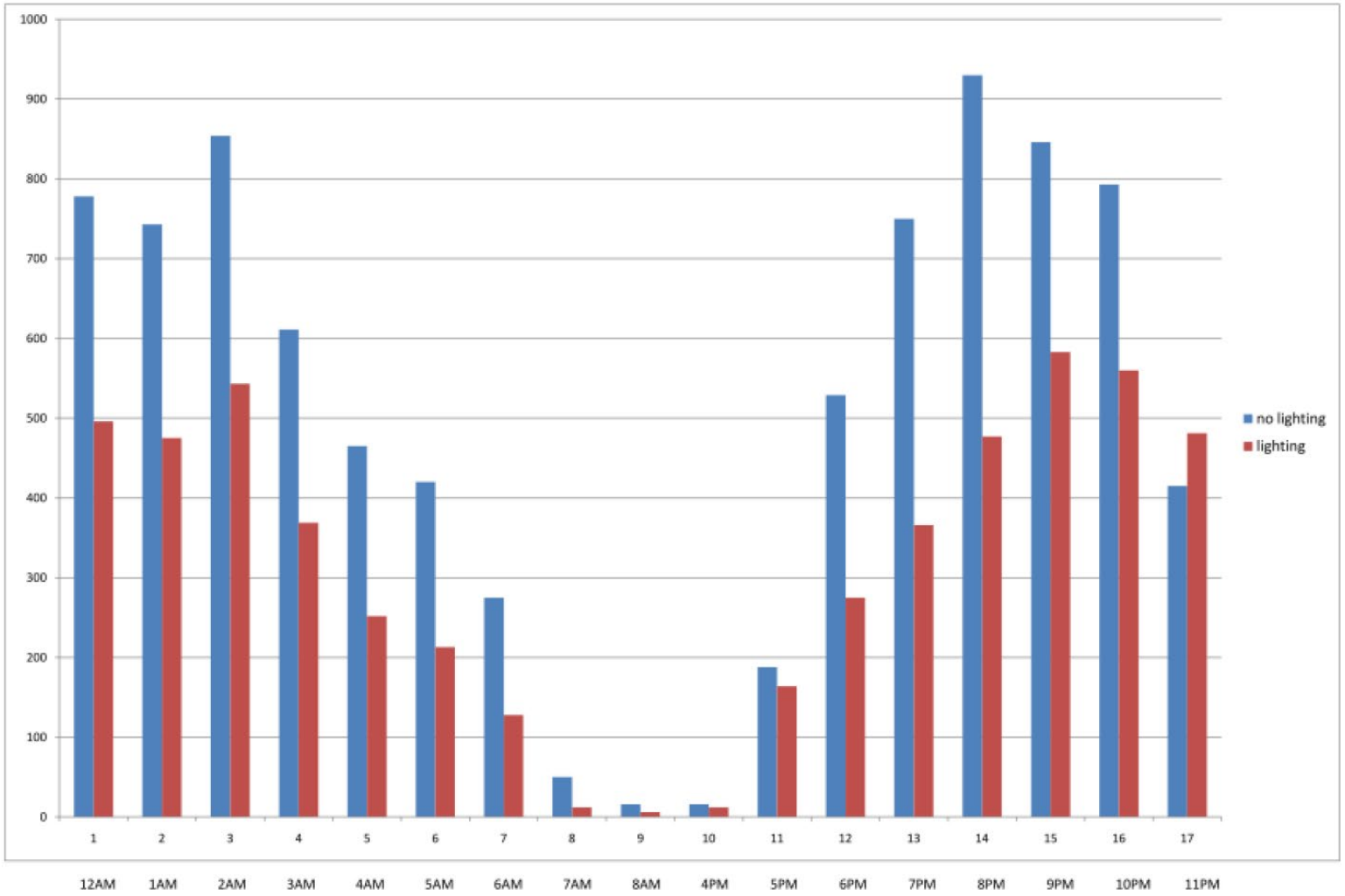
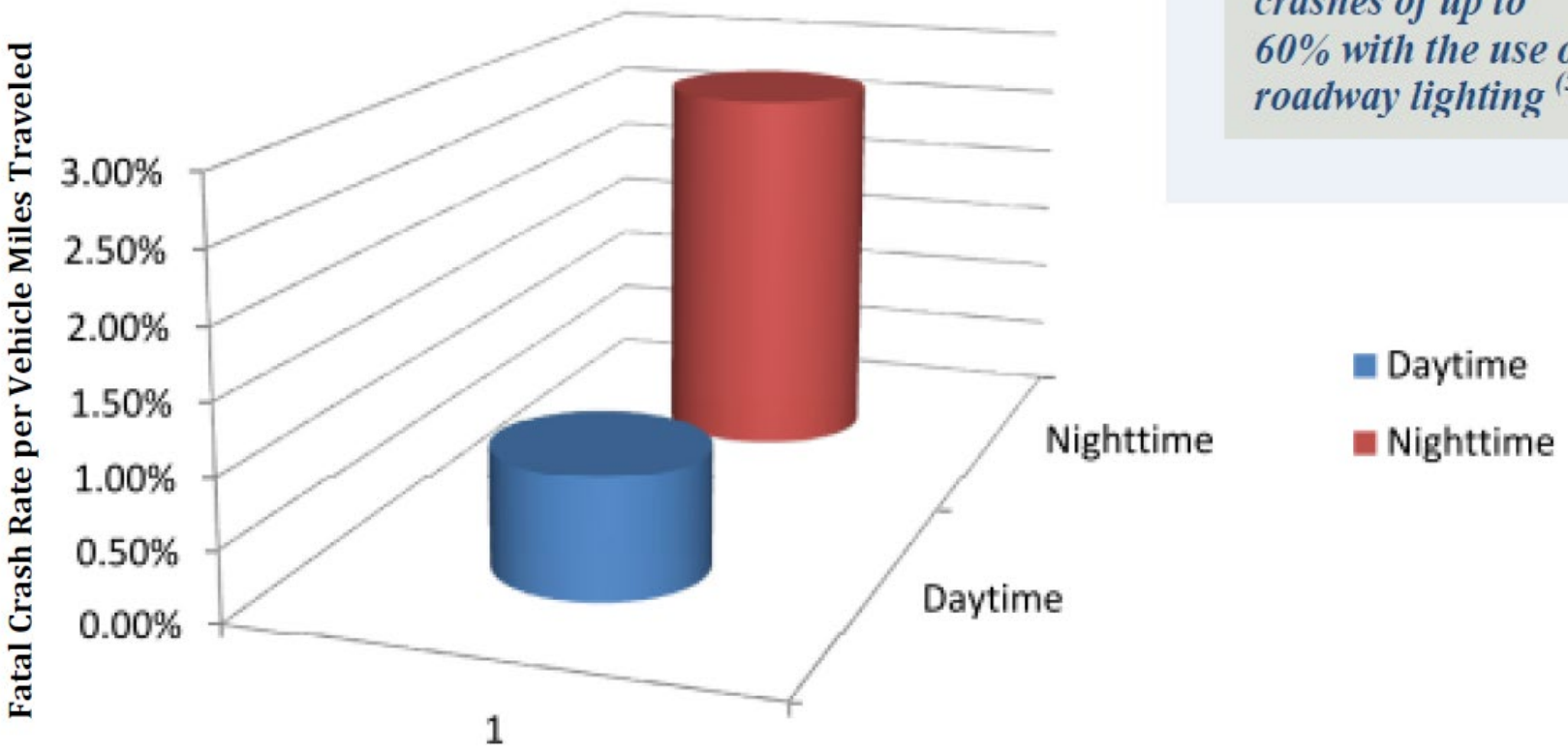


Figure 1b - Fatal Crashes during Darkness by Lighting Condition (2009 FARS data)

Studies have shown a reduction in nighttime fatal crashes of up to 60% with the use of roadway lighting [5]



- Countermeasure: Illumination

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type	Reference
0.62 [B]	38	★★★★☆	All	Serious injury,Minor injury	Not specified	Not specified	Elvik, R. and Vaa, T., 2004
0.72	28	★★★★☆	All	Serious injury,Minor injury	All	All	Elvik, R. and Vaa, T., 2004
0.69	32	★★★★☆	All	Serious injury,Minor injury	All	Urban	Elvik, R. and Vaa, T., 2004
0.73	27	★★★★☆	All	Serious injury,Minor injury	Principal Arterial Other Freeways and Expressways	All	Elvik, R. and Vaa, T., 2004
0.8	20	★★★☆☆	All	Serious injury,Minor injury	All	Rural	Elvik, R. and Vaa, T., 2004

Crash Modification Factors Clearinghouse at www.cmfclearinghouse.org

What causes Highway Crashes?

Research shows that Crashes are more likely caused by:

- Human preventable behaviors - speeding, following too close, unsafe lane changing and turning.
- Distracted driving - talking and texting on the phone, inattentive driving such as mirror usage or reaching for objects in the vehicle.
- Fail to follow visual warning cues from advance warning signs or markings such as Curve ahead, Signal ahead, construction zone traffic incidents and unexpected traffic event (e.g., unexpected stopping by the vehicle ahead).

Need to create a lighting environment that allows us to manage the effects of each of these events

- Can we control our driving and others?
- How do we maintain attention to task at hand which is driving our vehicle?
- How do we maximize detection of an unexpected event?

Lighting Impacts on Safety

- Lighting provides the benefit of improving safety for motorists and pedestrians;
- Larger impact on our nighttime environment for motorists.
- Ongoing research demonstrates the impact of lighting at night as it relates to human health and to the condition of wildlife and plant life.
- The above factors will change in our approach to light control and recommended lighting levels.
- Additional researches may also affects the decision-making process on whether, and where, lighting is beneficial.
- Other factors – Roadside design, delineations, markings.

FHWA Focus Approach to Safety Program (FAS)

- Provides additional resources to eligible high priority States to address the Nation's most critical safety challenges.
- Program benefits – data analysis, safety plan, tools and training.
- This data-driven process increases awareness on critical severe crash types, leads to key safety infrastructure improvements, assists in prioritizing limited resources, and creates positive organizational changes in safety culture, policies and procedures.
- These areas: Roadway Departure, Intersections, and Pedestrian/Bicycle crashes have been identified as providing the greatest potential to reduce highway fatalities using infrastructure-oriented improvements, over 90 % of crashes fall in these 3 areas.

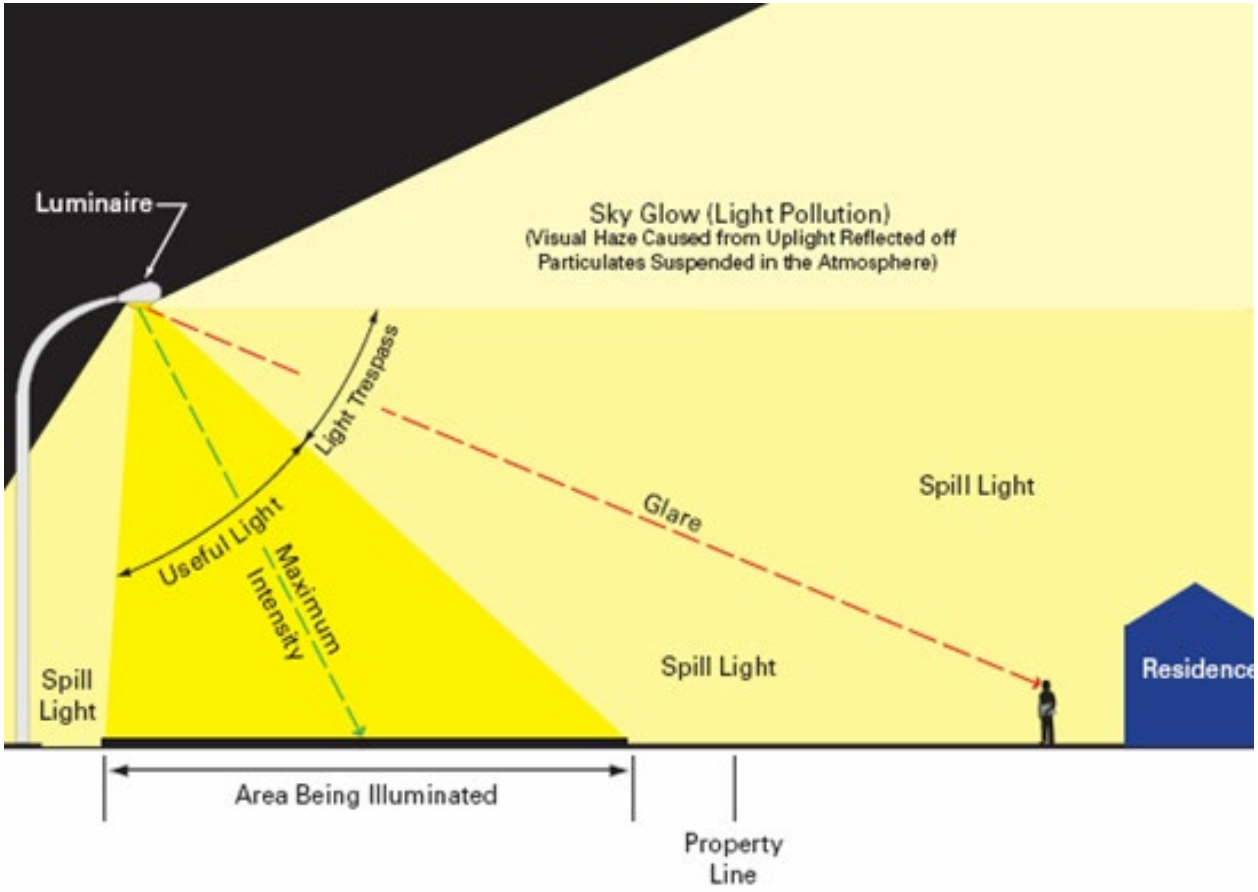
Factors affecting Lighting Design

- Light source types and characteristics - depreciation factors and efficacy
- Physical hardware characteristics – ballast, Luminaire, lens, mounting types, pole design with breakaway, clear zone criteria, luminaire mounting height and spacing
- State and Local laws on light trepass and sky glow
- Lighting quality measures –illuminance, luminance and veiling luminance, visibility, color spectrum
- Lighting technology – LEDs, HPS
- Maintenance, energy and life-cycle costs

LED vs HPS

Overpowered Luminaires

Disability glare is one of the most important elements to control in a lighting system. It affects your ability to adequately see, particularly for older drivers.



The impact of lighting systems on the environment and abutters should be assessed in all roadway lighting designs

Negative Impacts of Roadway Lighting

- Health Impacts - AMA Report - Use 3000k
- Sky glow
- Glare
- Impact on Flora and Fauna
- Other environmental impacts – fish and wildlife, migration habits and patterns
- many others

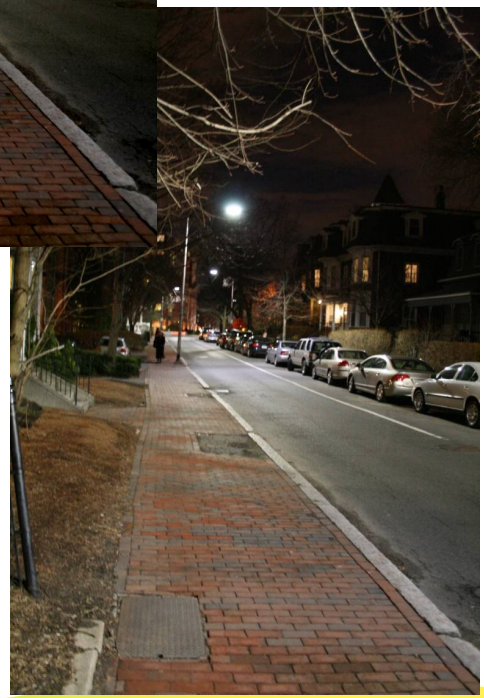
Keys for Minimizing the Impact of Roadway Lighting

- Reduce the amount of uplight and high angle light
- Reduce the amount of disability, discomfort glare generated by the lighting system
- Limit the amount of light trespass produced by the lighting system to criteria established by IES, AASHTO and CIE

- **Adaptive Lighting -** main benefits:
  - Operation and Maintenance costs.
  - Over-lighting.
  - Glare from roadway lighting installations
  - Light trespass.
  - Sky-glow.

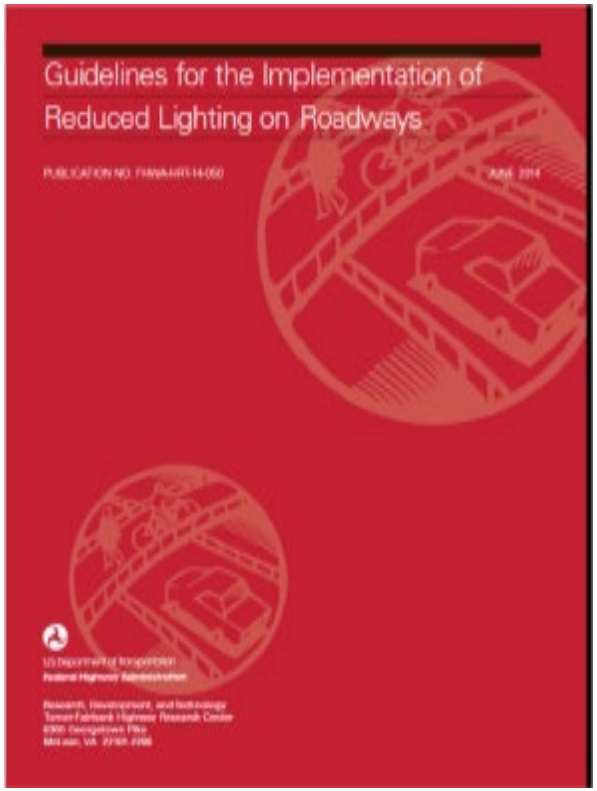
Adaptive Lighting

- Adjusting Lighting to Levels based on the needs of the user - New control and Ballast technology
- Using Light on When and Where it is needed- reduction of energy use between 20% to 40%
- Ability to adapt a roadway lighting system to the needs of the environment.
  - Traffic Volume
  - Crash characteristics
  - Pedestrian Usage for safety and security
  - Roadway characteristics
  - Weather
  - Lighting Condition



FHWA Research Documents

- Guidelines for The Implementation of Reduced Lighting on Roadways - Publication Number: FHWA-HRT-14-050 Date: July 2014
- Design Criteria for Adaptive Roadway Lightings - Publication Number: FHWA-HRT-14-051 Date: July 2014



The Immediate Future

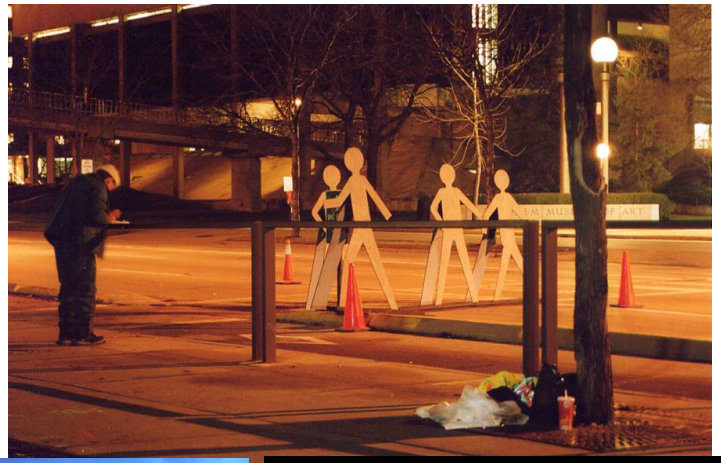
- Connected Vehicles
  - V2V, V2I, V2X
- Lighting on Demand
- DSRC and Cellular
- Pedestrian Pickup
- Other Issues
  - Comfort Level
  - How many luminaires, how big a space
  - Driver Glance Behavior
  - Object Detection / Safety

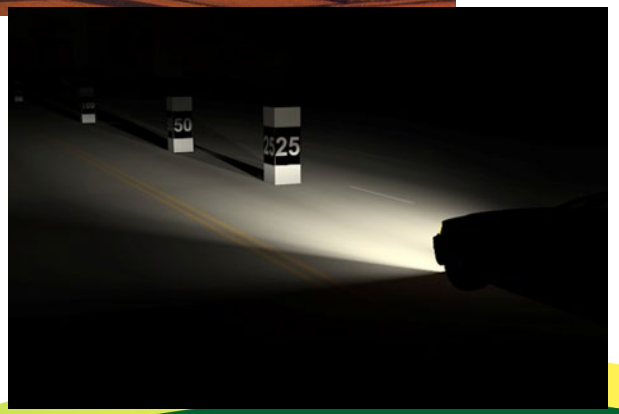
Lighting as the Backbone to the Smart City

- Breaking down the information silos in a city
- Traffic Flow
- Pedestrian usage
- Environmental factors
- Connected Vehicles
- Light Status
- Transit
- Information is linked on the lighting network backbone
- Linking through the IoT endpoints on each luminaire

FHWA position on roadway Lighting as it related to Safety has always been:

- Research based
- Data Driven

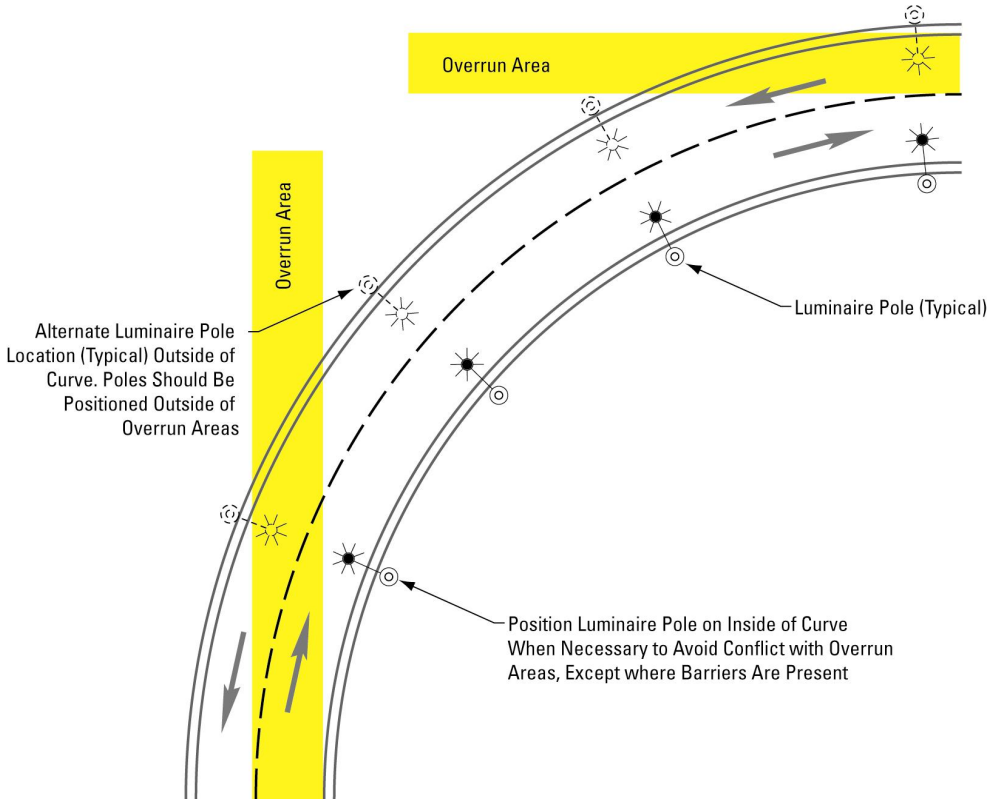


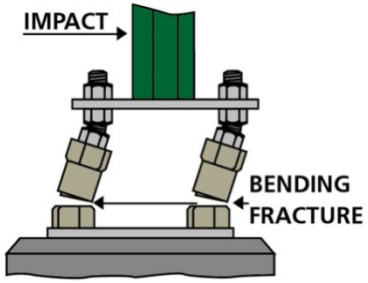


Completed and on-going FHWA and NCHRP researches related to lighting

- Roadway Visibility Research Needs Assessment
- Roadway Lighting workshop Training course
- Pedestrian Lighting
- NCHRP 5-22 – Guidelines for Solid-State Lighting
- NCHRP 5-23 – Effect of LED Roadway Lighting on Driver Sleep Health and Alertness
- NCHRP 20-07/Task 425 Emerging LED technologies, and their spectrum of use within tunnels
- Others – AASHTO Roadway Lighting Design Guide, 7th Edition
- SHRP 2 data for lighting design analysis

Roadside Hazards





Roadway Markings and Guidance

Questions?

Joseph.Cheung@dot.gov