231 Lighting

231.1 General

Roadway lighting benefits the traveling public by improving nighttime visibility of roadway geometry, vehicles, pedestrians, and obstructions. The design and layout of lighting should complement the basic highway design and must comply with the requirements of ***FDM 215*** for roadside safety.

Locate light poles between the right of way line and the outside edge of curbs or shoulders as applicable. Light poles are permitted in the median only when lighting from the outside cannot meet the criteria shown in ***Table 231.2.1*** without being supplemented by median lighting. Additionally, light poles placed in medians must be mounted on or behind barriers per the requirements in ***FDM 215.2.9*** and ***Standard Plans, Index 715-002***.

This chapter provides the process and criteria to be used in the development of lighting designs on the SHS. The design and installation of these lighting systems must comply with the National Electrical Code (NEC) unless otherwise specified by the Department.

231.1.1 Design Luminaires

Use only luminaires listed on the Department's ***Approved Products List (APL)*** for the corresponding usage cases. Obtain photometric information from manufacturers to use in the lighting design and resulting design luminaire selection. Include the design luminaire information with the Lighting Plans per the requirements of ***FDM 943***.

Where practical, use consistent luminaire models with the same input/output properties per new lighting location (e.g., per corridor, intersection, interchange, sidewalk, etc.).

231.1.2 Structural Supports

AASHTO's LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals and the ***FDOT Modifications to LRFDLTS-1*** provide structural design criteria.

Refer to ***FDM 261*** for information regarding structural support requirements. Refer to ***FDM 943*** for information regarding Lighting Plans requirements.

231.1.3 Attachments to Barriers

Refer to ***FDM 215*** for information regarding proposed attachments to bridge traffic railings, concrete median barrier walls, concrete shoulder barrier walls or the evaluation of existing attachments.

231.1.4 Voltage Drop Criteria

When determining conductor sizes for lighting electrical circuits, the maximum allowable voltage drop, measured from the power company's transformer through the last luminaire on any one circuit, must not exceed 5%.

The NEC's additional voltage drop criteria for the individual evaluation of feeders and circuit branches may be considered at the District's discretion.

231.1.5 Grounding

The grounding requirements for lighting systems, as shown in the ***Standard Plans*** are as follows:

(1) Install 20' of ground rod at each conventional height light pole and at each pull box.

(2) Install 40' of ground rod at each electrical service point.

(3) At each high mast pole, install an array of 6 ground rods 20' in length, as shown in the ***Standard Plans, Index 715-010***.

The above lengths of ground rod will be installed at each pole, pull box and service point, and the cost will be incidental to the unit or assembly being installed.

231.2 Design Criteria

Use the illuminance method for nighttime light level design. The design values for light levels are generally based on the ***AASHTO Roadway Lighting Design Guide's*** maintained values. These maintained values have been adjusted for Department-assigned light loss and maintenance factors, and they are provided in ***Table 231.2.1*** as the required initial light level criteria.

The ***AASHTO Roadway Lighting Design Guide*** permits either the illuminance technique or the luminance technique to be used in the design of highway lighting. The luminance technique requires a complex design process and knowledge of the reflective characteristics of the pavement surface used. These reflective characteristics change as the pavement ages and with variations in weather conditions. It is for these reasons that the luminance technique is not used for general nighttime light level design. As a result, direct illumination methods must be used in design software for general roadway lighting. The radiosity or reflectance of surfaces is not required in the analysis for meeting Horizontal Foot Candle (H.F.C.) and Vertical Foot Candle (V.F.C.) requirements of ***Table 231.2.1***.

For the differing daytime bridge underdeck analysis requirements, see ***FDM 231.3.6.2.***

The Veiling Luminance ratio also uses a different design method. For this glare check, simplified software tools for corridor optimization may be used (R3, Q0=0.07 unless other data is available).

Conventional lighting generally includes the basic fixtures for roadside placement that are used for the majority of roadway lighting cases, excluding the specialized fixtures used for high mast, underdeck, sidewalk, shared used path, and sign lighting.

Luminaire tilt is defined in ***Standard Plans, Index 715-001***. Luminaires may be tilted up to the following:

(1) 5 degrees for limited access facilities, excluding undivided segments and ramps

(2) 15 degrees for weigh stations, agricultural stations, and rest areas

Light poles installed within the clear zone must be breakaway or shielded by an approved barrier unless they are bridge or barrier mounted. Where practical, avoid placing unshielded light poles at locations where distracted or errant drivers may have a greater tendency for roadway departures (e.g., downstream of lane drops, shoulder narrowing, or gore areas). See ***FDM 215*** for additional information on roadside safety design.

Pole setback is the horizontal distance from the edge of the travel lane to the pole. Mounting Height is defined below.

Lighting Values:

Meet the requirements of ***Table 231.2.1*** as directed throughout this chapter. The table provides initial illumination levels, which must be met or exceeded. Where a hyphenated range is provided in the table, any value within the range may be used based on the designer's judgement regarding practical light pole placement and surrounding light conditions. Should reasonable hardware options result in exceeding these requirements, use illumination levels that are as low as practical.

For corridor lighting, the average Horizontal Foot Candle requirements of ***Table 231.2.1*** must not be exceeded by more than 30%. Where corridor lighting areas adjoin different areas with higher illumination requirements, the corridor lighting may exceed its illumination requirement only in the portion where light spill from the adjacent brighter area is unavoidable. These short segments may be excluded from the lighting value checks only as necessary to transition between differing requirements.

Table 231.2.1 Lighting Values

Roadway Classification	Illumination Level Average Foot Candle		Illumination Uniformity Ratios		Veiling Luminance Ratio
Or Location Type	**Horizontal (H.F.C.)**	**Vertical (V.F.C.)**	**Avg./Min.**	**Max./Min.**	**$L_{V(MAX)}/L_{AVG}$**
Corridor Lighting					
Limited Access Facilities	1.5	N/A	4:1 or Less	10:1 or Less	0.3:1 or Less
Major Arterials	1.5				
Arterial Lighting Retrofit	1.0-1.5				
Other Roadways	1.0				
High Mast Lighting					
All Roadway Classifications	0.8-1.0	N/A	3:1 or Less	10:1 or Less	N/A
Signalized Intersection and Roundabout Lighting					
New or Reconstruction	3.0 Std. 1.5 Min.	1.5 Std. 1.2 Min.	4:1 or Less	10:1 or Less	N/A
Intersection Lighting Retrofit	1.5 Std. 1.0 Min.	1.5 Std. 1.0 Min.			
Isolated Lighting	1.0-1.5	1.0-1.5			
Unsignalized Intersection Lighting					
All Project Types	1.0-1.5	1.0-1.5	4:1 or Less	10:1 or Less	N/A
Midblock Crosswalk and Ramp Crosswalk Lighting					
Low Ambient Luminance	N/A	1.5	N/A	N/A	N/A
Medium & High Ambient Luminance		2.3			
Sidewalks and Shared Use Paths					
Facilities Separated from the Roadway	2.5	N/A	4:1 or Less	10:1 or Less	N/A
Sign Lighting					
Low Ambient Luminance	5-10	N/A	N/A	6:1	N/A
Medium Ambient Luminance	10-20				
High Ambient Luminance	20-40				

Table 231.2.1 Lighting Values cont.

Roadway Classification	Illumination Level Average Foot Candle		Illumination Uniformity Ratios		Veiling Luminance Ratio
Or Location Type	Horizontal (H.F.C.)	Vertical (V.F.C.)	Avg./Min.	Max./Min.	$L_{V(MAX)}/L_{AVG}$
Rest Area Lighting					
All Roadways and Parking Areas	1.5	N/A	4:1 or Less	10:1 or Less	N/A
Wildlife-Sensitive Conventional Lighting					
Limited Access Facilities	0.8-1.0	N/A	4:1 or Less	10:1 or Less	0.3:1 or Less
Arterials and Collectors	1.0-1.5	N/A			
Signalized Intersections – New	1.5-3.0	1.0	4:1 or Less	10:1 or Less	N/A
Signalized Intersections – Retrofit or Isolated	1.0-1.5	1.0.			
Midblock Crosswalk and Ramp Crosswalk	N/A	1.0	N/A	N/A	N/A

Notes:

(1) Illumination Uniformity Ratios do not apply to V.F.C.

(2) Standard (Std.) values must be met unless doing so raises the accompanying H.F.C. or V.F.C. result in excess of double its required illumination level. For such cases, the Minimum (Min.) value may apply.

(3) Ambient luminance classifications are defined in the ***AASHTO Roadway Lighting Design Guide***.

Limited Access Facilities:

If the length of the mainline roadway between any two lighted areas is 0.5 mile or less, then that segment of the mainline must be lighted. These lighted areas may include roadway mainline segments, interchanges, service plazas, and toll facilities.

Interchanges:

For independently lighted interchanges with no connection to adjacent mainline or crossroad lighting, the lighting values for high mast lighting may be used throughout all areas, including bridge underdecks. See ***FDM 231.3.1*** for the included analysis zones and limits.

Where the mainline or crossroad corridors have a connecting lighting system adjacent to the interchange limits, continue the connecting corridor's lighting values through the interchange for consistency. Conventional and high mast style lights may work in conjunction to achieve these illumination levels. On ramps, either high mast lighting values or the corridor's lighting values may be used at the District's discretion, so long as consistent lighting value requirements are used throughout all ramps in the interchange.

For high mast lighting, the effects of elevated ramps and bridge decks must be accounted for in the design analysis, particularly when light is blocked by other raised objects (e.g., adjacent bridges, railings, signs, or miscellaneous structures). Meet the maximum illumination and uniformity ratio requirements to avoid bright spots.

Mounting Height:

Mounting height (M.H.) for conventional lighting is the vertical distance from the finished grade at the pole's base to the luminaire's light source, regardless of lateral placement of the pole.

Specify mounting heights for conventional lighting as shown in ***Standard Plans, Index 715-002***. In the photometric analysis, adjust the luminaire height to account for the difference between the finish grade elevation at the pole's base and the approximate average roadway surface elevation. In order to assume a simplified level roadway, a surface elevation tolerance of ±18" is permitted in the analysis.

The design luminaire must not exceed the maximum candela for the associated minimum mounting height per ***Table 231.2.2***.

Table 231.2.2 Minimum Mounting Heights Based on Maximum Candela

Minimum Mounting Height (feet)	Maximum Candela of Luminaire		
	Long Distribution	Medium Distribution	Short Distribution
20 or Less	5,000	10,000	15,000
25	10,000	15,000	20,000
30	15,000	20,000	25,000
35	20,000	25,000	30,000
40	25,000	30,000	35,000
45	30,000	35,000	40,000
50	35,000	40,000	45,000

Notes:

(1) "Distribution" refers to the longitudinal distribution of the luminaire output per the Illuminating Engineering Society of North America (IESNA).

(2) "Maximum Candela" is generally provided with the manufacturer's luminaire specific "IES" file for AGi32® or similar design software.

Color Temperature:

Apply the Correlated Color Temperature (CCT) requirements of ***Table 231.2.3*** to new designs for lighting projects that are warranted for reasons other than CCT. The requirements of ***Table 231.2.3*** alone do not warrant replacement of existing luminaire installations.

Where a small number of new luminaires are added within the limits of existing corridor lighting systems for maintenance, intersection retrofits, or similar purposes, the requirements of ***Table 231.2.3*** do not apply. Instead, match the CCT of the existing system to maintain color consistency. For new luminaires added within existing high pressure sodium systems, use 3000K or lower CCT.

For roadside facility lighting, use the same CCT as the nearest roadway lighting for consistency. Such facilities include, but are not limited to, sidewalks, shared use paths, toll sites, rest areas, and weigh stations. If roadway lighting is not visible from the roadside facility, then use 3000K or lower CCT for the roadside facility.

Where permitted per ***Table 231.2.3***, consider the use of the warmer 2700K CCT for aesthetic locations including residential areas, natural areas, historic areas, downtown districts, parks, and campuses. Additionally, the requirements of ***FDM 231.2.1*** for Environmental Lighting supersede the requirements of ***Table 231.2.3***.

Sign Lighting must be 5000K CCT per the ***Standard Specifications***.

Daytime underdeck lighting that is installed per the requirements of ***FDM 231.3.6.2*** must be 4000K CCT. For these locations, either 4000K CCT or the corridor values in ***Table 231.2.3*** may apply for the nighttime underdeck lighting operation phase at the District's discretion. If no daytime underdeck lighting is required, then the corridor values in ***Table 231.2.3*** apply to nighttime underdeck lighting.

Table 231.2.3 Correlated Color Temperature (CCT)

Design Speed	Context Classification	CCT
Arterials and Collectors		
≤ 35 mph	All	2700K[1] or 3000K
≤ 50mph	All	3000K
≥ 55mph	C1 & C2	3000K
≥ 55mph	C3[2]	4000K
Limited Access Facilities		
All	All	3000K[3]

Notes:

(1) Consider use of 2700K per the description above
(2) Higher number context classifications may apply
(3) Also includes all high mast lighting

231.2.1 Environmental Lighting

Wildlife areas of concern are identified by the District's environmental managers or permit coordinators on a project-specific basis. For lighting within these areas, follow the requirements for Wildlife-Sensitive Conventional Lighting listed in ***Table 231.2.1*** along with ***FDM 231.3***. Where practical, use only Wildlife-Sensitive Conventional Luminaires listed on the ***APL***, and orient lighting away from the wildlife-sensitive areas per ***FDM 231.2.2***.

For consideration of sea turtle nesting beaches, the Office of Environmental Management (OEM) provides additional resources on the ***Protected Species and Habitat*** website or through the ***Florida Geographic Data Library (FGDL)*** metadata explorer. The *Data Tools for Turtle Lighting* provide GIS shape files and Google Earth™ map layers showing the areas of concern where lighting may be visible from light-sensitive sea turtle nesting beaches. For projects within these areas, coordinate with the District's environmental managers or permit coordinators to evaluate proposed lighting impacts to sea turtles on nesting beaches. Where the lighting is visible from nesting beaches, the following requirements apply.

For Wildlife-Sensitive Buffer Areas:

(1) Orient lighting away from nesting beaches to avoid direct lighting and consider light shielding, where practical.

(2) Follow criteria for Wildlife-Sensitive Conventional Lighting per ***Table 231.2.1***. Use only Wildlife-Sensitive Conventional Luminaires as listed on the ***APL***.

(3) For night-time work zone lighting within the wildlife-sensitive buffer area that will occur during sea turtle nesting season, meet the requirements of ***FDOT Standard Specifications Workbook 8-4.1***.

For Dark-Sky Buffer Areas:

(1) Follow International Dark-Sky Association recommendations where practical, including the topics of light orientation and light shielding.

(2) Use Luminaires with a 3000K CCT or lower. Use traditional luminaires as listed on the ***APL***; specify CCT in Lighting Plans.

231.2.2 Light Spill

Design lighting systems to minimize light projection beyond the right of way line. Illumination levels outside of the right of way should be as low as practical, with attention given to reducing impacts to the surrounding areas.

If wildlife areas or residential properties are within 100 feet of a luminaire, select a luminaire model that has original manufacturer's shielding options available for a potential future installation. Where residential or commercial structures are directly adjacent to luminaires, determine whether immediate shielding would prevent light from entering nearby windows and living spaces. Call for such shielding in the plans where practical.

Provide a general overview of the light spill status to coordinate mitigation decisions with the District Design Office. Provide a brief summary of these coordination efforts, including the participants and results, in the LDAR per ***FDM 231.7***. See ***FDM 231.2.1*** for additional wildlife area requirements.

231.3 Design Methodology

A lighting design analysis is required where a new system of luminaires is being installed or where luminaire locations are being changed within an existing system. This requirement includes lighting retrofits, the general adding or moving of light poles, and the replacement of more than three consecutive luminaires on existing light pole runs for maintenance or other purposes.

Roadway Lighting:

Provide a photometric software analysis for roadway areas being illuminated throughout the project. Include a printout of the analysis in the LDAR per ***FDM 231.7***. Such printouts must be in electronic format (e.g. PDF) using 11" x 17" sheets with photometric data points that are clearly legible. The analysis results must indicate foot-candle values displayed on plan view with 1/10th precision (0.X foot-candles). Where solid objects (e.g. bridges) block luminaire light contributions, a 3D graphic representation must be included that accounts for such objects. Analysis using only typical sections is not permitted.

Use the polygon method for all horizontal area illuminance calculations. Establish illumination data points (i.e. calculation points) within the polygon at the following intervals and approximate orientations:

(1) Roadway Segments – General: 15 feet longitudinally and 5 feet transversely along the roadway

(2) Roadway Segments – Curved/Angled: 8 feet longitudinally and 8 feet transversely (segments with high variability from cardinal directions per designer's judgement)

(3) Roadway Segments – Beneath Bridge Underdecks: 5 feet longitudinally and 5 feet transversely along the roadway, including pedestrian ways.

(4) Signalized Intersections: 5 feet longitudinally and 5 feet transversely along the roadway.

Sign Lighting:

Provide a photometric software analysis for signs being illuminated throughout the project. The analysis must include illumination data points at a maximum 1-foot by 1-foot spacing, covering the entire sign area. Include a printout of the analysis in the LDAR per ***FDM 231.7***. Such printouts must be in electronic format (e.g. PDF), and they must have photometric data points that are clearly legible. The analysis results must indicate foot-candle values displayed with 1/10th precision (0.X foot-candles).

Refer to ***RCI Features & Characteristics Handbook***, Urban Classification – Feature 124 for additional information concerning urban designations Urban 1 through Urban 5.

231.3.1 Analysis Zones

Establish independent analysis zones for each signalized intersection segment and for each roadway segment between signalized intersections. Roadway lighting for roadway segments, signalized intersection segments, and pedestrian lighting are to meet the criteria shown in ***Table 231.2.1.***

Analyze signalized intersection segments using one analysis zone bounded by the back of sidewalks and the signalized intersection stop bars on each approach. See ***FDM 231.3.2*** for additional intersection information, including vertical illumination analysis information.

The termini for each roadway segment will be either the lighting project limits, or the signalized intersection stop bars. Continue lighting through bridge underpasses using underdeck lighting per ***FDM 231.3.6.*** The boundary for each underdeck segment will be the same as the roadway corridor passing through it. The boundary of each roadway segment is described as follows:

Flush Shoulder Roadways:

(1) Analyze divided roadway segments with grassed medians or bridge supports using two analysis zones (i.e., one for each direction of travel). Each zone will be bounded by the outside and median shoulder breaks (includes full-width shoulders).

(2) Analyze multi-lane undivided roadway segments using two analysis zones (i.e., one for each direction of travel). Each zone will be bounded by the outside shoulder break and the centerline of the roadway (includes full-width shoulders).

(3) Analyze two and three lane roadway segments as one analysis zone bounded by the outside shoulder breaks (includes full-width shoulders).

Curbed Roadways:

(1) Analyze divided roadway segments with grassed medians or bridge supports using two analysis zones (i.e., one for each direction of travel). Each zone will be bounded by the back of sidewalk and the back of the median curb.

(2) Analyze multi-lane undivided roadway segments, including roadways with two-way left-turn lane, using two analysis zones (i.e., one for each direction of travel). Each zone will be bounded by the back of sidewalk and the center of the roadway.

Limited Access Facilities and Interchanges:

Establish independent analysis zones for the mainline roadway segments, ramp segments, underdeck segments, and crossroad segments at interchanges.

The termini for each mainline roadway segment will be the lighting project limits. Logical termini for the other segments will be determined by the designer. The boundary for each underdeck segment will be the same as the ramp or roadway corridor passing through it. The boundary of each segment is described as follows:

(1) Analyze divided mainline roadway with grassed median or bridge supports using two analysis zones, one for each direction of travel (i.e., one zone for each direction of travel). Each zone will be bounded by the outside and median shoulder breaks (includes full-width shoulders).

(2) Analyze barrier separated mainline roadway as one analysis zone bounded by the outside shoulder breaks of each direction of travel (includes full-width shoulders).

(3) Analyze each ramp segment as one analysis zone bounded by the shoulder breaks (includes full-width shoulders). Light ramps where the connecting mainline or interchange is lighted.

(4) Analyze crossroad segments based on the criteria given above for flush shoulder or curbed roadways. Light crossroads when the connecting interchanges are lighted, following the limits below.

(5) Analyze interchanges, including the mainline, ramps, crossroads, and underdeck areas per above. For interchanges where there is no connecting crossroad lighting, extend the interchange’s crossroad lighting to the limits of the interchange ramps. For interchanges where there is no connecting mainline lighting, place the interchange’s mainline lighting within the limits of 200 feet upstream and 200 feet downstream of the exit and entrance ramps, respectively.

Rest Areas:

(1) Analyze each ramp as defined for limited access facilities above. Light all ramps connecting to rest areas.

(2) Analyze the mainline roadway as defined for limited access facilities above. Mainline lighting is required adjacent to rest areas. If there is no continuous mainline lighting adjacent to the rest area, place mainline lighting within the limits of 200 feet upstream and 200 feet downstream of the exit and entrance ramps, respectively.

(3) Analyze all paved areas and parking lots around the rest area facilities. Light these areas within limits defined at the District’s discretion.

231.3.2 Intersections

231.3.2.1 Signalized Intersections

For signalized intersections within context classifications C3 through C6, provide lighting meeting the requirements of ***Table 231.2.1***. For all other signalized intersection contexts, lighting may be provided at the District's discretion. Use new or reconstruction lighting values unless different lighting values are called for in the subsections below.

Vertical illuminance is the primary design value used to measure driver visibility of pedestrians. Research has determined that visibility of pedestrians in crosswalks at intersections is a function of the following:

(1) Background illuminance

(2) Luminaire location in relation to the approach vehicle

(3) Luminaire mounting height

(4) Distance from the luminaire to the crosswalk

(5) Photometrics of the luminaire

The vertical illuminance calculation method to be used at intersections will be the variable light meter aimed toward the driver's location. This calculation will provide the vertical illumination level of a pedestrian which the driver sees approaching the crosswalk. This type of vertical illumination calculation is outlined in the ***IESNA Design Guide for Roundabout Lighting (DG-19-08)***. When performing this calculation, the driver's location from the crosswalk must be established. Use the stopping sight distance for the nearside approach based on the posted speed of the near approach roadway. Use the stopping sight distance for the turning movement approaches based on the operating speed for each specific turning radius.

The vertical illuminance must be calculated for three movements for each intersection approach. The first is the thru movement for the near side crosswalk. The second is the right-turn movement for the crosswalk on the adjacent side street or channelized right-turn lane per ***FDM 231.3.4***. The third is the left-turn movement for the crosswalk on the side street. ***Figures 231.3.1*** through ***231.3.3*** indicate each of these three movements and the corresponding crosswalk area that must be analyzed. Note that ***Figure 231.3.2*** shows a crosswalk for a basic right-turn, but a channelized right-turn is similar. The vertical illuminance data points will be on a line centered in the crosswalk, with a horizontal point spacing of 1.65 feet at a height of 5 feet above the pavement. The linear data points are oriented toward the approaching driver.

See ***FDM 231.3.2.1.1*** for projects where pedestrian lighting improvements are desired, but the existing intersection infrastructure will remain and be supplemented to achieve the desired improvements.

Figure 231.3.1 Vertical Illuminance Calculation for Near Side Movement

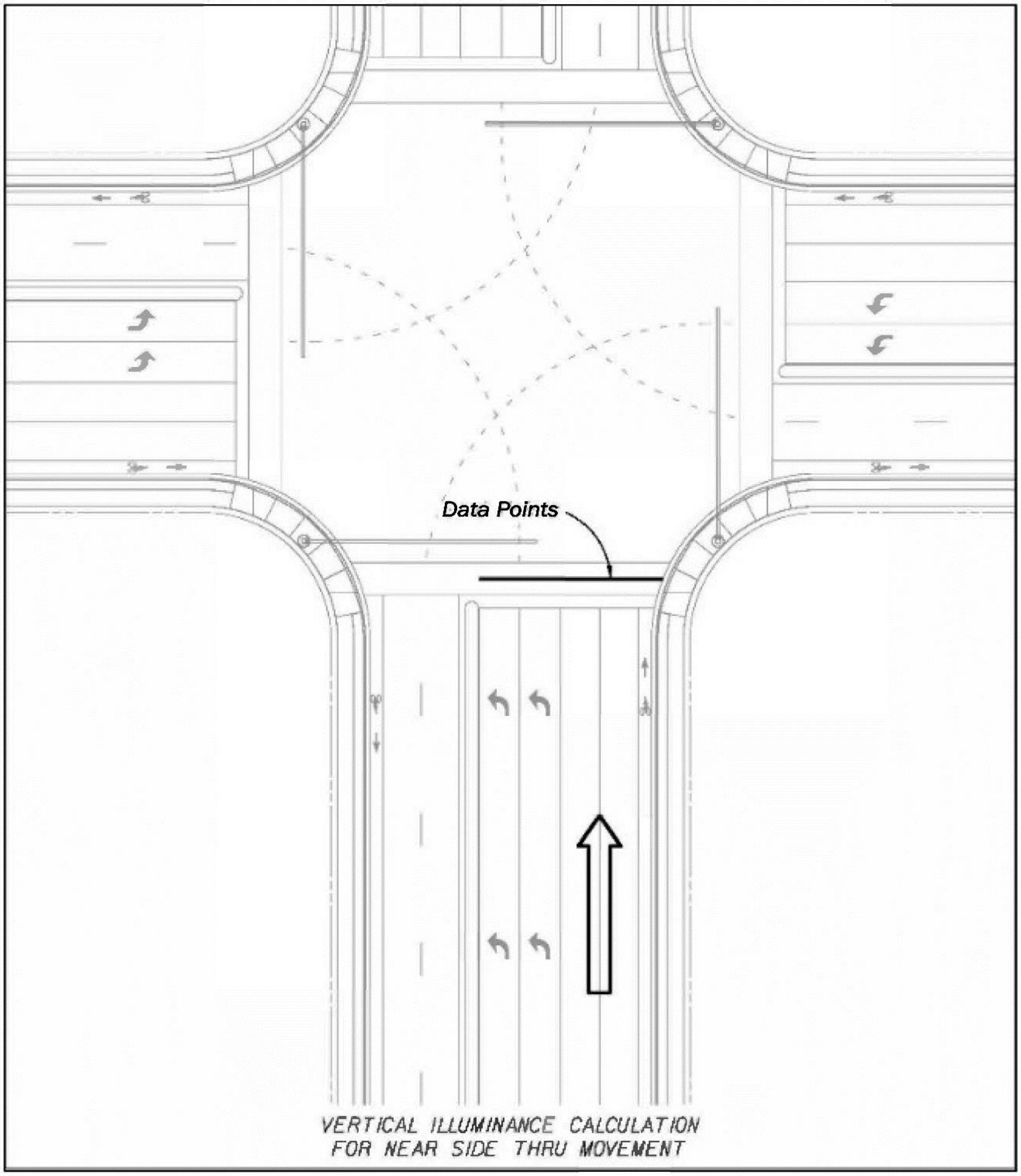


Figure 231.3.2 Vertical Illuminance Calculation for Right-Turn Approach

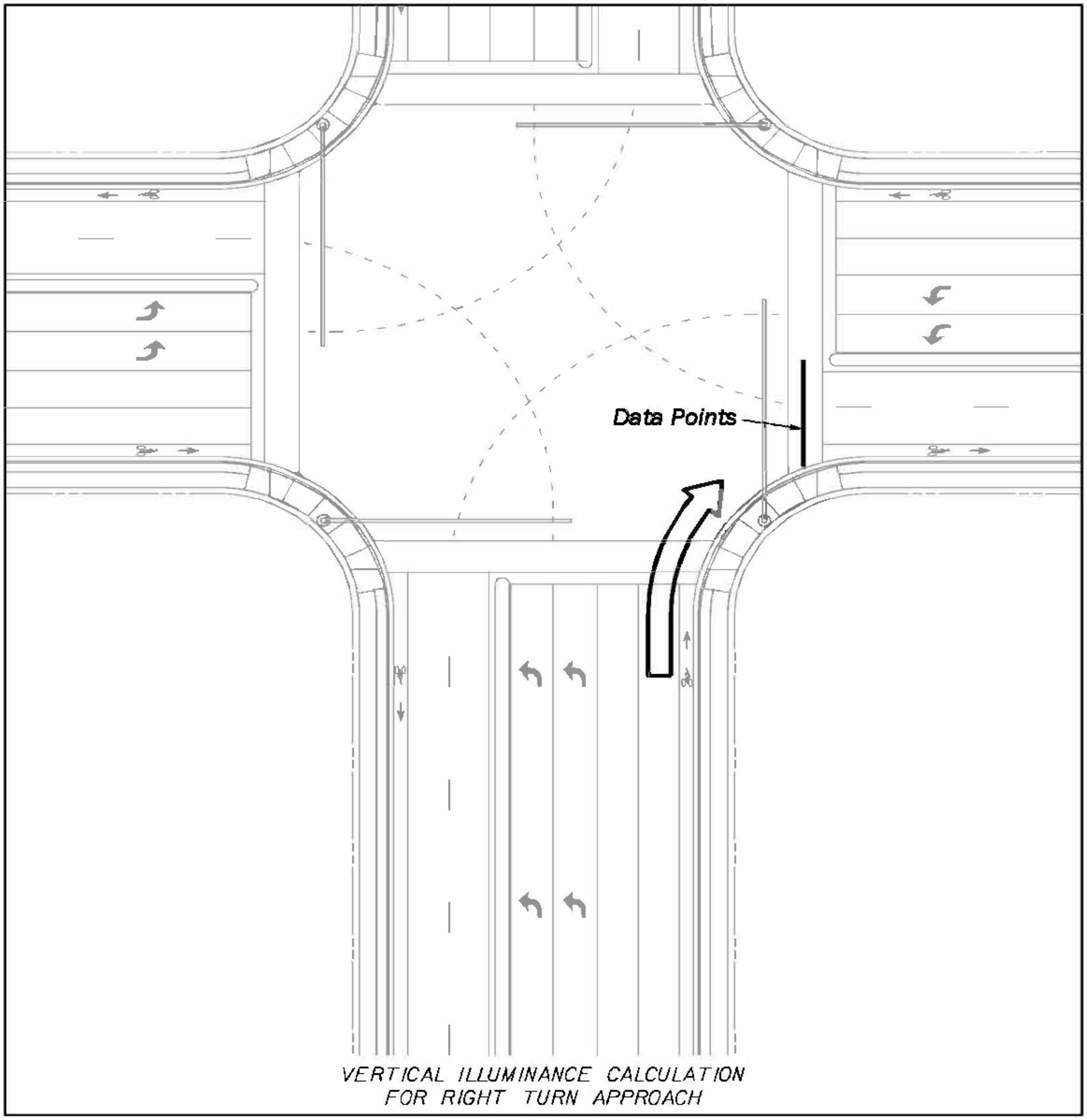


Figure 231.3.3 Vertical Illuminance Calculation for Left-Turn Approach

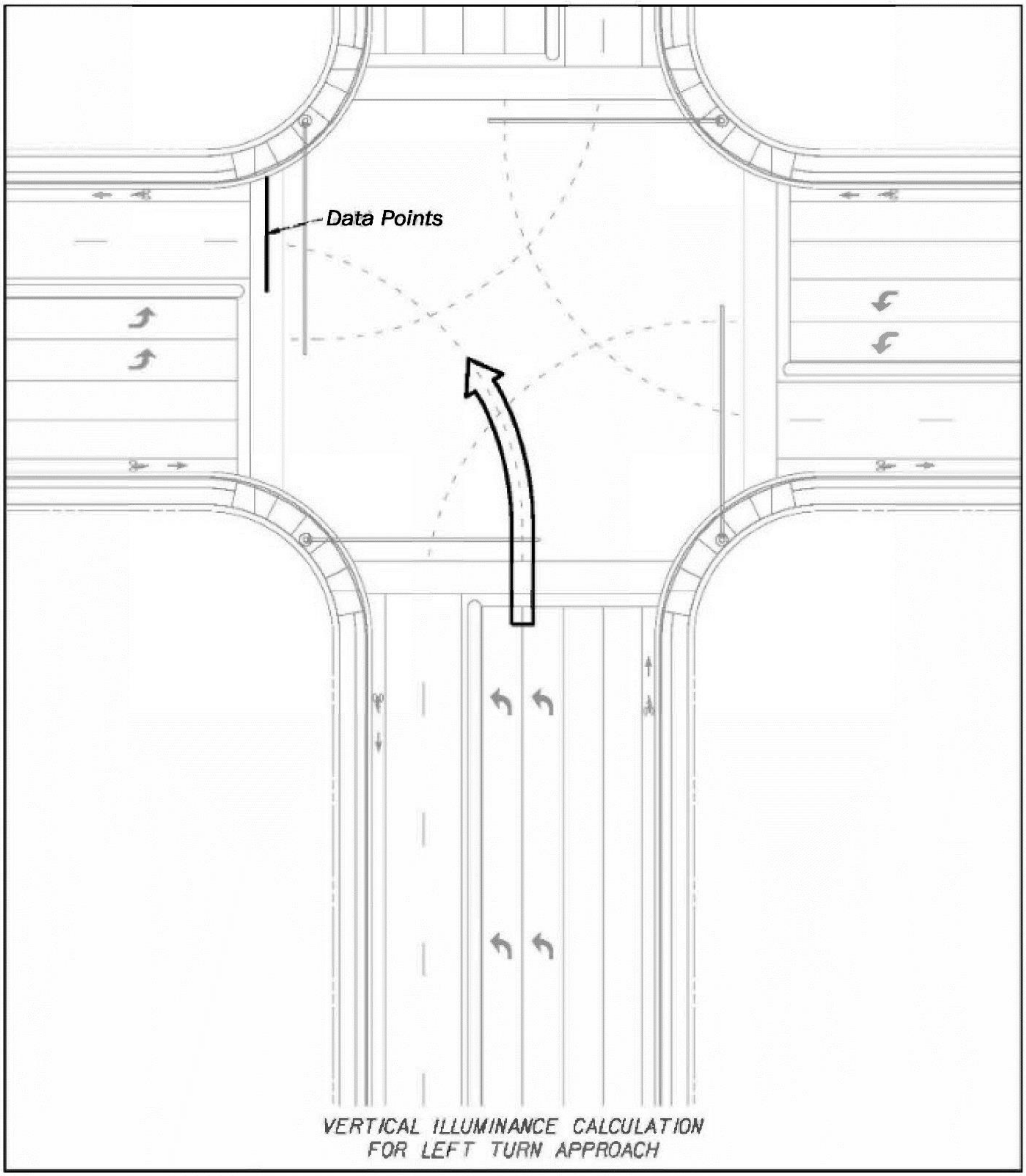
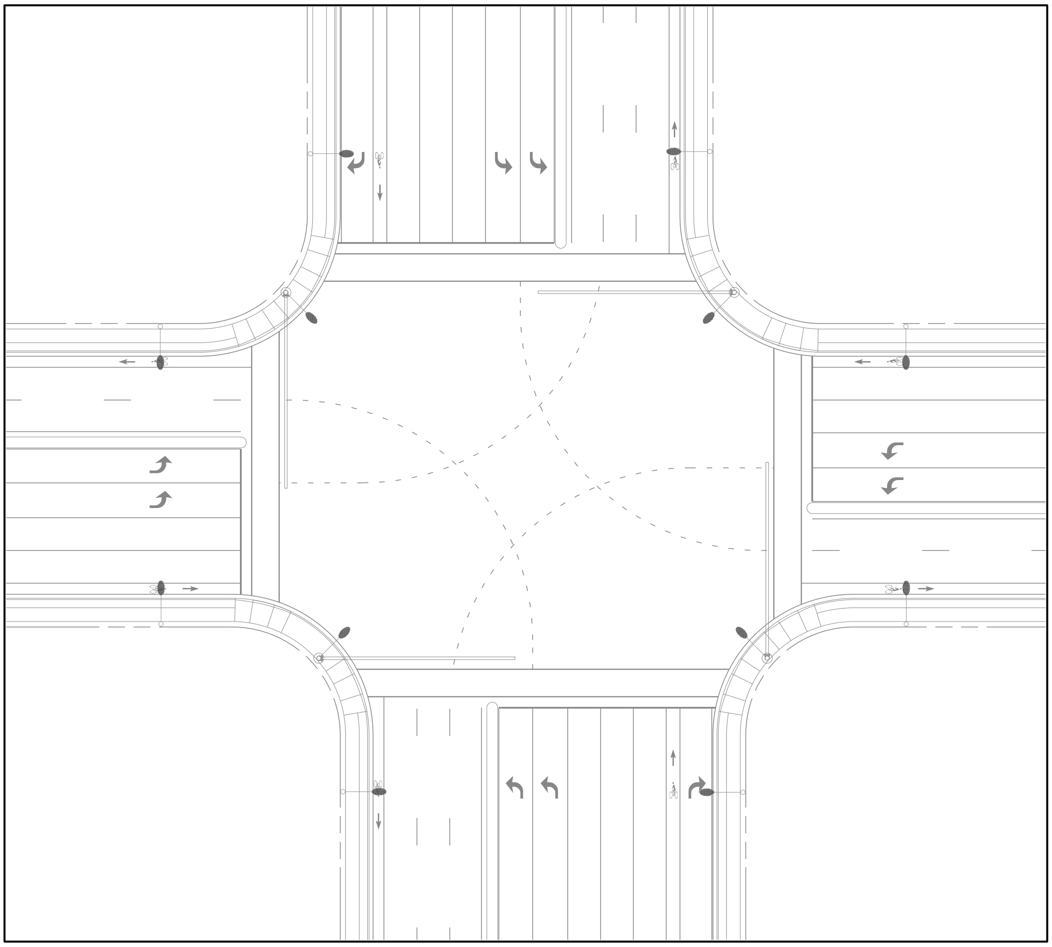


Figure 231.3.4 shows the typical lighting layout for a large intersection. The crosswalk and luminaire locations must be coordinated to optimize the vertical illumination level.

Figure 231.3.4 Typical Lighting Layout for Large Intersection



231.3.2.1.1 Intersection Lighting Retrofit

For existing signalized intersections where a full signal upgrade is not occurring, the existing infrastructure may restrict the placement of additional lighting structures necessary to meet the New and Reconstructed criteria of ***Table 231.2.1***. With these challenges considered, ***Table 231.2.1*** provides reduced illumination requirements which may be used for Intersection Lighting Retrofit designs. These retrofits provide safety benefits of improved lighting without the full reconstruction of light and signal structures.

Lighting retrofits should be considered for use at existing signalized intersections that have a history of nighttime pedestrian crashes. Lighting retrofits may be included with

RRR and minor intersection improvement projects that do not include full signal reconstruction. An Intersection Lighting Retrofit operation may include replacing older luminaire types with LED luminaires, adding additional light poles, adding luminaire support arms to existing structures, and any other minor modifications needed to meet the Lighting Retrofit requirements of ***Table 231.2.1***. Lighting retrofits generally do not include removing or replacing existing structures such as light poles and signal structures.

For Intersection Lighting Retrofit designs, the vertical illuminance requirement of ***Table 231.2.1*** only applies to crosswalks for the near side movement (see ***Figure 231.3.1***) as well as any channelized right-turn lanes per ***FDM 231.3.4***.

Existing, low-mounted sidewalk lighting is generally not intended to meet the lighting requirements of ***Table 231.2.1***. To prevent increased glare, do not increase light output at existing luminaire locations with mounting heights less than 30 feet.

Evaluate new and existing structures in accordance with ***FDM 261***.

Independent maintenance operations that update existing fixtures to LED fixtures are not considered Intersection Lighting Retrofits for design and planning purposes.

231.3.2.1.2 Isolated Lighting Intersections

Use the Isolated Lighting requirements of ***Table 231.2.1*** for signalized intersections with no connecting lighting on approach corridors. The vertical illuminance requirement only applies to crosswalks for the near side movement (see ***Figure 231.3.1***) as well as any channelized right-turn lanes per ***FDM 231.3.4***.

231.3.2.2 Unsignalized Intersections

Provide lighting for unsignalized intersections consistent with any connecting corridors that meet warranting requirements of ***FDM 231.4.***

Consider adding lighting for unsignalized intersections with a history of nighttime pedestrian crashes, particularly for marked crosswalks on uncontrolled approach legs. For marked crosswalks at such intersections, the vertical illuminance requirement of ***Table 231.2.1*** is only required for the near side movement (see ***Figure 231.3.1***) as well as any channelized right-turn lanes per ***FDM 231.3.4***.

231.3.3 Roundabouts

Provide lighting for roundabouts as required per ***FDM 213***.

The roundabout lighting criteria for new or reconstruction in ***Table 231.2.1*** applies where pedestrian features are provided. Calculate the vertical illuminance for crosswalks on each near side approach and for each right-turn movement in accordance with the methodology outlined in ***FDM 231.3.2***. Use conventional corridor lighting criteria for roundabouts where pedestrian traffic is not anticipated. Use the Isolated Lighting requirements of ***Table 231.2.1*** for roundabouts with no connecting lighting on approach corridors.

231.3.4 Standalone Crosswalks

Where required for standalone crosswalks, calculate the vertical illuminance for approach movements in accordance with the methodology outlined in ***FDM 231.3.2***.

231.3.4.1 Midblock Crosswalks and Ramp Crosswalks

Provide lighting for midblock crosswalks as required per ***FDM 222***. This lighting requirement also applies for crosswalks on entrance and exit ramps. Use the corresponding criteria provided in ***Table 231.2.1***.

Where midblock crosswalks are placed to serve a facility that generates pedestrian crossings only during daylight hours, this lighting requirement may be omitted at the District's discretion.

231.3.4.2 Channelized Turn Lane Crosswalks

Provide lighting for crosswalks on channelized right-turn lanes if the intersection is lighted. For channelized right-turns with a near-perpendicular entry per ***FDM 212.12***, use the vertical illumination level for the corresponding intersection type per ***Table 231.2.1***. For channelized right-turn lanes with a large radius and significant separation from the intersection thru lanes, midblock crosswalk criteria may be used at the District's discretion.

231.3.5 Sidewalks and Shared Use Paths

Lighting criteria for sidewalks and shared use paths are provided in ***Table 231.2.1***. These values are only intended for facilities separate from the roadway.

When sidewalk or shared use path lighting affects an adjacent roadway, then the sidewalk or shared use path illumination requirements are reduced to match those of the adjacent roadway. When such lighting is mounted below a height of 30 feet, use full cutoff luminaires with low output. Include the effects of this sidewalk or shared use path lighting when meeting the roadway's lighting requirements in ***Table 231.2.1***, including the veiling luminance check for glare.

231.3.6 Bridge Underdeck Lighting

Luminaires for underdeck lighting are wall-mount fixtures that are mounted to the bridge substructure, including the piers, pier caps, end bents, or wall copings.

231.3.6.1 Nighttime Underdeck Lighting

If the roadway passing under the bridge has lighting immediately adjacent to the bridge, then bridge underdeck lighting is required to maintain continuity of the lighting system. The roadway lighting values for bridge underdeck lighting must be equal to, or an average of, the connecting roadway lighting on either side of the underpass per ***Table 231.2.1***.

If there is no adjacent roadway lighting per above, bridge underdeck lighting may still be used at the discretion of the Districts. This lighting is typically provided where frequent pedestrian traffic is expected or where changing roadway geometry and features occur. Follow the lighting value requirements of ***Table 231.2.1*** for the appropriate roadway classification or location type.

231.3.6.2 Daytime Underdeck Lighting

Daytime underdeck lighting may be required where wide bridge structures block natural sunlight from reaching the roadway below, causing rapid brightness changes that affect driver visibility. The length and geometry of the underpass area are the primary considerations for determining the need for daytime underdeck lighting and any resulting analysis.

The underpass length is the distance that a vehicle would travel underneath the bridge structure, measured along the centerline of the roadway passing under the bridge structure. Parallel bridges must be considered as one continuous structure unless the lateral distance between them is greater than 15 feet and the resulting opening is free of obstructions that would prevent daylight from reaching the roadway below.

For underpasses 80 feet long or less, daytime underdeck lighting is not required and may be used at the District's discretion. For underpasses greater than 80 feet but less than or equal to 150 feet, underdeck lighting designed for nighttime lighting values per ***Table 231.2.1*** must be installed and run continuously throughout daytime hours. These conditions assume an overpass height of at least 15 feet above the roadway and a width of at least 40 feet.

For underpasses not meeting the above conditions, a daytime underdeck lighting analysis using ***ANSI/IES RP-22-11 Tunnel Lighting (ANSI/IES-TL)*** guidance is required as described below. At a minimum, the following procedure applies:

(1) Determine the need for daytime supplemental lighting for the underpass using methodology from the ***ANSI/IES-TL Table 2***. If the adjustment factor is zero, then no further daytime lighting underdeck analysis is required.

(2) Use the ***ANSI/IES-TL 6.4.1*** Table Method to determine the Threshold Zone Luminance requirements.

(3) Use the ***ANSI/IES-TL 6.4.3*** Reduction Curve Method to determine luminance level requirements throughout the Threshold Zone and Transition Zones as applicable. Note that if the Threshold Zone length exceeds the underpass length, then the initial Threshold Zone value may be used throughout the entire underpass.

(4) Use the ***ANSI/IES-TL 6.4.4*** methodology and ***ANSI/IES-TL Table 7*** to determine the luminance requirement for the Interior Zone, if applicable for longer underpasses.

(5) Consider all other aspects described throughout ***ANSI/IES-TL***, including non-roadway surface illumination per ***ANSI/IES-TL 6.4.6*** and flicker effects per ***ANSI/IES-TL 6.5***.

(6) Perform a daylight study using lighting simulation software capable of 3-D modeling of proposed underpasses. AGi32® or equivalent lighting software is recommended. Some considerations include luminance contributions from the sun per weather station data, material reflectance, and underpass orientation per ***ANSI/IES-TL***. Create a design that meets the above established requirements. A process framework is described below:

(a) Create an underpass model. The model must include all light-reflecting surfaces, all openings, the roadway layout below the underpass, the bridge structures beneath the underpass (e.g. columns), and any other light sources or obstacles to light.

(b) Apply surface reflectivity characteristics. The recommended material reflectivity characteristics may be obtained from ***Table 231.3.1*** below.

(c) Create calculation zones for the roadway(s) beneath the proposed underpass per the ***ANSI/IES-TL Figure 1 and Figure 8***. Data points near the edges of the underpass may artificially inflate the luminance average, so it is recommended that those data points not be considered in the overall average luminance. Per ***ANSI/IES-TL Table 2*** notes, daytime lighting is not required within 23 feet of the underpass entry and exit.

(d) Run daylight models and calculate average luminance values within calculation zones established per above. Site location coordinates are required for weather station data (if available). To establish if supplemental lighting is needed, a daylight module analysis must be run with the orientation of the sun at 9:00am, 12:00pm, and 3:00pm for the summer and winter solstice as well as the fall and spring equinox (12 analysis times total).

(e) If average luminance requirements per (2) through (4) cannot be met using daylight alone per part (d), then provide supplemental wall mount luminaires beneath underpass as needed to meet the average luminance requirements per zone. Use of nighttime luminaires in conjunction with the daytime supplemental luminaires is permitted where practical. The goal is to meet the average luminance requirement using the least number of fixtures while avoiding flicker effects. Adjust and re-run the daylight plus luminaire analysis module as needed to meet the average luminance values per zone as determined above. Design and select luminaires to meet the requirement at the time of least daylight contribution.

(f) In the LDAR, provide all assumptions, conclusions, and visual representations of photometric results as produced by the lighting software.

(7) Based on the completed lighting analysis, develop underdeck lighting plans, including the following:

(a) Provide the specific locations of required design luminaires in plan, elevation, and isometric views. Show the specific baseline lumen output per location, as required by the analysis. This information must be specified along with all other design luminaire requirements per ***FDM231.1.1***, including details for the following:

For underpasses 250 feet or less, a photo sensor control may be used to switch from daytime to nighttime operation. The switch may be adjusted to occur at a timeframe after dawn and before dusk at the District's discretion.

For underpasses greater than 250 feet, each design luminaire output must be adjustable by remote control, pre-programmed timer, and photo sensor. Each luminaire must be capable of at least 20% higher and 20% lower lumen output than the baseline determined in the analysis.

(b) Describe the expected maintenance agreement and required expertise in the Lighting Coordination document per ***FDM 231.6***. Provide expected provisions for the lighting's future oversight, maintenance, programming, and remote adjustments as needed.

(c) Provide other applicable elements of the lighting plans per ***FDM 943***, including the electrical system design as coordinated per ***FDM 231.6***.

Table 231.3.1 Material Reflectivity

Material of Surface	Recommended Reflectivity
Concrete	0.25
Steel	0.20
Asphalt	0.38

231.3.7 Arterial Lighting Retrofit

Upgrading the luminaires on existing light poles is sometimes beneficial for arterial roadway corridors. This provides advantages of newer lighting technology without the cost of removing or replacing existing pole structures. However, using existing light pole locations also restricts the design placement of new luminaires. Considering these limitations, reduced lighting values are provided in ***Table 231.2.1*** for Arterial Lighting Retrofits. An Arterial Lighting Retrofit operation generally includes replacing older luminaire types with LED luminaires while leaving the existing light poles in place. Where practical, a limited number of light poles may be added or removed as needed to meet the design requirements. Do not reduce illumination levels from the existing condition. Any existing sidewalk illumination must be maintained or increased. When replacing existing luminaires, also replace any existing light shielding where present.

Use Arterial Lighting Retrofits at the discretion of the District Traffic Design Engineer. Consider if increased light levels from an all-new light pole system may instead be appropriate based on past safety performance. Evaluate both new and existing structures in accordance with ***FDM 261***.

At the District's discretion, a simplified lighting design analysis using only software optimization tools for corridors (e.g., AGi32® Roadway Optimizer or similar) may be used in lieu of the polygon method described above. Alternatively, the design analysis may consist solely of replacing existing luminaires with new luminaires of nearly equivalent lumen output and ***ANSI/IES*** distribution type per the approval of the District Traffic Design Engineer.

231.3.8 Railroad Grade Crossings

Provide lighting for railroad crossings where required per ***FDM 220***.

Apply horizontal illumination meeting the requirements of ***FDM 231.3*** for the roadway on both sides of the track. Use corridor lighting values for the roadway's classification type per ***Table 231.2.1***. The analysis zone must extend at least 125 feet from the track on each side, measured along the roadway centerline.

Also, provide vertical illumination running along each rail of the track. Extend the analysis across all traffic lanes and include an additional 5 feet on both sides of the roadway. Data points for each rail must follow a 1.5-foot x 1.5-foot grid pattern, covering a plane that projects vertically above the rail to a height of 15 feet. The light meter for each data point is oriented parallel to the roadway and pointed outwards from the track, in the direction opposite the adjacent rail. Note that each railroad grade crossing will require calculations for two different vertical planes (one for each rail). Each vertical plane will have all data points oriented in the same direction, which is opposite from the adjacent vertical plane. The required light level for each vertical plane is an average of 0.9 V.F.C. with a uniformity of 4:1 or less (Avg.: Min.).

Where practical, keep all light pole arms oriented perpendicular to the roadway to help avoid driver disorientation at the crossing. Locate light poles at least one full pole length away from the railroad infrastructure. Where multiple train tracks occur at the same crossing, apply a similar practice as above except that the vertical illumination will be calculated along the two outer rails that are farthest apart. For additional background and concept visuals, see ***ANSI/IES RP-8-25***.

231.4 Lighting Justification

The Department follows the warrants for lighting of corridors and interchanges established by ***AASHTO***. The warrants are based on benefit-cost ratios determined from the Average Daily Traffic (ADT), the ratio of night to day crashes, initial cost, and maintenance.

Interchanges that are not on the interstate highway system will require a warrant analysis. A benefit-cost ratio of 2.0 or greater is the threshold for lighting usage at these interchanges.

Interchanges that are on the interstate highway system must all be lighted to assure consistency and to meet driver expectations. A warrant analysis is still required for funding evaluation and information, but it will not be used as the determining factor for lighting usage at these interchanges.

A lighting justification must be completed in accordance with ***Manual on Uniform Traffic Studies (MUTS), Chapter 14***.

231.5 Existing Lighting During Construction

The maintenance of existing lighting will be the responsibility of the contractor only if the lighting is affected by the construction. The contractor is not expected to replace lamps and pole knockdowns or to repair wiring if these problems are not caused by the construction work.

The plans are to specify the scope of the contractor’s responsibility for the maintenance of existing lighting.

231.6 Lighting Design Coordination

Agency Coordination Document:

Contact applicable local construction, power, and maintaining agencies to confirm roles of lighting stakeholders. Prior to developing the Lighting Plans, create a document entitled “Lighting Agency Coordination”, and include the following information:

(1) Project ID, roadway name, and limits

(2) Lighting designer or EOR

(3) Local agencies and personnel contacted

(4) List of local agency requirements, including structural, electrical, and aesthetic requirements that will substitute for FDOT requirements

(5) Lighting EOR that will accept the above local agency requirements as an equivalent substitute for FDOT requirements

(6) A brief summary of expected operating and maintenance agreement, including responsible parties and term lengths

Include “Lighting Agency Coordination” document with the project documentation. All local agency requirements listed must later be included with the details or notes of the Lighting Plans. The “Lighting Agency Coordination” document may be updated as design work progresses, but the latest version must be saved and included with the project documentation.

General Coordination:

Contact the District Utilities Engineer when the pole locations are set and the electrical load has been determined. The designer should coordinate with the utility company providing power on the preferred location for the electrical service.

Coordinate with the Drainage Section to assure that high water tables, stormwater retention areas, or other water bodies will not be a problem with the proposed location of light poles and the light pole pull boxes.

Coordinate locations of lighting equipment and conduits with other utilities and systems, including ITS, traffic signal, or toll site equipment layouts. In general, check light poles, pull boxes, and lighting circuit equipment to avoid physical conflicts or interference with ITS and toll site functions.

Coordinate locations of lighting equipment and conduits on bridge structures with the bridge structural designer. Include light and conduit locations, and attachment details in the plans. Refer to ***Structures Design Guidelines*, *Section 1.9*** for details and restrictions related to bridge attachments.

Typically, the District Maintenance Engineer in conjunction with the District Utilities Engineer obtains the required maintenance agreements. The designer should coordinate with these offices to ensure that this activity is either underway or scheduled.

Any lighting project, especially high mast, adjacent to or in the vicinity of an airport, may present a potential conflict. For poles located within 3 miles of airports, check coordinates of light pole structures with the FAA website tool to determine if further filing and coordination with the FAA is necessary.

Modification for Non-Conventional Projects:

Delete ***FDM 231.6*** and replace with the following:

231.6 Lighting Project Coordination

The Lighting Engineer of Record is responsible for all necessary coordination.

231.7 Lighting Design Analysis Report

Prepare a Lighting Design Analysis Report (LDAR) that provides a photometric analysis for all lighted areas, including each intersection segment, mainline segment, ramp segment, interchange area, and structure with underdeck lighting. These designs, including horizontal and vertical illumination analyses, should be shown on separate photometric plan sheets. For additional analysis and formatting details, see ***FDM 231.2*** and ***231.3*** along with corresponding sections above.

Provide a summary statement on the cost-effectiveness of the lighting design. In general, the system with the largest pole spacing that meets design requirements and avoids detrimental light spill will be the most cost-effective design. Also, provide information for at least three luminaire models/manufacturers considered, and explain why the final design luminaire was chosen based on cost-effectiveness.

Provide voltage drop calculations, load analysis calculations for each branch circuit, and lighting calculations for each lighting system.

Include the Lighting Agency Coordination document per ***FDM 231.6***. If applicable, include the FAA coordination documents per ***FDM 231.6*** Include the light spill coordination summary per ***FDM 231.2.2***.

For LDAR components, provide sufficient detail in print format (e.g., PDF) so that reviewers do not require compatible design software to check inputs and results of calculations.