
BRITISH COLUMBIA

# Section 300

# Lighting Design

Engineering Branch

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# 300 LIGHTING DESIGN

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# 301 INTRODUCTION TO LIGHTING DESIGN

## 301.1 ABOUT SECTION 300

.1 Section 300 provides the guidelines for the design of lighting installations within the British Columbia highway system. These lighting installations can include not only roadways, but off roadway facilities such as parking lots, rest areas, and pedestrian facilities. The Ministry has standardized design criteria, lighting equipment, and construction methods for most of the installations throughout the province.

.2 Section 300 outlines the engineering standard practice that is to be employed for designing lighting systems for highways and roadways that are under the jurisdiction of the BC Ministry of Transportation. Section 300 also provides basic details of the standard lighting equipment and materials used by the Ministry. Specific and advanced details of the lighting equipment can be found in the Ministry's *Electrical and Signing Material Standards*. Construction methods and details for lighting systems can be found in Section 635 of the Ministry's *Standard Specifications for Highway Construction*, which are updated and issued yearly.

.3 This manual presents recommended standard practices and design guidelines for roadway and related lighting systems. At all times good engineering practices and sound engineering judgment shall be used in determining the required solutions for the lighting designs. The Ministry Project Management Team, providing they are supported by proper engineering principles and sound engineering judgment, will consider variations to these recommended practices.

## 301.2 PURPOSE OF ROADWAY LIGHTING

.1 The primary purpose of roadway lighting is to produce accurate and comfortable vision along roadways at night, and through tunnels. However, roadway lighting serves different functions depending on the roadway type and area that is being illuminated. For example, lighting on a freeway or major highway is primarily for traffic flow and driver while lighting in a downtown or commercial area serves both vehicular traffic and pedestrians. For the general highway system, roadway lighting provides three specific functions:

.1 *Vehicular Traf*fic: Lighting of the roadway provides visual guidance for the vehicular traffic thereby reducing nighttime accidents (and daytime accidents in tunnels) and their associated human and economic costs.

.2 Personal Safety: Lighting provides an aid to police protection and enhances the sense of personal security. Proper nighttime vision also reduces the risk of pedestrian/vehicle accidents.

.3 Commercial Promotion: Lighting in a commercial area promotes business activities and the use of public facilities during nighttime hours.

.2 The Ministry is primarily responsible for lighting that pertains to vehicular and pedestrian safety and, as such, limits their responsibility to lighting that is necessary for these safety related purposes. In general, lighting that pertains to commercial promotion of a downtown or commercial area is the responsibly of the local municipal jurisdiction.

## 301.3 ENGINEERING AND REFERENCE DOCUMENTS

.1 These lighting design guidelines, as produced by the Ministry, have been developed following generally accepted engineering practices for roadway lighting and associated lighting systems. These guidelines reference engineering standard practice documents, which, in part, form the requirements of lighting design for British Columbia highways.

### 301.3.2 Primary Reference Documents

.1 The following documents and manuals form the technical requirements for lighting design on British Columbia highways. In order to undertake a properly engineered lighting system design, it is mandatory that all lighting designers have access to, and refer to, the latest release of the following manuals and documents, as produced by the named organizations.

.2 Illuminating Engineering Society of North America (IESNA)

| | | |
|---|---|---|
| .1 | IESNA HB-9-2000 | *IESNA Lighting Handbook, Ninth Edition* |
| .2 | IESNA RP-8 | *American National Standard Practice for Roadway Lighting* |
| .3 | IESNA RP-17 | *Recommended Practice for Lighting Airport Road and Automobile Parking Areas* |

| | | |
|---|---|---|
| .4 | IESNA RP-19 | *Recommended Practice for Roadway Sign Lighting* |
| .5 | IESNA RP-20 | *Recommended Practice for Lighting for Parking Facilities* |
| .6 | IESNA RP-22 | *American National Standard Practice for Tunnel Lighting* |
| .7 | IESNA RP-33 | *Recommended Practice on Lighting for Exterior Environments* |
| .8 | IESNA TM | A*ddressing Obtrusive Light in Conjunction with Roadway Lighting* |
| .9 | IESNA TM | *Light Trespass: Research, Results and Recommendations* |

.3 Transportation Association of Canada (TAC)

.1 *Illumination of Isolated Rural Intersections*

.4 Transport Canada (TC)

| | | |
|---|---|---|
| .1 | Transport Canada | *Road/Railway – Grade Crossing Manual* |

## 301.3.3 Auxiliary Reference Documents

.1 The following documents and manuals may be referred to for additional reference information pertaining to lighting systems. All lighting designers should have access to and refer to the latest release of these manuals and documents.

| | | |
|---|---|---|
| .1 | IESNA RP-7 | *Recommended Practice for Industrial Lighting* |
| .2 | IESNA DG-4 | *Design Guide for Roadway Lighting Maintenance* |
| .3 | IESNA DG-5 | *Recommended Lighting for Walkways and Class 1 Bikeways* |
| .4 | IESNA G-1 | *Guideline for Security Lighting for People, Property and Public Places* |
| .5 | IESNA LM-50 | *Photometric Measurements of Roadway Lighting Installations* |
| .6 | IESNA LM-52 | *Photometric Measurements of Roadway Sign Installations* |

| | | |
|---|---|---|
| .7 | IESNA LM-64 | *Photometric Measurements of Parking Areas* |
| .8 | IESNA LM-69 | *Interpretation of Roadway Luminaire Photometric Reports* |
| .9 | IESNA LM-71 | *Photometric Measurement of Tunnel Lighting Installations* |
| .10 | TC TP-312E | *Aerodrome Standards and Recommended Practices* |
| .11 | TC Standard 621.19 | *Standards Obstruction Markings* |
| .12 | Transport Canada | *Navigable Waters Bridges Regulations* |

### 301.3.4 Conflicting Recommendations

.1 Many requirements and recommendations provided by the IESNA, TAC and TC may conflict between documents, as revisions and updates are published. The requirements and recommendations provided in the document with the most recent publishing date shall be taken as the most current and the most appropriate for use in lighting designs.

## 301.4 BEFORE YOU BEGIN

.1 This manual assumes the designer has a sound knowledge of lighting design. Refer to the latest edition of the *IESNA Lighting Handbook,* as well as the documents listed in *Clause 301.3,* above, for thorough information on lighting theory, design concepts, and terminology.

.2 The Ministry no longer explicitly includes critical lighting design information such as classification definitions and design criteria in this manual. This required information is referenced by the appropriate IESNA Recommended Practice (RP), Design Guide (DG), Guide (G), Technical Memorandum (TM) or Lighting Measurement (LM) documents.

.3 Designers shall note that there are three distinct design methods used for calculating roadway lighting levels and producing a roadway lighting design. It should be noted that each of these three methods may produce different designs and different luminaire spacing; although each are acceptable engineering practices. These design methods are the Illuminance Method, the Luminance Method, and Small Target Visibility (STV); each of which has a different set of design criteria and recommended values. The three design methods are fully explained in the latest edition of the IESNA *RP-8-00, American National Standard*

*Practice for Roadway Lighting.* The appropriate application of the different design methods is outlined in *Clause 304.4* of this manual.

.4 Further to *Clause 301.3*, above, designers shall refer to the applicable manuals and documents listed noted in *Chapter 104* of this manual.

# 302 JURISDICTIONS AND COST SHARING

## 302.1 JURISDICTIONS AND AREAS OF RESPONSIBILTY

.1 The jurisdictions and areas of responsibility within a highway project can include both the provincial Ministry and local incorporated municipalities and cities. Responsibility for the lighting system can include both financial responsibility and legal liability. Furthermore, the financial responsibility and legal liability for the lighting system may not follow strict jurisdictional lines; that is, under certain circumstances a municipality may be required to assume both financial responsibility and legal liability for the lighting system even though it exists within the Ministry of Transportation's jurisdictional area.

.2 In general the Ministry has jurisdiction over all provincial highways (numbered and unnumbered), even if the highway runs through a city or municipality. The Ministry also has jurisdiction over all roads, whether they are considered main or local, in unincorporated areas of the province.

.3 In general, a local municipality or city has jurisdiction over the roads that are within its incorporated boundaries, except for the roads or highways that are specifically controlled by the Ministry.

.4 With the recent devolution of some provincially controlled highways and with the formation of regional road systems in some areas of the province, it is not always obvious where the jurisdictional boundaries are within a project, particularly with respect to the roadway lighting. The designer must research and obtain clear direction from the Ministry project officials and, where necessary, from the local municipal officials, as to where the jurisdictions and areas of responsibility are defined.

.5 Third parties having jurisdiction and/or responsibility for roadway lighting are not limited to incorporated municipalities or cities, but may also include regional districts, fire protection districts, unincorporated towns, and others.

## 302.2 COST SHARING AND FINANCIAL RESPONSIBILTY

### 302.2.1 Ministry Warranted Lighting

.1 A current version of the Ministry's *Circular G23/87 - Classified Highways – Part 3, Highway Act, Responsibility and Cost Sharing Guide* outlines the financial responsibilities for the Ministry and for municipalities for work on highways within the Ministry's jurisdiction, including traffic signals and lighting. A section in the guide deals with the division of costs for the installation and operation of roadway lighting that meets the Ministry's lighting warrants as defined in *Chapter 303*. Contact the Ministry Electrical Representative for this document.

### 302.2.2 Lighting Not Warranted by the Ministry

.1 The Ministry's *Circular G23/87* does not deal with the case where a municipality wishes to install lighting along a section of a roadway within the Ministry's jurisdiction, but does not meet Ministry lighting warrants. If a municipality requests lighting and Ministry lighting warrants as defined in *Chapter 303* are not met, the municipality is responsible for 100 percent of the design and construction costs and for 100 percent of the operational and maintenance costs of the lighting (except as outlined below for some intersection lighting situations). It is the designer's responsibility to clearly define and document this situation if it arises in a project, and to ensure that the municipality is fully aware of both the immediate and ongoing costs associated with the unwarranted lighting requested.

.2 The Ministry will not share in the cost of design and installation of unwarranted roadway lighting between intersections.

## 302.3 DESIGN REQUIREMENTS FOR UNWARRANTED LIGHTING

.1 In order that proper lighting design guidelines are met for unwarranted lighting, one of the following options, including approvals from the Ministry, must be employed:

.1 Ministry Designs and Installs Standard Roadway Lighting

.2 The Ministry designs and installs the lighting and charges the Municipality for 100 percent of the costs. The Ministry owns, operates, and maintains the lighting and invoices the Municipality, on a quarterly basis, for 100 percent of the operational (power) and maintenance costs. In this option all lighting must be designed to Ministry standards using Ministry standard materials.

.3 Municipality Designs and Installs Standard Roadway Lighting

The Municipality designs and installs the lighting at its own cost. The Ministry owns, operates, and maintains the lighting and invoices the Municipality quarterly for 100 percent of the operational (power) and maintenance costs. In this option all lighting must be designed to Ministry standards using Ministry standard materials.

.4 Power Utility Leased Roadway Lighting

The Municipality arranges with the local power utility company for leased lighting on utility poles as noted in *Clause 307.6.4* . Leased lighting shall be owned, operated, and maintained by the appropriate power authority. The Municipality shall pay the power utility company directly for 100 percent of the leasing, operational (power) and maintenance costs. The Ministry may cost share in the operational and maintenance costs of unwarranted intersection lighting providing successful negotiations with the Ministry have been concluded, and the following has been undertaken.

.1 The cost sharing party shall complete and submit form *H-380 - Application for Cost Sharing of Intersection Lighting* when applying for cost sharing on power utility company leased lighting. *Appendix 300.2* to this manual contains a blank form H-380 for reference. New leased lighting is acceptable to the Ministry for cost sharing, provided the following criteria are met:

.1 The luminaire and mast arm brackets are oriented perpendicular to the highway. Other orientations will not be accepted.

.2 The cross street(s) is a designated public access and is not a private driveway(s).

.3 The luminaire offset is no more than 15 m from the cross street shoulder and a maximum of 1 m from the edge of traveled lane on the highway.

.4 The IESNA classification and light distribution of the luminaire is approved by the Ministry.

.2 A cost sharing agreement is produced by the Ministry and signed by both parties.

.5 Decorative or Ornamental Lighting

The Municipality may install decorative and ornamental lighting that is not to Ministry material standards provided that it meets the following technical requirements.

.1 All lighting design criteria meet or exceed IESNA recommended standard practices, including recommendations relating to obtrusive light and light pollution.

.2 Luminaire poles are structurally approved for use in traffic locations.

.3 The Ministry approves the lighting source.

.4 Pole locations are compatible with other facilities within the project area.

.5 For various intersection configurations, where required, poles shall have frangible or breakaway bases and meet the general requirements of Clause 504.3 Frangible and Breakaway Bases.

.6 The Ministry Electrical Representative approves the lighting design.

.7 The Municipality owns, operates, and maintains the lighting and is 100 percent responsible for the costs of design, installation, operation and maintenance.

# 303 LIGHTING WARRANTS

## 303.1 GENERAL

.1 Designers shall review all roadways in a project and determine their warrant status. The warrant status shall be reviewed and approved by the Ministry Electrical Representative prior to commencing the detailed design of any lighting systems.

.2 Situations may occur where lighting is warranted but cannot be installed because power is not available (i.e., not economically feasible). The Ministry will monitor the site on an ongoing basis and install lighting when power becomes available.

## 303.2 DEFINITIONS

.1 *Continuous Lighting* refers to lighting that runs continuously along a highway between intersections or interchanges.

.2 *Full Lighting* refers to lighting covering an intersection or interchange in a uniform manner over the entire traveled portions of the roadway. Full lighting for an interchange may include continuous lighting along ramps and collector roads between sub-intersections within the interchange area.

.3 *Partial Lighting* refers to the lighting of key decision areas, potential conflict points, and/or hazards in and on the approach to an intersection or interchange. Partial lighting may also guide a driver from one key point to the next, and (if sufficient luminaires are used) place a driver on a safe heading after leaving a lighted area.

.4 *Delineation Lighting* is a special case of partial lighting, referred to as "sentry" lighting, that marks an intersection location for approaching traffic, or to the illumination of vehicles on a cross road.

## 303.3 WARRANTS

### 303.3.1 Situations Warranting Lighting

.1 *Sub-clauses 303.3.2* to *303.3.17* describe situations where the Ministry will consider lighting as being warranted.

.2 Lighting in all other situations will be considered unwarranted and, if required or requested by a project, will be subject to the jurisdictional and cost sharing rules as outlines in *Chapter 302 – Jurisdictions and Cost Sharing*.

### 303.3.2 Continuous Lighting

.1 Continuous lighting is required between intersections or interchanges in the following situations:

.1 Areas with nighttime accident rates repeatedly above the critical rates as determined by the Ministry Electrical Representative or the Project Traffic Engineer.

.2 Sections of road with four seconds or less travel time between illuminated areas, providing that these areas are warranted for *full lighting* as outlined above.

### 303.3.3 Intersections

.1 For the purposes of this section of the manual, intersections are defined as Non-Urban Intersections or Urban Intersections. Also included in the category of Intersections are Roundabouts and Isolated Traffic Conflict Areas.

.2 For warrant purposes:

.1 **Non-Urban Intersections** are intersections at which two or more non-continuously lighted roadways join or cross at the same level. Non-Urban Intersections are characterized by the absence of sidewalks, parking lanes, and substantial nearby residential or commercial development. They are usually characterized by the absence of significant pedestrian activity, particularly at night. However, this may not be the case where the intersection is used as

a transportation assembly point (such as a school bus pickup/drop-off point).

.2 **Urban Intersections** are intersections within an area of a city or municipality with dense commercial development such as restaurants, shopping centres, malls, movie theaters, bars, etc. Downtown central business districts are included in this category.

.3 **Roundabouts** are a form of intersection that accommodates traffic flow in one direction around a central island, operates with yield control at the entry points and gives priority to the vehicles within the roundabout. Roundabouts may be located in rural, suburban or urban areas.

.4 An **Isolated Traffic Conflict Area** is an area on a roadway without a lighting system, or separated from a lighting system by twenty seconds or more of driving time, where an increased potential exists for collisions between vehicles, between vehicles and pedestrians or between vehicles and fixed objects. Such areas include mid-block crosswalks and railway grade crossings among others.

.3 Intersection lighting is warranted as outlined below:

.1 For Non-Urban Intersections

.1 Full, partial, delineation or no lighting is required at non-urban intersections as determined by application of the warrant process outlined in the TAC *Illumination of Isolated Rural Intersections*.

.2 The designer shall determine by use of the TAC warrant system and spreadsheet which intersections in a project require lighting, and whether the lighting will be full, partial or delineation.

.3 Partial lighting, as a minimum, is required at non-urban intersections with overhead pedestrian signs.

.2 For Urban Intersections

.1 Full lighting is required at all urban intersections.

.3 For Roundabouts

.1 Full lighting is required at all roundabouts.

.4 For Isolated Traffic Conflict Areas

.1 Isolated traffic conflict areas shall be treated as rural intersections.

## 303.3.4 Interchanges

.1 Interchanges are controlled access intersections generally utilizing on and off ramps and underpasses and overpasses in a separated grade configuration. Interchanges are usually restricted to roadways that are classified as freeways or expressways, as defined in *IESNA RP-8-00 Section 2.1*.

.2 For warrant purposes, interchanges are divided into two classifications:

.1 Class A Interchanges are interchanges along Class A Freeways. These generally exist in urban areas.

.2 Class B Interchanges are interchanges along Class B Freeways or along Expressways. These generally exist in non-urban areas.

.3 Interchange lighting is warranted in the following situations:

.1 Full lighting is required for all Class A Interchanges.

.2 Partial lighting, as a minimum, is required at Class B Interchanges.

.3 Full lighting or expanded partial lighting may be required at Class B Interchanges if accident rates are repeatedly above the critical rates as determined by the Ministry Electrical Representative or the Project Traffic Engineer.

.4 Full lighting or expanded partial lighting may be required at Class B Interchanges along sections with high traffic weaving volumes as determined by the Ministry Electrical Representative or the Project Traffic Engineer.

## 303.3.5 Bridges and Overpasses

.1 Roadway Lighting

.1 Bridges are generally considered to be part of the roadway and, as such, do not require any special lighting. However, there exists a public perception of roadways on bridges being less safe than at-grade roadways. This perception can cause traffic flow to deteriorate along typically long or high bridges. As a result, warrants are detailed below to aid traffic flow on bridges.

.2 The roadways that travel across overpasses are included in the definition of bridges.

.3 Roadway lighting on bridges is not required unless warranted as part of the regular roadway lighting.

.4 Roadway lighting may be considered, at the discretion of the Ministry Electrical Representative, on bridges and their approach ramps where one or more of the following situations exist:

.1 Sag or crest vertical curves exist where the roadway cannot be illuminated by vehicle headlights for at least one safe stopping sight distance (SSSD).

.2 Shoulder widths are less than 2.5m.

.2 Marine Navigation Lights or Hazard Lights on Bridges

.1 The warrant for marine navigation lights or hazard lights on bridges over a waterway is defined in the Transport Canada Navigable Waters Bridges Regulations.

.2 The designer shall confirm the need and requirements for marine navigation lighting or hazard lights on bridges over navigable waterways with the Ministry Navigable Waterways/Rail Coordinator, Engineering Branch, Victoria.

.3 Bridge Piers in Navigable Waters

.1 Bridge pier floodlighting or marker lighting may be required on some bridge projects for safety reasons, such as heavy marine traffic on the water, or for aesthetic and architectural reasons.

.2 The designer shall confirm the need for floodlighting or marker lighting on bridge piers with the Ministry Navigable Waterways/Rail Coordinator and the Ministry Electrical Representative.

.4 Aircraft Obstruction Lights on Bridges

.1 The purpose of aircraft obstruction lighting is to provide an effective means of indicating the presence of likely hazards to aircraft safety.

.2 The warrant for aircraft obstruction lights on bridges is determined by the application of TC Standard 621.19, Chapter 2 (view at http://www.tc.gc.ca).

.3 The designer shall confirm the need and requirements for aircraft obstruction lights on bridges with tall towers with the Ministry Navigable Waterways/Rail Coordinator, Engineering Branch, Victoria.

## 303.3.6 Tunnels

.1 The sole purpose of general roadway lighting is to provide for nighttime vision. However, the primary purpose of tunnel lighting is to provide proper internal pavement and wall luminance to counteract the effects of entering a dark restricted area during the daytime.

.2 *Tunnels* and *Underpasses* are defined as structures under roadways. Tunnels are more specifically defined as structures that restrict the normal daytime illumination of a roadway section such that the driver's visibility is substantially diminished. To differentiate between tunnels and underpasses, the definitions in *IESNA RP-22 Section 2.2.1* must be applied.

.3 Lighting warrants for daytime and nighttime lighting in tunnels shall be determined by the application of *IESNA RP-22 Section 2.2.1*.

.1 *Vehicle tunnels* as specified by *IESNA RP-22.* It should be noted that the lighting requirements methodology of RP-22 may indicate that no lighting is required for certain tunnels, particularly short tunnels with good wall reflectance or good daylight penetration. It should also be noted that a tunnel that does not warrant daytime lighting may require nighttime lighting if the adjacent roadway is warranted for lighting.

.4 Lighting is generally warranted in *Pedestrian and Bicycle Tunnels*. The designer shall confirm the lighting warrant with the Ministry Electrical Representative.

## 303.3.7 Pedestrian Walkways and Bikeways

.1 Lighting specifically installed for pedestrian walkways and bikeways (i.e., separate from the roadway lighting and with no potential for vehicle/pedestrian conflicts) is warranted in the following circumstances:

.1 Ramps to pedestrian overpasses

.2 Locations of stairs of more than 2 risers high or others similar hazards

.3 Walkways in known high security areas as determined by the Ministry Electrical Representative

## 303.3.8 Signs

.1 Lighting is required on the following signs:

.1 W-116 and W-116R advance warning signs or any other overhead signs with amber flashers;

.2 Overhead SP-005L or R signs, which may also be internally illuminated. Refer to *Section 407- Special Crosswalk Signs*.

.2 Overhead HOV signs may be illuminated at the start and end of the HOV lane, if power is available

.3 Other overhead signs may require illumination in areas such as border crossings, airports, ferry terminals, etc. Use of sign lighting shall be discussed with the Project Traffic Engineer or Signing Designer and Ministry Regional Traffic Engineer.

.4 Lighting is not required on the following signs:

.1 Shoulder mounted signs.

.2 Overhead guide or information signs, provided the signs are fabricated from high intensity retro-reflective material (or better), and that the signs are located on a tangent section of the highway. If an overhead guide sign, fabricated from high intensity retro-reflective material, is located off tangent, the designer must determine from the technical specifications of the retro-reflective material whether or not the off-tangent angle is greater than that allowable for proper retro-reflection. If the off-tangent angle is too great, and provides poor retro-reflection, then sign lighting will be required.

## 303.3.9 Rest Areas

.1 Rest areas have a high mix of both vehicular and pedestrian traffic and such require special treatment to ensure safety and security.

.2 Lighting is required in all “formal” rest areas that are part of major highways and are open to the public at night.

.3 Lighting is required in “informal” rest areas and in rest areas along minor highways that are open to the public at night, only when specifically requested by the District Transportation Manager responsible for the area.

## 303.3.10 Weigh Scale Areas

.1 Weigh scale areas have a high mix of both vehicular and pedestrian traffic, as well as workers undertaking particular tasks such as vehicle inspections. As a result, full area lighting is required at all weigh scales that are operational at night, for not only roadway and area lighting, but to also increase worker safety and for weigh scale operators to perform inspections of the vehicles using the facility.

.2 For weigh scales that are closed or non-operational at night, only basic security area lighting shall be provided.

## 303.3.11 Roadways Under CCTV Surveillance

.1 All roads under surveillance by closed circuit television cameras will require special CCTV level lighting if the surveillance is intended to extend into the nighttime.

.2 Continuous lighting will be required in areas of continuous CCTV surveillance, such as freeway traffic management systems.

.3 Partial CCTV lighting may be required in areas of remote surveillance, such as Web cameras along mountain highways. The partial lighting shall extend for the field of view of the camera, including multiple viewing areas if pan, tilt, and zoom are employed.

.4 Roadways meeting the warrant for CCTV level lighting require lighting to the design criteria outlined in *Sub-clause 304.3.16*. Lighting is not required to meet roadway lighting design criteria requirements, unless the roadway lighting warrants are met.

## 303.3.12 Brake Check Areas and Chain-up Pullouts

.1 For the purposes of this manual, brake check areas and chain-up pullouts are classified as either “formal” or “informal”.

.2 Formal brake check areas and chain-up pullouts are facilities that are designed as an integral part of the highway system and are typically located along major highways. They are generally identified by the presence of acceleration and deceleration lanes and the presence of roadside barrier.

.3 Informal brake check areas are facilities that are simple, non-protected pullouts on the side of roadways and are typically located along minor

highways. They do not have acceleration and deceleration lanes or roadside barrier.

.4 For the purposes of this manual, chain-up and chain-off pullouts are considered one and the same.

.5 Brake check areas and chain-up pullouts have a medium mix of both vehicular and pedestrian traffic and, as such, require special treatment to ensure safety and security.

.6 Lighting is required in all formal brake check areas and chain-up pullouts that are part of major highways.

.7 Lighting is required in informal brake check areas and chain-up pullouts along minor highways, only under the special request of the District Transportation Manager responsible for the area.

## 303.3.13 Ferry Terminals

.1 Road and Area Lighting

.1 Ferry terminals have a high mix of both vehicular and pedestrian traffic, as well as workers undertaking particular tasks such as loading and unloading vehicles and pedestrians. As a result, full area lighting is required at all ferry terminals that will be operational at night, not only for roadway and area lighting, but also to increase worker safety while performing their work tasks.

.2 For ferry terminals that are closed or non-operational at night, only basic security area lighting shall be provided.

.2 Marine Navigation Lights

.1 The designer shall confirm the need and requirements for marine navigation lighting at ferry terminals with the Ministry Navigable Waterways/Rail Coordinator, Engineering Branch, Victoria.

.3 Piers in Navigable Waters

.1 Terminal pier floodlighting or hazard marker lighting may be required at some ferry terminal projects for safety reasons, such as heavy ship traffic along the water, or for aesthetic and architectural reasons. Pier floodlighting or hazard marker lighting is generally required for all terminal piers located within or near a navigable waterway.

.2 The designer shall confirm the need for floodlighting and/or hazard marker lighting of ferry terminal piers with the Ministry Navigable Waterways/Rail Coordinator and the Ministry Electrical Representative.

## 303.3.14 Toll Plazas

.1 Toll Plazas have a high mix of both vehicular and pedestrian traffic, as well as workers undertaking particular tasks such accepting toll payments. Furthermore, traffic at toll plazas tends to be erratic with unusually high vehicle/vehicle and pedestrian/vehicle conflicts. As a result, full area lighting is required at all toll plazas.

## 303.3.15 Parking Facilities

.1 Most surface parking facilities are owned and operated by jurisdictions rather than the Ministry. However, in special circumstances, such as Park-and-Rides, the parking facility may fall under the Ministry's jurisdiction.

.2 Lighting is required for "formal" parking facilities under the Ministry's jurisdiction in urban or suburban areas when these facilities are used during nighttime hours. The designer shall confirm the requirement for full or partial lighting with the Ministry Electrical Representative.

.3 Lighting is required for "informal" parking facilities or for parking facilities in rural areas only when specifically requested by the District Transportation Manager responsible for the area.

## 303.3.16 Construction Detours

.1 Lighting is required at all temporary construction detours where roadway lighting existed before the detour was put in place.

.2 Lighting is required at detours, as determined by the Ministry Electrical Representative, when any one of the following conditions exists:

.1 The road geometry is overly complex

.2 There is a medium to high level of nighttime pedestrian traffic

.3 Vehicle or pedestrian safety is a concern

.3 Lighting is only required at detours that will be in use during nighttime hours.

.4 The above warrants apply to lighting for vehicular and pedestrian traffic only. These are not warrants for task lighting that may be required for nighttime construction work. The lighting for construction work is the contractor's responsibility and is regulated by the Workers Compensation Board.

## 303.3.17 Construction Zone Lighting

.1 The Workers Compensation Board regulates construction site lighting requirements and sets the warrant for construction zone lighting.

## 303.3.18 Other Situations Requiring Lighting

.1 There may be other situations within a project where lighting is not generally warranted but may be warranted on a special basis. The designer is encouraged to review *IESNA RP-8, Annex D*, which describes situations that may require special consideration for lighting. The designer shall review the entire project in detail to determine if, in the designer's opinion, any such special situations exist. The designer shall confirm the need for lighting these special situations with the Ministry Electrical Representative.

.2 Special lighting systems may be required in areas with nighttime accident rates repeatedly above the critical rates as determined by the Ministry's Regional Traffic Engineer or by the Project Traffic Engineer.

# 304 LIGHTING DESIGN

## 304.1 DESIGN REQUIREMENTS

.1 All lighting, warranted by the Ministry, must meet the design criteria and the design requirements of the appropriate IESNA Recommended Practice (RP), Design Guide (DG), Guideline (G), Technical Memorandum (TM) or Lighting Measurement (LM) documents.

## 304.2 DEFINITIONS

### 304.2.1 Land Use Classifications

.1 Land Use Classifications, such as urban, suburban, and rural are no longer formally used in lighting engineering. These terms may, however, be informally used in sections of this document

### 304.2.2 Roadway Classifications

.1 Roadway classifications, which describe the general conditions of vehicular traffic interaction, are detailed in *IESNA RP-8, Section 2.1*.

.2 It should be noted that these classifications are the industry standard used by lighting engineers and are not necessarily the same as those used by traffic engineers and municipal planners, even though the classification names may be similar. The lighting designer shall classify all roads within a project using the IESNA classifications, and shall not just apply traffic or municipal engineering roadway definitions to the lighting design.

### 304.2.3 Pedestrian Walkway and Bikeway Classifications

.1 Pedestrian Walkway and Bikeway classifications are detailed in *IESNA RP-8, Section 2.1*. Walkways and Bikeways are additionally classified in *IESNA DG-5 Sections 2 and 3*.

### 304.2.4 Pedestrian Conflict Area Classifications

.1 Pedestrian Conflict Area Classifications which describe vehicle/pedestrian interaction are defined in *IESNA RP-8, Section 2.2.* These classifications replace the Land Use Classifications previously referenced in former lighting design methods.

### 304.2.5 Pavement Classifications

.1 Pavement Classifications are based on the pavement reflection characteristics of the CIE Four Class system. Pavement classifications are detailed in *IESNA RP-8, Section 2.3 and Table 1.*

.2 Roadway lighting calculations for Ministry projects generally use pavement reflectance values for R2/R3 pavement classification as the majority of Ministry roads are asphalt surfaced. The designer should take special note that in some cases (bridges, tunnels, snowsheds, etc.) the road surface may be Portland cement concrete. As such, the use of a road surface classification of R1 may be appropriate.

## 304.3 DESIGN CRITERIA

.1 Design criteria for highway lighting systems are based on the appropriate IESNA Recommended Practice (RP), Design Guide (DG), Technical Memorandum (TM) or Lighting Measurement (LM) documents.

.2 All design criteria as recommended by the appropriate documents shall be met for a lighting system, including but not limited to:

- .1 Lighting levels (using the illuminance or luminance method)
- .2 Visibility levels (for STV method)
- .3 Uniformity ratios
- .4 Veiling luminance (glare)
- .5 Obtrusive light (sky glow, spill light and light trespass) criteria as set out in *Chapter 305 – Obtrusive Light and Light Pollution.*

.3 The designer shall confirm the required design criteria with the Ministry Electrical Representative before proceeding with the lighting design.

.4 Specific design criteria and design requirements are referenced in the following sub-clauses.

## 304.3.2 Continuous Roadway Lighting

.1 **Illuminance Method** – Recommended roadway lighting design values when using the illuminance method are detailed in *IESNA RP-8, Table 2*.

.2 **Luminance Method** – Recommended roadway lighting design values when using the luminance method are detailed in *IESNA RP-8, Table 3*.

.3 **Small Target Visibility Method** – Recommended roadway lighting design values when using the small target visibility method are detailed in *IESNA RP-8, Table 4.*

## 304.3.3 Intersection Lighting

.1 Intersections of Continuously Lighted Roads

.1 Recommended lighting design values for intersections in areas of continuous roadway lighting are outlined in *IESNA RP-8, Table 9.*

.2 Lighting design values are given for the illuminance method only. However, corresponding luminance and STV values (by interpretation from *IESNA RP-8, Tables 2, 3, and 4*) may be used.

.2 Roundabouts

.1 Recommended lighting design values for roundabouts located on continuously lighted roads are outlined in *IESNA RP-8, Table 9.*

.2 Recommended lighting design values for roundabouts located on unlit roads in rural areas are outlined in *IESNA RP-8, Tables D1, D2 and D3.*

.3 Isolated Intersections and Isolated Traffic Conflict Areas

.1 **Illuminance Method** -- Recommended lighting design values for isolated intersections and isolated traffic conflict areas when using the illuminance method are detailed in *IESNA RP-8, Table D1*.

.2 **Luminance Method** – Recommended lighting design values for isolated intersections and isolated traffic conflict areas when using the luminance method are detailed in *IESNA RP-8, Table D2*.

.3 **Small Target Visibility Method** – Recommended lighting design values for isolated intersections and isolated traffic conflict areas when using the small target visibility method are detailed in *IESNA RP-8, Table D3.*

### 304.3.4 Interchange Lighting

.1 Interchanges that require full lighting, as determined by the warrants outlined in *Sub-clause 303.3.3,* shall meet the lighting design values detailed in *IESNA RP-8, Tables 2, 3 and 4* for continuous roadway lighting.

.2 Interchanges that require partial lighting, as determined by the warrants outlined in *Sub-clause 303.3.3,* are subject to the lighting design values detailed in *IESNA RP-8, Tables D1, D2 and D* for Isolated Intersections and Isolated Traffic Conflict Areas.

### 304.3.5 Pedestrian Walkway and Bikeway Lighting

.1 Recommended lighting design values for pedestrian walkways and bikeways are detailed *in IESNA RP-8, Tables 5, 6, 7, and 8*.

### 304.3.6 Bridge Lighting

.1 No specific design criteria are provided for bridges. When bridge lighting is warranted, the lighting shall meet the recommended lighting design values detailed in *IESNA RP-8, Tables 2, 3 and 4* and criteria for the roadway classification that the bridge falls into.

### 304.3.7 Tunnel Lighting

.1 Recommended lighting design criteria for vehicle tunnels are determined through detailed analyses of parametres particular to the specific projects as outlined in *IESNA RP-22*.

.2 Recommended lighting design criteria for pedestrian and bicycle tunnels are detailed in *IESNA RP-8, Table 8*.

### 304.3.8 Sign Lighting

*.1* Recommended lighting design values for roadway signs, including both sign illuminance and sign luminance, are detailed in *IESNA RP-19 Table 4.*

## 304.3.9 Parking Facility Lighting

.1 Recommended lighting design values for parking lots are detailed in *IESNA RP-20 Table 1*.

## 304.3.10 Rest Area Lighting

.1 Recommended lighting design values for rest areas are detailed in *Table 1* below.

.2 These design criteria are provided for the area lighting only. Building lighting design criteria are the responsibility of the building design team.

| AREA DESCRIPTION | LUX (AVG) | UNIFORMITY (AVG:MIN) | GLARE $L_{Vmax}/L_{avg}$ | LUMINAIRE TYPE |
|---|---|---|---|---|
| Interior Roads (Ingress and Egress) | 14 | 6:1 | 0.3 | Cobra head (flat glass) |
| Parking Areas | 18 | 6:1 | 0.3 | Cobra head (flat glass) |
| Public Areas | 22 | 6:1 | 0.3 | Cobra head (flat glass) |
| On/Off Ramps | Refer to IESNA RP-8 for design criteria and *Sub-clause 304.3.3* for design requirements and details | | | |

Table 1. Maintained Horizontal Illuminance Levels for Rest Areas.

## 304.3.11 Brake Check Area and Chain-up Pullout Lighting

*.1* Recommended lighting design values for brake check areas and chain-up pullouts are detailed in *Table 2* below.

.2 Lighting is provided at brake check areas and chain-up pullouts for vehicle and pedestrian safety; task lighting (for inspection or tire chain mounting and removal) is not provided. The required task lighting must be provided by the vehicle or vehicle operator.

## 304.3.12 Weigh Scale Lighting

.1 The IESNA does not have any recommendations or design documents specifically related to weigh scale lighting. Recommendations for weigh scale lighting design criteria have been developed by the Ministry using

the design principles and recommendations outlined in *IESNA RP-8* and *IESNA RP-20*. Certain working task design values have been developed using *IESNA RP-7 Industrial Lighting*.

.2 Recommended lighting design criteria for weigh scales, during their operational hours, are detailed in *Table 2* below.

| AREA DESCRIPTION | LUX (AVG) | UNIFORMITY (AVG:MIN) | GLARE $L_{Vmax}/L_{avg}$ | LUMINAIRE TYPE |
|---|---|---|---|---|
| Interior Roads (Ingress and Egress) roads | 14 | 3:1 | 0.3 | Cobra head (flat glass) |
| Parking Areas | 18 | 3:1 | 0.3 | Cobra head (flat glass) |
| Inspection Area | 30 | 3:1 | 0.3 | Cobra head (flat glass) |
| Weigh scales | 50 | 3:1 | 0.3 | Wall mount on building or cobra head (flat glass) |
| On/Off Ramps | Refer to IESNA RP-8 for design criteria and *Clause 304.3.3* for design requirements and details | | | |

Table 2. Maintained Horizontal Illuminance Levels for Brake Check Areas, Chainup Pullouts and Weigh Scale Facilities

.3 Weigh scale areas that are closed or non-operational during nighttime hours shall have their area lighting levels reduced to basic security lighting design criteria as detailed in *IESNA RP-20 Table 1*.

.4 The determined lighting levels for weigh scales shall be confirmed with the Ministry Electrical Representative prior to proceeding with the detailed design.

## 304.3.13 Airport Road and Parking Area Lighting

.1 Roadway and parking area lighting in the vicinity of airports shall be designed in accordance with the recommendations and special requirements criteria detailed in *IESNA RP-17*.

.2 Lighting design criteria for roadways in the vicinity of airports shall be as recommended in *IESNA RP-8* for the type of road. Only luminaires with full cutoff optics shall be used.

.3 Recommended lighting design criteria for parking areas can be found in *IESNA RP-20, Table 1*. Only luminaires with full cutoff optics shall be used.

.4 The designer shall give particular consideration to the following special requirements as defined in *IESNA RP-17* in the design of the lighting design:

.1 The amount of incident light and ambient light on control tower windows;

.2 The location of lighting equipment in relation to the control tower and the runway.

.5 The designer shall also insure that the lighting design meets the requirements of TC TP-312E *Aerodrome Standards and Recommended Practices*. Special note is made of the requirement for specific minimum clearances and structure height restrictions in certain areas relative to runways.

.6 The designer shall contact the following prior to and during preparation of the lighting design:

.1 Transport Canada Western Region Safety Branch, Edmonton AB at (780) 495-3850 to determine if TC has jurisdiction in the area of the proposed lighting, and for approval of the proposed lighting design.

.2 Local airport operator or manager to determine factors that may affect luminaire pole location and height, and luminaire type and wattage.

.3 Ministry Electrical Representative to confirm the scope and requirements of the lighting affected by the airport prior to proceeding with detailed design.

.7 Additional information relating to the lighting in the vicinity of airports can be found via the Transport Canada website at http://www.tc.gc.ca

## 304.3.14 Ferry Terminal Lighting

.1 Ferry terminals have a high mix of both vehicular and pedestrian traffic and closely resemble either parking lots or rest areas. The designer shall analyze the project and determine whether to use the design criteria for parking facilities or for rest areas, or a combination of both.

.2 Ferry terminals that are closed or non-operational during nighttime hours shall have their area lighting levels reduced to the basic security lighting design values as detailed in *IESNA RP-20, Table 1.*

.3 The determined lighting levels for the outdoor areas of ferry terminals shall be confirmed with the Ministry Electrical Representative prior to proceeding with the detailed design.

.4 These special recommendations apply to area lighting for vehicular and pedestrian traffic only. These are not recommendations for the task lighting that may be required for ferry terminal workers. The Workers Compensation Board regulates task lighting requirements.

.5 These design criteria are provided for area lighting only. Building lighting design criteria are the responsibility of the building design team.

## 304.3.15 Toll Plaza Lighting

.1 Toll plazas have a high mix of both vehicular and pedestrian traffic and as such closely resemble either parking lots or rest areas. The designer shall analyze the project and determine whether to use the design criteria for parking facilities or for rest areas, or a combination of both.

.2 The determined lighting levels for the outdoor areas of toll plazas shall be confirmed with the Ministry Electrical Representative prior to proceeding with the detailed design.

.3 These special recommendations apply to area lighting for vehicular and pedestrian traffic only. These are not recommendations for task lighting that may be required for toll plaza workers. The Workers Compensation Board regulates task lighting requirements.

.4 These design criteria are provided for area lighting only. Building lighting design criteria are the responsibility of the building design team.

## 304.3.16 CCTV Lighting

.1 Where roadway lighting is warranted in an area where CCTV surveillance is required, the design criteria for continuous roadway lighting shall be used. Roadway lighting design values provide sufficient illumination for CCTV cameras.

.2 Where roadway lighting is not warranted in an area where CCTV surveillance is required, the minimum maintained illuminance shall be 4 lux, with a maximum to minimum uniformity not to exceed 6:1.

## 304.3.17 Construction Detour Lighting

.1 To ensure safety, roadway lighting on temporary construction detours may require higher lighting levels than those noted in *IESNA RP-8*. Issues such as speed, road geometrics, number of detour stages, proximity of roadside hazards, volume of traffic, and driver safety will affect detour lighting levels. If lighting of temporary construction detours is required (as outlined in *Sub-clause 303.3.16*), the design values for the class of roadway in question shall be selected, and the required lighting level increased by 50%. (This is based on the principle outlined in *IESNA RP-8 Paragraph 3.6.4*, which recommends increasing roadway lighting levels by 50 percent for special traffic conflict areas.)

.2 These special recommendations apply to lighting for vehicular and pedestrian traffic only. These are not recommendations for task lighting that may be required for nighttime construction work. The lighting for construction work is the contractor's responsibility and is regulated by the Workers Compensation Board. Refer to the current edition of the Ministry *Standard Specifications for Highway Construction*, Chapter 194.

## 304.3.18 Situations Requiring Special Consideration

.1 Where it is determined that lighting is required in situations where it is not otherwise warranted, the designer shall apply the general design principals outlined in *IESNA PR-8, Annex D.*

## 304.3.19 Non-Compliance

.1 In extreme cases where the required design criteria cannot be achieved due to circumstances beyond the designer's control, the designer shall review the circumstances with, and gain approval to design to modified design criteria from the Ministry Electrical Representative prior to proceeding.

## 304.4 LIGHTING DESIGN AND CALCULATIONS

### 304.4.1 Design and Calculation Methods

.1 Lighting design and calculations for roadways, walkways, signs, tunnels, and open areas can be done using different methods as appropriate for the specific situations. The design and calculation methods appropriate for the specific situations are outlined in the IESNA document relating to that situation as listed in *Clause 304.3 Design Criteria*.

### 304.4.2 Roadway Lighting Design and Calculation Methods

.1 The IESNA provides three distinct design and calculation methods for roadway lighting. These methods are the Illuminance Method, the Luminance Method, and Small Target Visibility (STV). Different design criteria apply to each of the three methods.

.2 It is the requirement of the Ministry that at least one of the lighting design and calculation methods, along with its corresponding design criteria, be met when designing a Ministry roadway lighting project. It is not required that the design requirements for all three calculation methods be met.

.3 The different design and calculation methods will produce different designs and lighting layouts for the same project. Furthermore, one method of lighting design is not always more efficient than another because different design and calculation methods suit different road geometrics. As such, the designer should select the most appropriate design and calculation method to produce the most energy efficient lighting design.

.4 The designer should refer to *IESNA RP-8, Annex B Design Guide and Examples* for design suggestions and comparisons of the three different design methods. The designer should pay particular attention to the system changes and modifications that can be employed and their effect on pavement luminance and small target visibility.

.5 The designer should refer to *IESNA RP-8, Annex F Description and Background of STV Method* for information on small target visibility.

.6 The designer should note the following recommendations when selecting the most appropriate method for a roadway lighting design:

.1 Small roadway lighting projects, such as isolated intersections and isolated conflict areas, are adequately designed using the

illuminance method. The luminance and STV methods can be employed at the designer's discretion.

.2 Medium sized roadway lighting projects, which include straight sections of roadway with continuous lighting and intersections of higher complexity, should be designed using the illuminance method and luminance method, with the most energy efficient design selected. The STV method can be employed at the designer's discretion.

.3 Large roadway lighting projects will require a design prepared using all three design methods, with the most energy efficient design selected.

.7 Lighting design using the luminance and STV methods is an iterative process and, unlike the illuminance method, cannot be calculated directly. The following design process is suggested for designing medium to large roadway lighting projects:

.1 Select the appropriate luminaire wattage and pole height.

.2 Determine the appropriate illuminance design criteria.

.3 Calculate the pole spacing using the illuminance method.

.4 Evaluate the design in terms of luminance and STV and their respective design criteria.

.5 Make changes to the design and reiterate the process to achieve the luminance and STV design criteria. Refer to *IESNA RP-8, Annex B Table B1, Common Lighting System Changes and the Effects Produced*.

## 304.4.3 Computer Programs for Lighting Design

.1 Illuminance lighting calculations can be performed manually without difficulty. This is adequate for small lighting designs. Luminance and STV calculations are highly complex and best performed by specialized lighting design computer programs.

.2 The designer must ensure that the lighting design programs used on a project meet the requirements of all IESNA design methodologies and design criteria, i.e., as a minimum they must be able to calculate and analyze lighting levels, uniformity, and glare. Programs must be IESNA approved and use luminaire photometrics in the IESNA standard format. Not all lighting programs will adequately calculate all types of lighting designs. In particular the designer shall note the following;

.1 Certain roadway lighting programs may not be adequate for area lighting such as parking lots and rest areas if they cannot calculate the lighting on vertical surfaces.

.2 Indoor lighting programs are not acceptable for outdoor lighting designs. Indoor lighting uses different design methods than outdoor lighting.

.3 Tunnel lighting design requires special programs that are specific to tunnels. Most roadway lighting programs cannot adequately calculate tunnel lighting designs because they do not take interior reflectance into account. Indoor lighting programs cannot adequately calculate tunnel lighting designs because they have no parameters for pavement reflectance and generally cannot calculate luminance.

.4 Sign lighting and floodlighting programs must be able to calculate the lighting on vertical surfaces.

.3 Where computer lighting calculations are being performed, designers shall use the manufacturer's IESNA format photometrics. The luminaire manufacturer upon request generally provides IESNA format photometrics in digital file. Pre-approved manufacturers' photometric file numbers are shown on the Ministry Recognized Products List.

## 304.4.4 Calculation Area

.1 A grid shall define the extents of the lighting calculation area. Different procedures are required when selecting a grid for roadways, parking areas, tunnels, signs, etc. Also, different grid arrangements may be required for straight roadway sections, for curves, and for intersections and traffic conflict areas. The selection of the lighting calculation areas and the appropriate grid for a lighting design are outlined in the appropriate IESNA document for the area under design.

## 304.4.5 Light Loss Factors

.1 Lighting calculations shall be prepared using initial rated lamp lumens and the total light loss factor (LLF). Lamp lumen values for the standard Ministry Pre-approved HID lamps may be found in the Ministry *Electrical and Signing Materials Standards, Chapter 502 – HID Lamps*. Total light loss factors and their components vary depending on the area and the objects to be lighted and are outlined in the appropriate IESNA document for the facility under design.

.2 The Ministry has standardized the light loss factors to be used in roadway lighting calculations. The light loss factors to use for all Ministry lighting design calculations can be found in *Table 3* below.

| Area | Lamp Lumen Depreciation (LLD)[3] | Luminaire Dirt Depreciation (LDD)[3] | Luminaire Component Depreciation (LCD)[4] | Equipment Factor (EF)[5] | Total Light Loss Factor (LLF) |
|---|---|---|---|---|---|
| General [1] | 0.88 | 0.88 | 0.98 | 0.97 | 0.78 |
| Special [2] | 0.88 | 0.82 | 0.98 | 0.97 | 0.69 |

Notes:

(1) This applies to most areas of British Columbia, including small to medium sized towns. This is the default classification.

(2) Typically areas with heavy industrialization. This classification is rarely used and applies to very few industrial areas in the Province. This classification may only be used if confirmed with Ministry Electrical Representative.)

(3) Based on a 4 year maintenance cycle

(4) Degradation of the reflector and refractor

(5) Effect of ambient temperature, voltage fluctuations, and the ballast and lamp factors

Table 3. Standardized Light Loss Factors

# 305 OBTRUSIVE LIGHT AND LIGHT POLLUTION

## 305.1 INTRODUCTION

.1 Obtrusive light, sometimes referred to as Light Pollution, has become a common concern of the general public. Obtrusive light not only detracts from the enjoyment of the nighttime setting, but also has been shown by recent research to have negative effects on biological systems. Furthermore, most obtrusive light is the result of light not directed specifically at the area of consideration and, therefore, can be considered as wasted light. All wasted light is also wasted energy. Therefore the reduction of obtrusive light will typically lead to the increased energy efficiency of the lighting design.

.2 Obtrusive Light can be classified into three categories:

.1 *Light Trespass* can be described as the effects of light that strays from its intended purpose and becomes an annoyance, a nuisance or a detriment to visual performance.

.2 *Sky Glow* is the result of stray light being scattered in the atmosphere, resulting in added "sky brightness".

.3 *Glare*, which can be described as unwanted source luminance, is defined by the IESNA as "the sensation produced by luminance in the visual field that is sufficiently greater than the luminance to which the eye has adapted to cause annoyance, discomfort, or loss of visual performance and visibility".

## 305.2 DESIGN RECOMMENDATIONS

.1 With the absence of legislation, the Ministry has developed the following recommendations that shall be followed in developing a lighting design. These recommendations shall be applied to all Ministry lighting design projects.

.2 All lighting designs shall be designed to minimized obtrusive light by applying the recommendations in the following IESNA technical documents:

*.1 IESNA TM-10*

*.2 IESNA TM-11*

*.3 IESNA RP-8, Annex C*

.3 In certain circumstances, and in special geographical areas, obtrusive light may be considered as a specifically important factor in the design development process. In these cases, as determined and identified by the Ministry Electrical Representative, lighting systems shall be designed to minimize light pollution as outlined in *IESNA RP-33 Lighting for Exterior Environments.*

# 306 LIGHTING EQUIPMENT

## 306.1 STANDARD LIGHTING EQUIPMENT

.1 Refer to the Ministry Electrical and Signing Material Standards Manual for roadway lighting equipment specifications.

.2 All lighting equipment used on Ministry projects must be Ministry pre-approved. A current copy of the Ministry's Recognized Products List can be viewed on the Ministry website at http://www.th.gov.bc.ca/publications/eng_publications/geotech/recognized_products_book.pdf.

.3 Although the Ministry has standardized on its lighting equipment, material suppliers and equipment specifications may change from time to time. The designer shall have a current copy of the Ministry's *Recognized Products List* to insure that all equipment used in Ministry designs is listed.

## 306.2 HIGHMAST LIGHTING EQUIPMENT

.1 Refer to the Ministry Electrical and Signing Material Standards Manual for highmast lighting equipment specifications. Standard highmast lighting equipment generally consists of the following:

.1 30m, 35m, 40m and 45m high multisided or round galvanized steel poles. The designer may consider custom mounting heights;

.2 1000W HPS highmast luminaires;

.3 The luminaires shall be mounted on a lowering ring. The luminaire mounting ring is supported by two cables and is raised and lowered by an electrically driven double drum winch located inside the pole hand hole. An internal or portable drive motor drives the winch;

.4 A power distribution panel is located inside the handhold of each pole.

.5 Highmast lighting on cellular antenna towers must meet the intent of this specification. The Manager, Electrical Services must approve maintenance procedures.

## 306.3 SPECIALTY LIGHTING EQUIPMENT

.1 Non-standard specialty lighting equipment shall be selected to suit the project requirements. Specialty materials are not covered by the Ministry pre-approval process and must be approved for use by the Ministry Electrical Representative and the Ministry Manager, Electrical Services on a project-by-project basis. This equipment typically includes, but is not limited to, the following:

.1 Highmast luminaires

.2 Vehicular tunnel luminaires

.3 Floodlights

.2 Where non-standard lighting equipment is specified, it shall be of the highest standard and quality. Non-standard equipment must be readily available and easy to maintain, and all products of a similar nature must be of a single manufacturer. Custom products shall be avoided because they can cause maintenance problems. Where custom products cannot be avoided, designers shall ensure that spare parts are supplied to the Ministry Manager, Electrical Services, as part of the project.

.3 When using non-standard luminaires, designers shall undertake the lighting design using a computer lighting program. Most luminaire manufacturers have photometrics available on diskette in the IESNA format for use with a computer lighting program. Computer lighting calculations and design shall meet the approval of the Ministry Electrical Representative.

# 307 ROADWAY LIGHTING

## 307.1 CONTINUOUS, FULL, AND PARTIAL LIGHTING

.1 The Ministry's general policy is to minimize the amount of lighting required for a project while still maintaining the proper engineering requirements as recommended by the IESNA, TAC and TC as applicable. Prior to starting any roadway lighting design the extent of the required lighting must be determined following by application of the requirements in *Chapter 303 – Lighting Warrants*.

## 307.2 CONVENTIONAL DAVIT VS HIGHMAST LIGHTING

### 307.2.1 Conventional Davit Lighting

.1 Roadways are generally illuminated with flat glass cobra head luminaires mounted on davit luminaire poles. Existing installations with dropped refractor luminaires may require the use of the same type of luminaire to ensure the proper uniformity criteria are met, however, the use of dropped refractor luminaires is discouraged.

### 307.2.2 Highmast Lighting

.1 Large interchanges requiring full roadway and area lighting may be more effectively illuminated with highmast lighting. Smaller interchanges requiring only partial lighting are generally more economically illuminated with conventional davit lighting. However, highmast lighting may be used for partial lighting installations in certain cases if it is shown to be cost effective. The advantages and disadvantages of highmast lighting over conventional davit lighting are:

.1 Advantages:

.1 Reduced glare

.2 Improved uniformity

.3 May be installed at an early stage of construction and be used to provide required detour lighting

.4 Greater offset from traffic lanes, improving safety and reducing pole knockdowns

.5 Reduced maintenance costs.

.2 Disadvantages:

.1 May produce additional light trespass on adjacent properties

.2 May obstruct views in residential areas

.3 Require pullouts for maintenance vehicles and room to facilitate lowering and maintenance

.2 Highmast luminaire poles shall be located well clear of the roadway to reduce hazards and allow for easy maintenance. Clear zone requirements must be met. When locating highmast poles, ensure they will be easily accessible to maintenance vehicles. Pullouts and working areas for the maintenance vehicles may be required.

.3 Editions of *IESNA RP-8* prior to the current year 2000 edition recommended lower lighting levels if highmast lighting was used instead of conventional davit lighting. This option no longer forms part of current IESNA recommendations due to the lack of adequate research to justify the lower lighting levels.

.4 For projects where highmast lighting is being considered, the Ministry may require that the designer prepare a cost/benefit analysis of highmast versus conventional davit lighting. The analysis should consider initial capital costs for materials and construction, as well as ongoing operational and maintenance costs over a 25-year period. The cost benefit analysis may include systems that are shared financially and functionally with others such as cellular providers and transit authorities.

.5 Highmast lighting should generally be avoided in residential areas due to its higher potential for light trespass onto adjacent properties. Where installing highmast lighting near residences, luminaire glare shields or louvers may be required to control light trespass on residences.

.6 Consideration must always be given to the aesthetic affect that the highmast poles have on the background scenery. The designer of a highmast lighting system must fully analyze the impact that the poles will have on views from strategic locations. This analysis must be formally documented and presented for review and discussion to the Ministry Electrical Representative.

## 307.3 ROADWAY LUMINAIRE LAYOUT

.1 Cobra head luminaires mounted on davit poles, which are referred to as luminaire poles, are generally configured as shown on *Figure 1*.

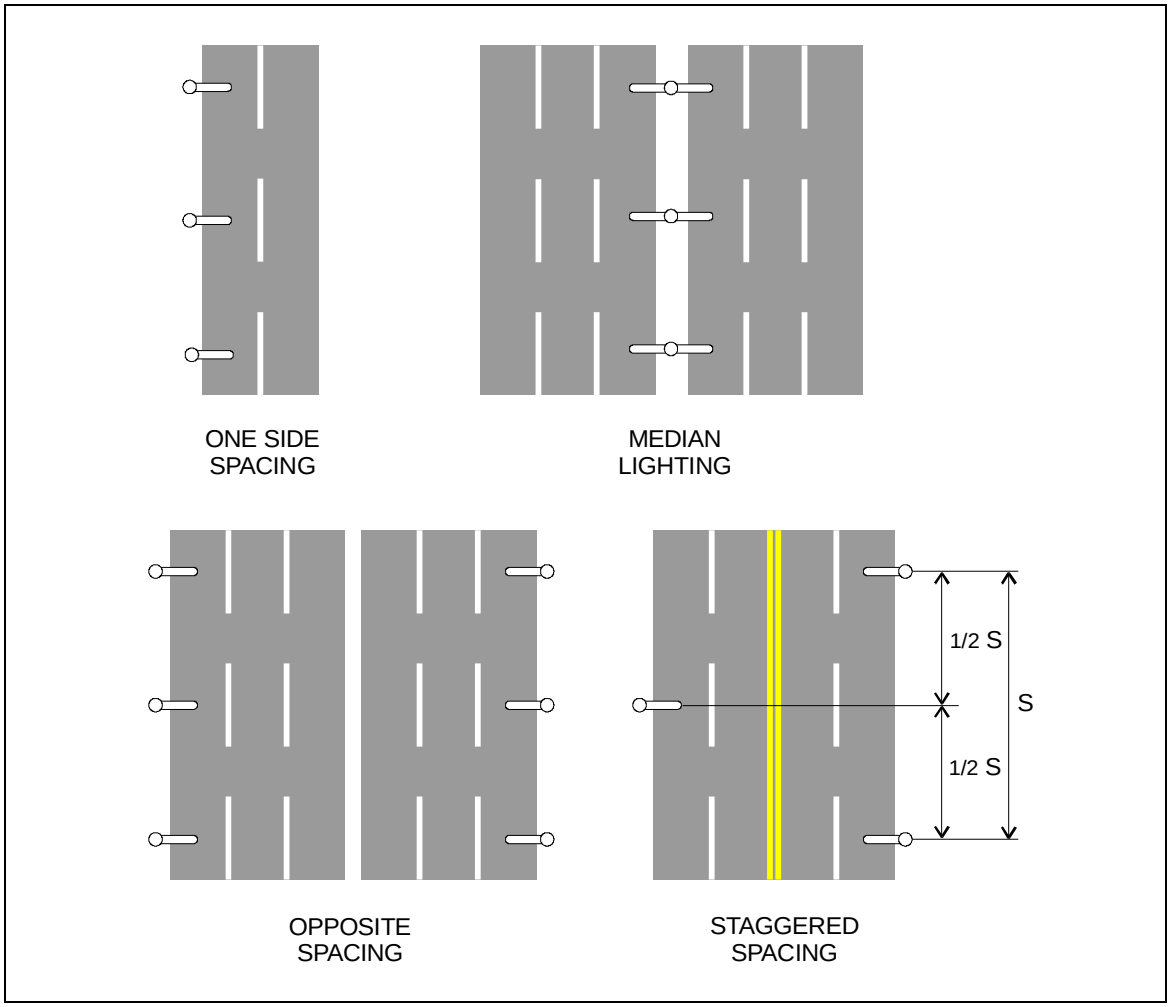



Figure 1. Typical Davit Luminaire Pole Layouts

.2 Davit luminaire pole spacings shall be applied as follows:

.1 One side lighting is generally used on one and two lane roads.

.2 Staggered or opposite lighting is generally used on roads three lanes or wider.

.3 Opposite lighting is generally used on very wide roads. Opposite spacing also is common for lighting designs prepared using the STV method.

.4 Median lighting is generally used on roads that have wide medians or centre concrete barrier. Median lighting is common for lighting designs prepared using the STV method.

.3 Designers should examine the possibility of future road widening. If road widening is planned for within a reasonable timeframe, then the lighting design should be consistent with the ultimate design required in the future.

.4 Where possible, for safety reasons davit luminaire poles shall be placed on the inside of curves as shown in *Figure 2*, if concrete roadside barrier is not present or proposed (providing that one sided lighting produces an acceptable design).

.5 Refer to *Figure 20* in *Chapter 309* for typical davit luminaire pole location information around underpasses, overpasses, and tunnel structures. Positioning luminaires in optimum locations is critical in achieving proper lighting under the structures.

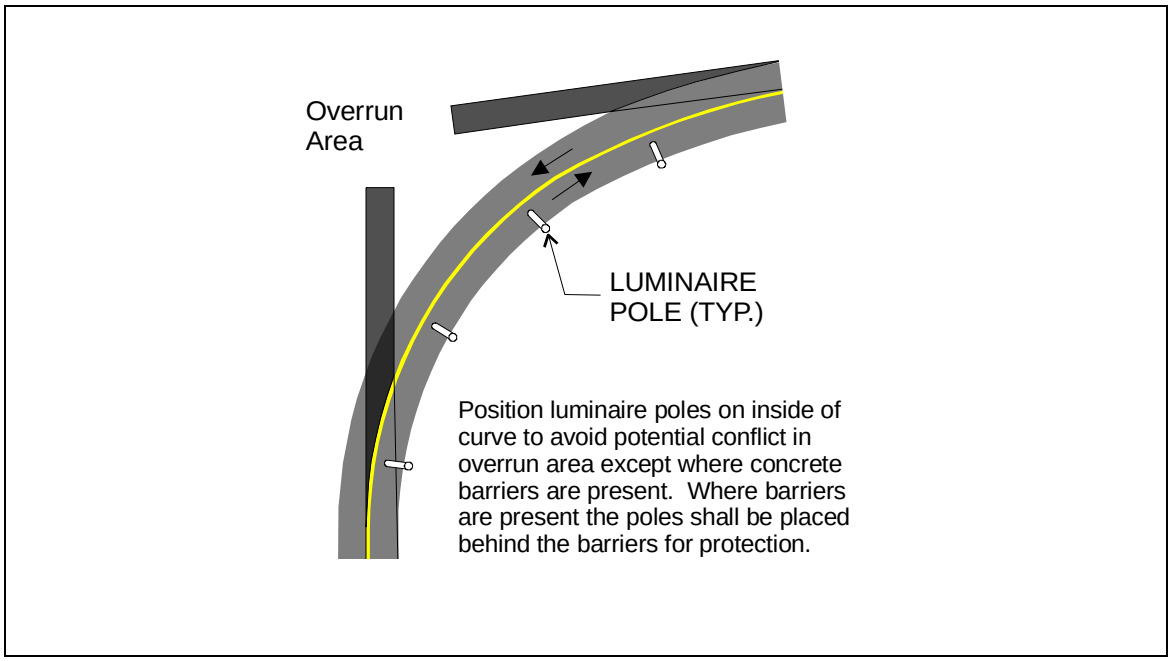



Figure 2. Position of Luminaire Poles on Curved Roads

## 307.4 ROADWAY LUMINAIRES AND POLE MOUNTING HEIGHTS

.1 Standard davit luminaire pole heights and luminaire wattages can be found in the Ministry *Electrical and Signing Material Standards Manual*.

.2 Designers shall select the most effective luminaire wattage and mounting height combination with consideration given to quality of the lighting design, installation cost and operating cost. *Table 4* below gives typical luminaire and pole height combinations for use on various road types. The designer is not required to restrict the design to these combinations. All possible combinations of luminaire wattage and pole height can be considered.

.3

| Road Type | Pole Height | Luminaire Wattage |
|---|---|---|
| 1 to 3 lane roads | 9 m<br>11 m | 150W HPS<br>250W HPS |
| 4 to 6 lane roads | 11 m<br>13.5 m | 250W HPS<br>400W HPS |
| 7 to 8 lane roads | 13.5 m | 400W HPS |
| Freeway and expressway acceleration and deceleration lanes, ramps, and tapers | 9 m<br>11 m<br>13.5 m | 150W HPS<br>250W HPS<br>400W HPS |

Table 4. Luminaire Mounting Heights and Wattages for Various Road Types

.4 Prior to selecting the luminaire mounting height, designers shall determine the height of any overhead power lines that may be in conflict with the lighting. The designer shall also confirm the required overhead power line clearances with the local utility company. Designs shall not exceed the minimum clearances required between luminaire poles and power lines as outlined in *Figure 3*.

.1 Where utility poles are being relocated due to road construction, designers shall confirm that the minimum clearances outlined in *Figure 3* are maintained. This may require the utility company installing taller poles to accommodate the required luminaire pole mounting heights. Designers shall coordinate the required power line heights with the utility company by working with the utility company designer.

.2 Where power poles are not being relocated, and overhead lines are in conflict with the proposed luminaire poles, designers shall consider the following options:

.1 One-sided lighting with taller poles.

.2 Utility company raising the power lines. Obtain a cost estimate from the utility company.

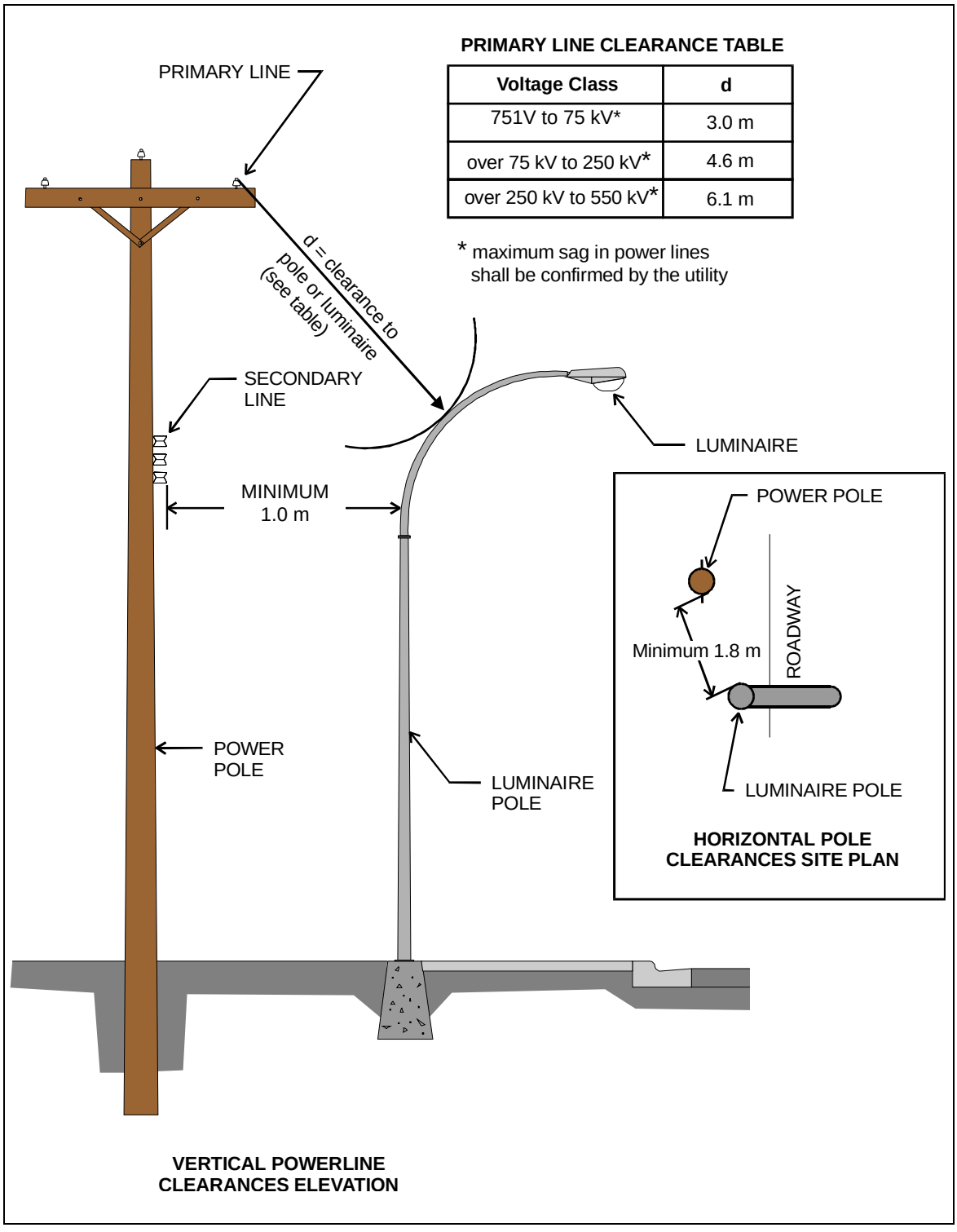
.3 Custom luminaire arm brackets.

.4 Luminaire poles as short as 7.5 m.

.5 Using lease lights on the utility company's poles. Refer to *Clause 307.6.4* .

.6 Post-top luminaires on short poles.

.3 The best option generally involves using one-sided lighting with taller poles. Installing post top luminaires is the least preferred option and should be avoided due to its inefficiency for roadway lighting and its increased glare. After reviewing all options, designers shall select the most cost-effective option and then obtain approval from the Ministry Electrical Representative.




**PRIMARY LINE CLEARANCE TABLE**

| Voltage Class | d |
|---|---|
| 751V to 75 kV* | 3.0 m |
| over 75 kV to 250 kV* | 4.6 m |
| over 250 kV to 550 kV* | 6.1 m |

* maximum sag in power lines shall be confirmed by the utility

Figure 3. Minimum Horizontal and Vertical Clearances Between Power Lines and Luminaire Poles

## 307.5 SPECIAL CONSIDERATIONS

.1 Many situations arise that require special design consideration. The designer shall refer to and be fully familiar with *IESNA RP-8 Annex D Situations for Special Consideration* for design methods and recommendations for special situations.

## 307.6 TYPICAL DESIGN RECOMMENDATIONS

### 307.6.1 Intersection Lighting

.1 Lighting requirements at intersections are determined in *Clause 303.3 – Warrants*. The warrant analysis can result in:

.1 No lighting required

.2 Delineation lighting required

.3 Partial Lighting required, or

.4 Full Lighting required

.2 Luminaire wattages and pole mounting heights at intersections shall match those on the approach roads if continuous lighting is required between intersections. For isolated intersection lighting, pole heights and luminaire wattages shall be consistent with those used on the types of intersecting roads.

.3 If the intersection is signalized, the luminaires shall be mounted using combination signal/luminaire poles and positioned to suit the traffic signal. Consideration shall be given to the possible future signalization of intersections with the interim luminaire poles located accordingly.

.4 Suggested luminaire pole layouts for typical intersection configurations are shown in *Figures 4* to *Figure 13* below. The designer shall determine pole heights and luminaire wattages to suit the size and configuration of the intersection and the lighting design criteria.

.5 A typical approach to roundabout lighting is illustrated in *Figures 14* and *Figure 15 below*.

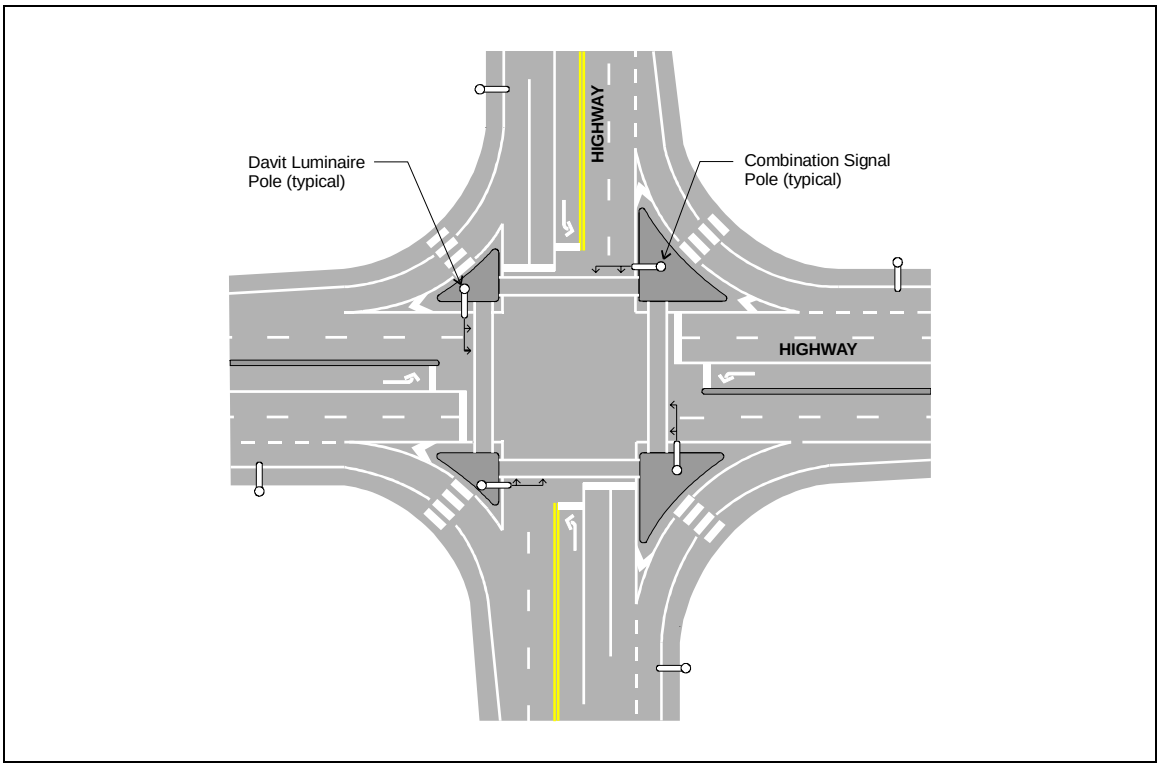



Figure 4. Typical Major Intersection of Two Highways – Full Lighting

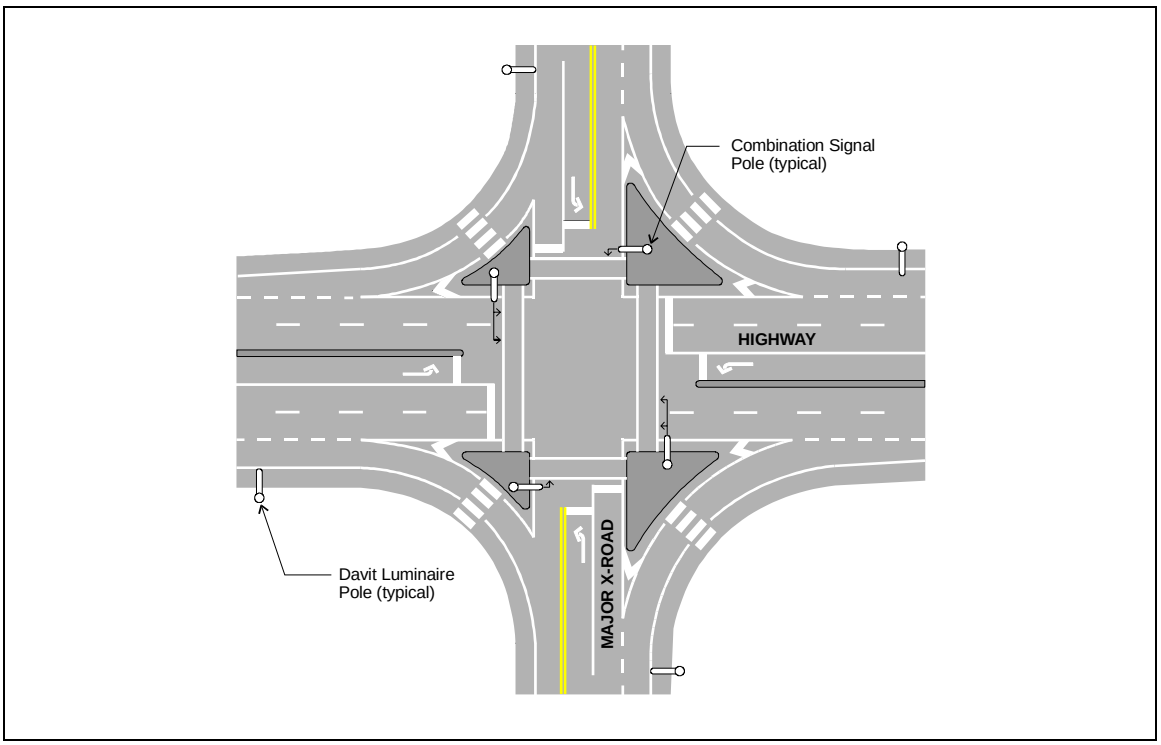



Figure 5. Typical Major Intersection with Major X-Road – Full Lighting

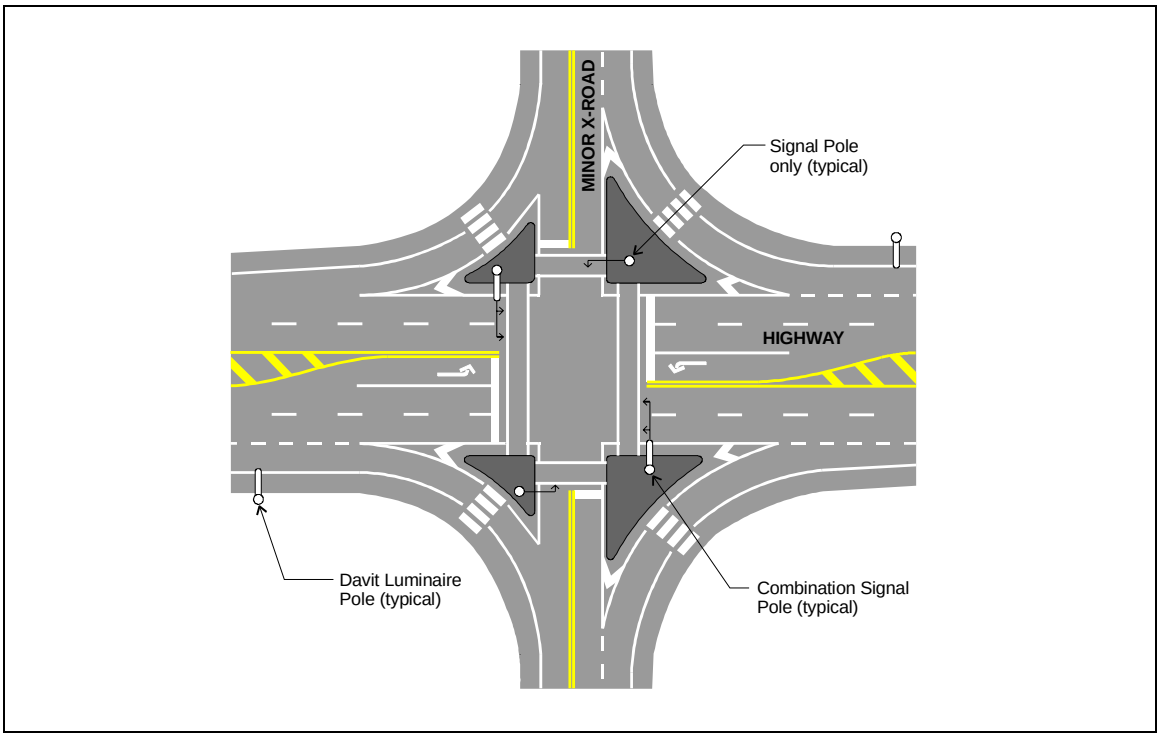



Figure 6. Typical Major Intersection with Minor X-Road – Partial Lighting

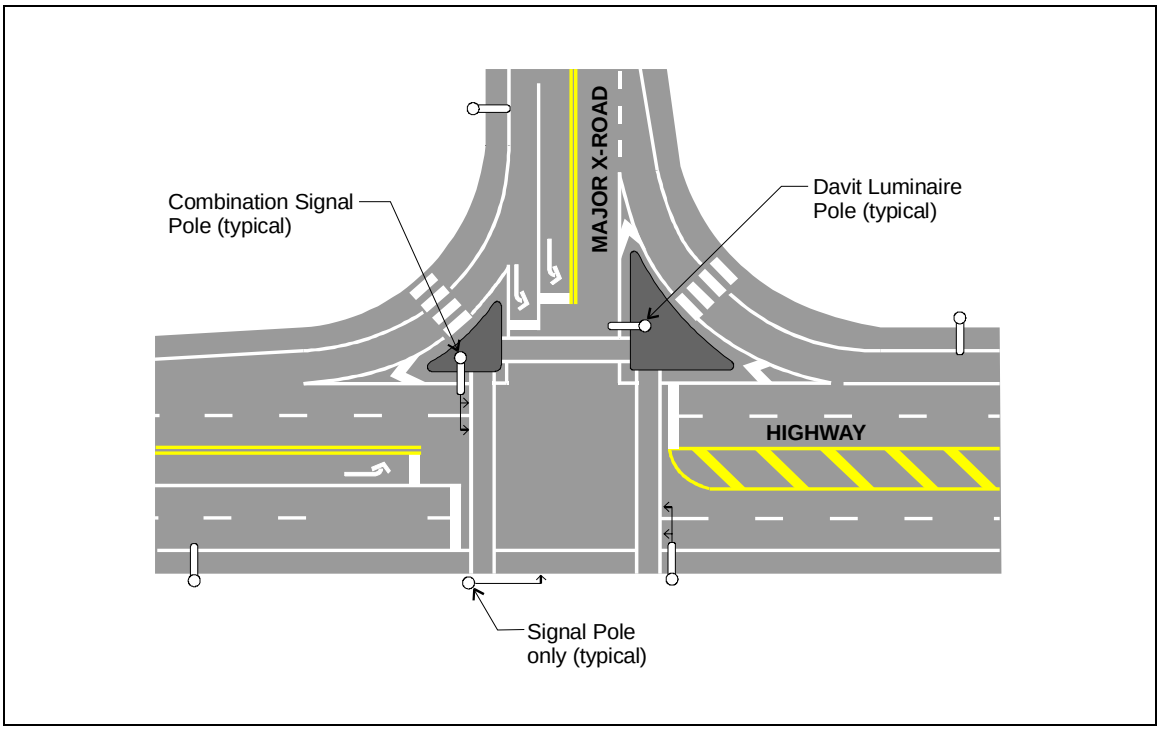



Figure 7. Typical Major 'T' Intersection with Major X-Road – Full Lighting

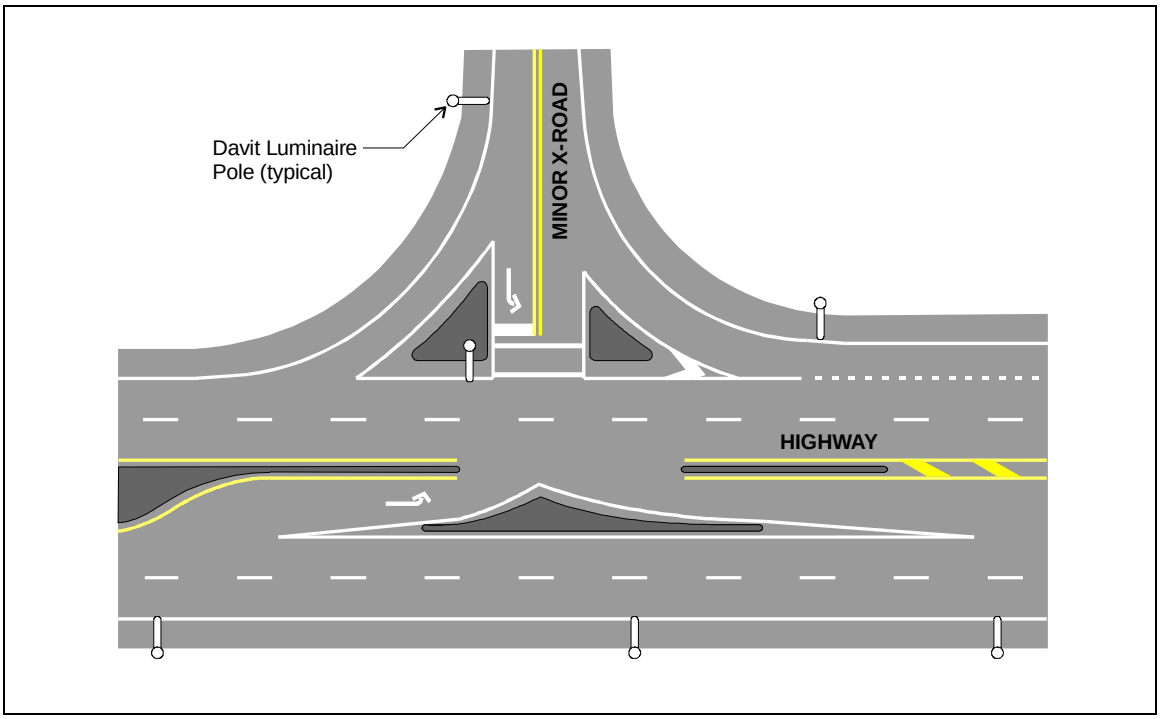



Figure 8. Typical Major 'T'-Intersection with Minor X-Road – Full Lighting

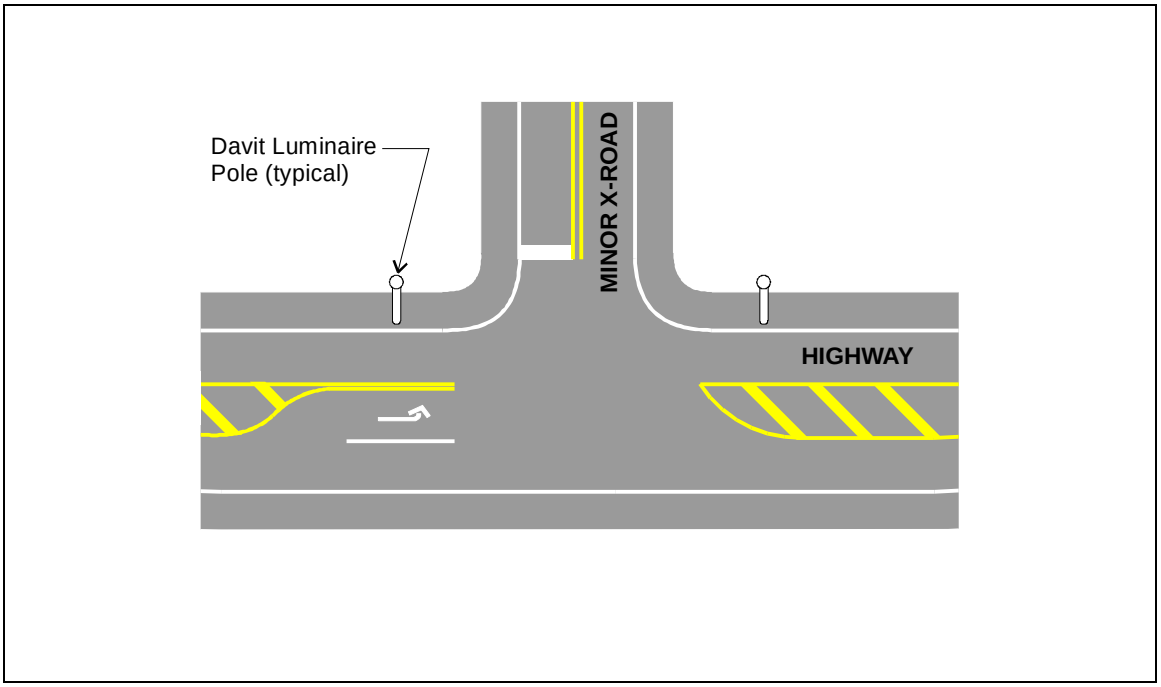



Figure 9. Typical Major 'T' Intersection with Minor X-Road – Partial Lighting

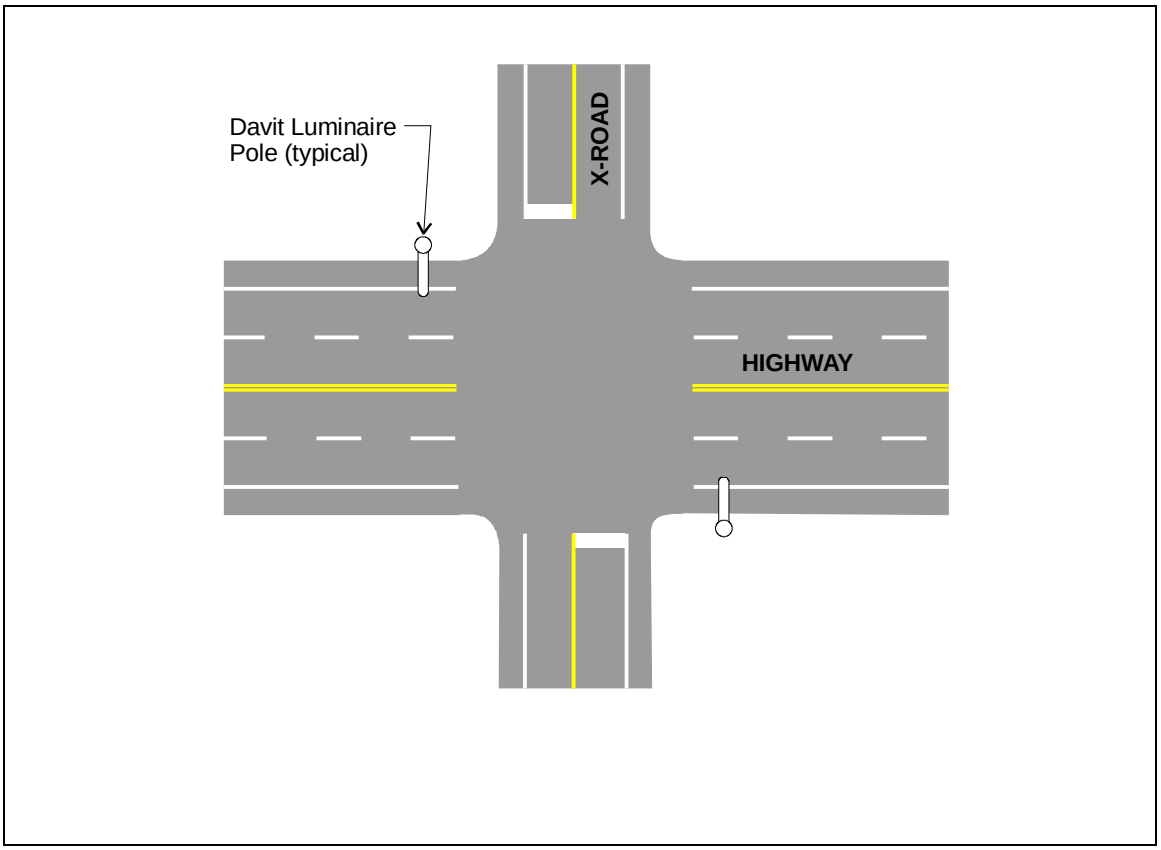



Figure 10. Typical Minor Intersection with Large Area – Partial Lighting

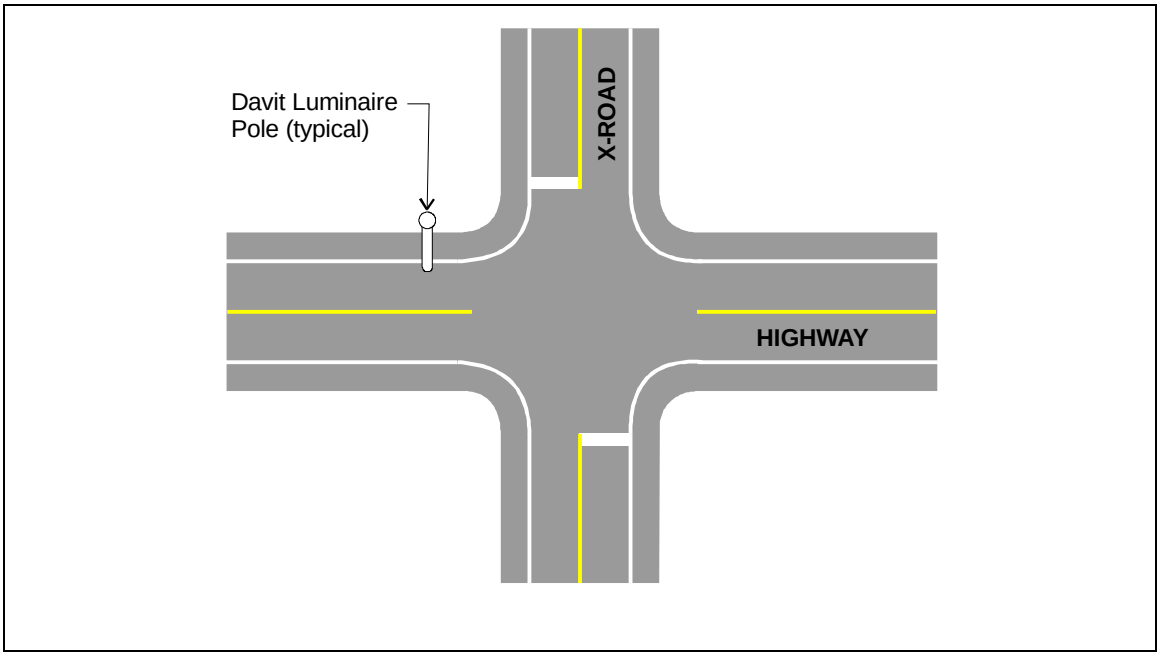



Figure 11. Typical Minor Intersection with Small Area – Partial Lighting

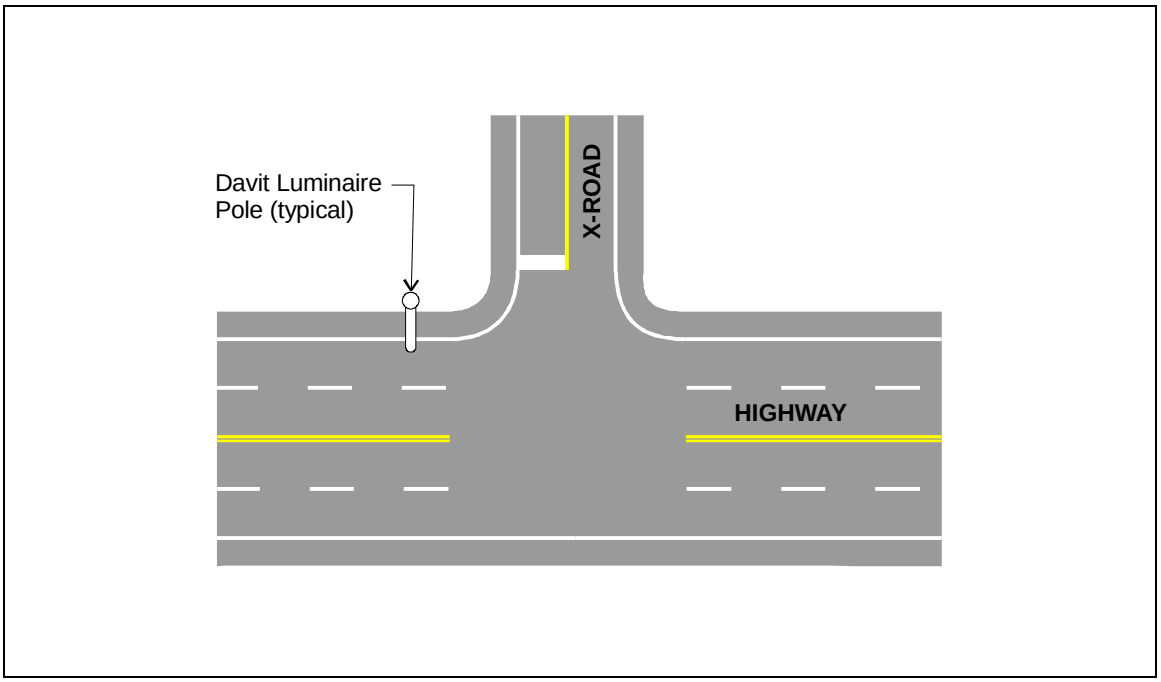



Figure 12. Partial Lighting for Typical Minor 'T' Intersection

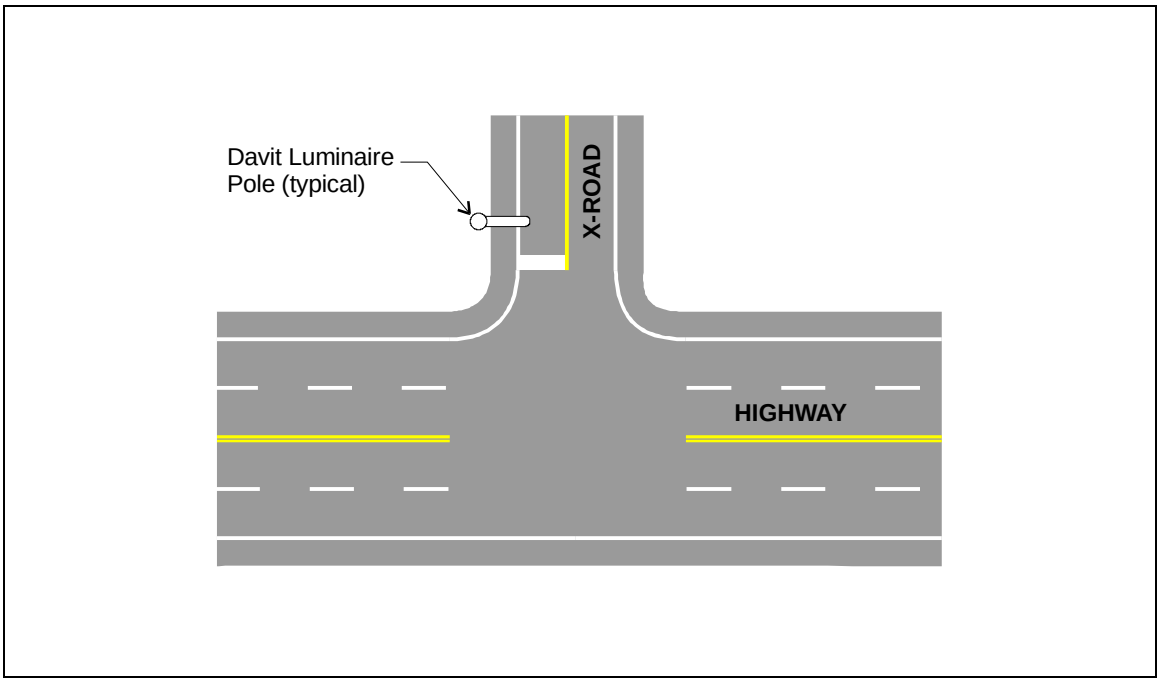



Figure 13. Delineation Lighting for Typical Minor "T" Intersection

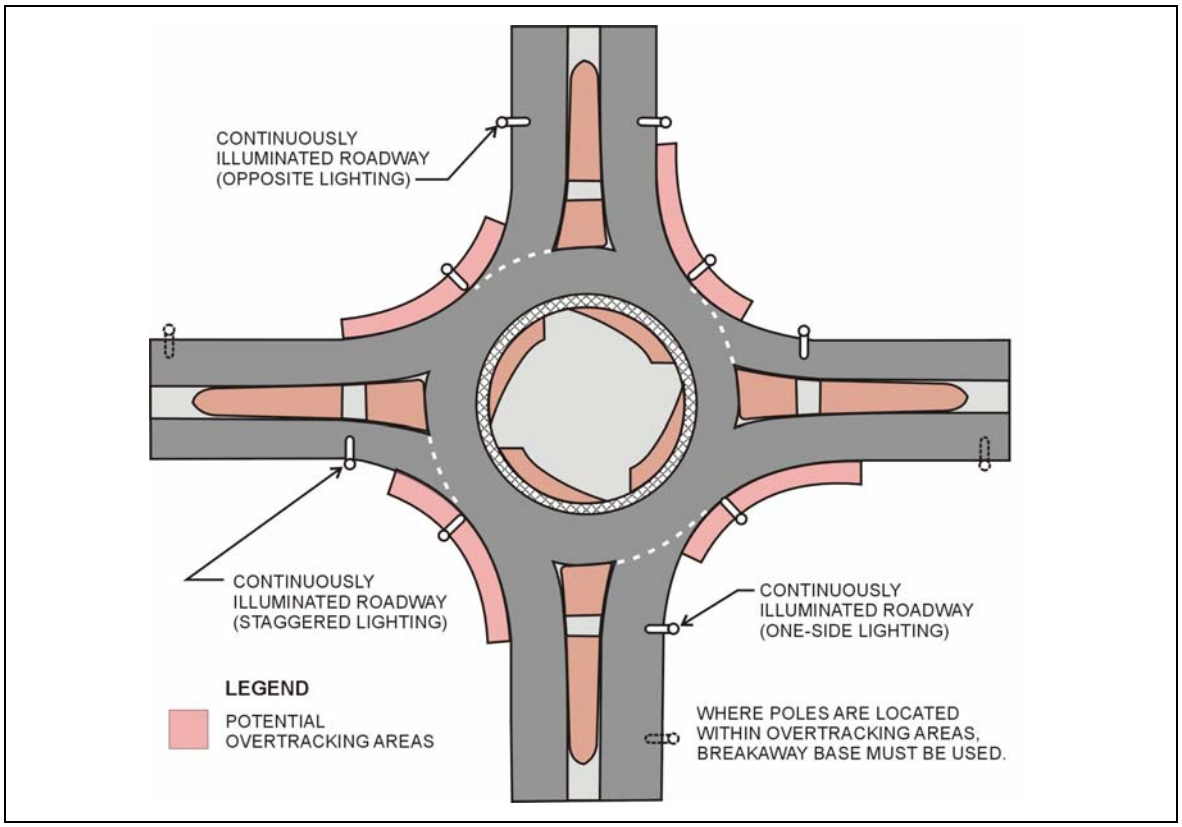



Figure 14. Example of Full Lighting on a Roundabout on Continuously Lit Roadways

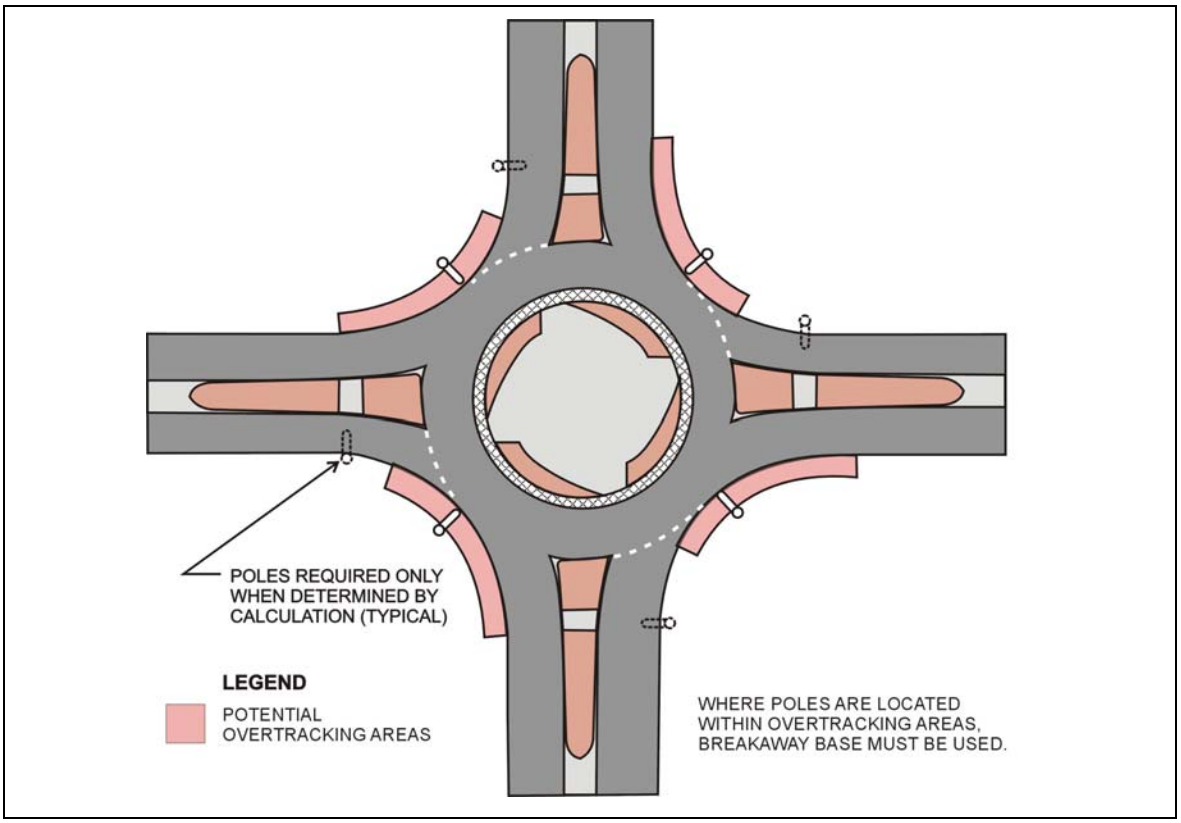



Figure 15. Example of partial lighting for a roundabout on unlighted Roadways

## 307.6.2 Continuous Lighting Between Intersections

.1 Where continuous lighting is required between intersections, the luminaire poles shall be positioned in a one-sided spacing, a staggered spacing, an opposite spacing, or a median spacing as illustrated in *Figure 1*.

.2 The pole locations at intersections, as determined in *Sub-clause 306.7.1*, above, shall take priority in a lighting design. The lighting spacing between intersections shall be designed to suit these preferred locations of poles at the intersections.

.3 When spacing luminaires between intersections, designers shall measure the distance from the near side of each intersection, then calculate and determine the optimum spacing that will be required to achieve the proper lighting levels, as well as to provide a consistent spacing of the luminaire poles.

.4 Roadways that change their width or required lighting levels, and therefore change the luminaire pole spacing distance, shall change spacing distances in a smooth transition over several pole cycles. For example, if the spacing distance must change from 40m to 60m (due to the narrowing of the roadway), it is advisable to change in increments of 5m.

.5 The optimum pole spacing, as calculated to meet the theoretical design criteria, may not suit an even or consistent spacing between intersections. The designer shall use good engineering judgment to either compress or stretch out the theoretical pole spacing so that even and consistent pole spacings are achieved.

## 307.6.3 Interchange Lighting

.1 Interchanges are generally made up of on/off ramps, acceleration and deceleration lanes, the main highway (typically a freeway or expressway), and a crossroad. Interchanges can come in several shapes and configurations from diamond interchanges to full cloverleaf interchanges. Connections between two freeways or expressways are often served by large high-speed complex interchanges with multiple levels, ramps, overpasses, and flyovers.

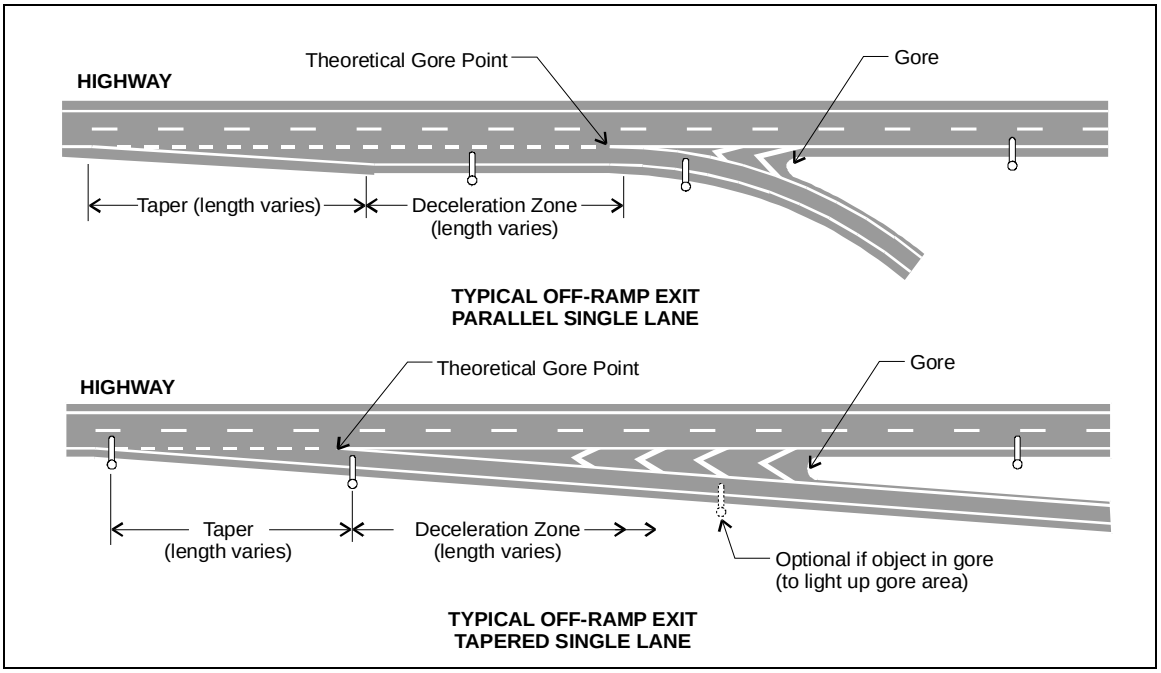



Figure 16. Typical Off-Ramp – Partial Lighting

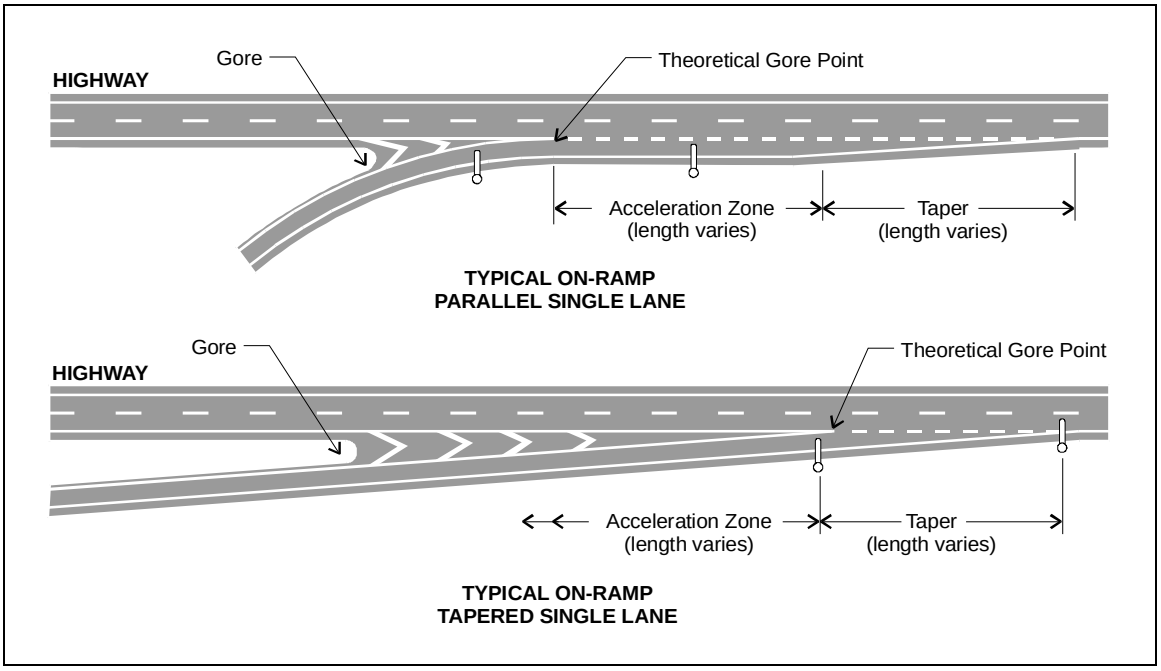



Figure 17. Typical On-Ramp – Partial Lighting

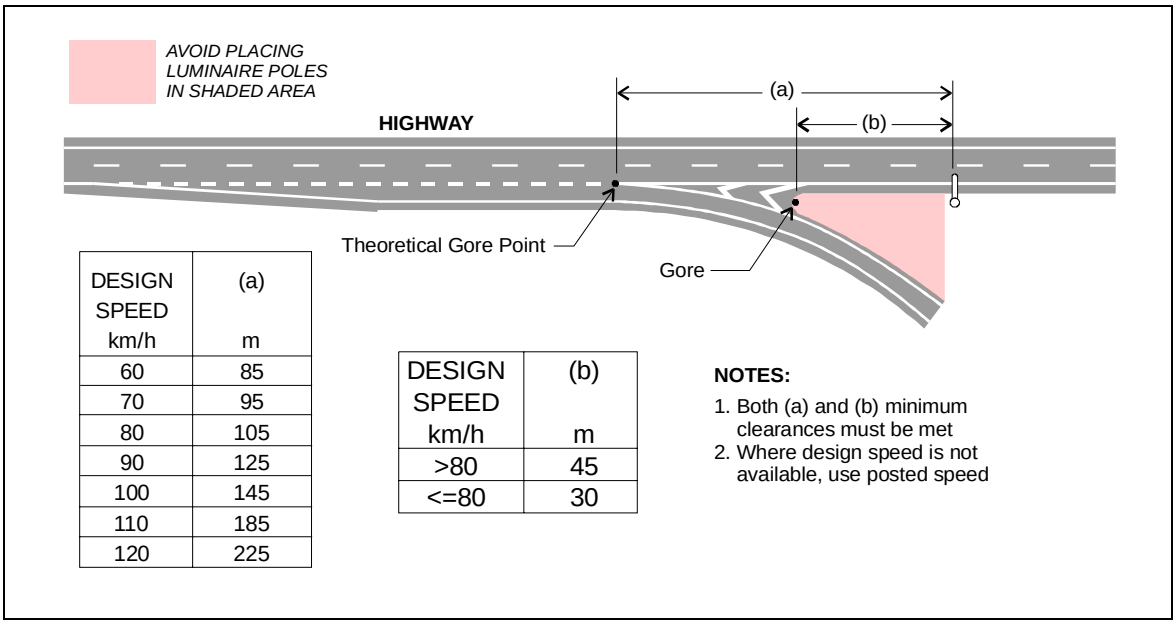
.2 Interchange lighting, as required by the warrants, shall generally adhere to the following principles:

.1 The main highway shall be designed as required for typical roadways.

.2 The intersections of the ramps and the crossroads shall be designed as required for intersections.

.3 The ramps and the acceleration and deceleration lanes, where full lighting is required shall be designed as required for typical roadways.

.4 The ramps and the acceleration and deceleration lanes, where partial lighting is required shall be designed as shown in *Figures 16, 17,* and *18.*




| DESIGN SPEED km/h | (a) m |
|---|---|
| 60 | 85 |
| 70 | 95 |
| 80 | 105 |
| 90 | 125 |
| 100 | 145 |
| 110 | 185 |
| 120 | 225 |

| DESIGN SPEED km/h | (b) m |
|---|---|
| >80 | 45 |
| <=80 | 30 |

**NOTES:**

1. Both (a) and (b) minimum clearances must be met
2. Where design speed is not available, use posted speed

Figure 18. Pole Location in Gore Area

## 307.6.4 Power Utility Company Leased Lighting

.1 Although the Ministry generally prefers that new lighting systems are designed and constructed using Ministry owned and operated infrastructure, special situations may arise where the use of power utility company leased lighting systems are either desirable due to financial considerations, or necessary due to physical constraints or constructability. Power utility company leased lighting may be used on projects, for either Ministry warranted or unwarranted lighting, if approved for use by the Ministry Electrical Representative.

.2 Power utility company leased lighting consists of cobra head luminaires and mast arm brackets mounted on utility company poles. These luminaires and brackets are generally supplied, installed, owned, operated, and maintained by the local power utility company.

# 308 SIGN LIGHTING

## 308.1.1 Lighting Requirements

.1 Refer to *Chapter 303 – Lighting Warrants* for sign lighting warrants. (In general the Ministry no longer lights overhead guide signs provided the sign face is fabricated from high intensity retro-reflective material (or better). Lighting of overhead guide signs is only required for signs faces that use engineering grade material or are painted.)

.2 Refer to *Chapter 304 – Lighting Design* for sign lighting design criteria.

## 308.1.2 Lighting Materials

.1 The Ministry Electrical and Signing Material Standards categorizes sign lighting into three types as follows:

.1 Type A1 175W MV - For use with all signs that are 1.8m high x 3.0m wide or smaller (luminaires with a wide beam pattern).

.2 Type A2 250W MV - For use with signs higher than 2.4 m (luminaires with a narrow beam pattern).

.3 Type B 250W MV - For use with signs wider than 3.0m and 2.4m high or less (luminaires with a wide beam pattern).

.2 Although the Ministry has standardized on its sign lighting equipment, material suppliers and equipment specifications may change from time to time. A current copy of the Ministry's *Recognized Products List* can viewed on the Ministry website.

## 308.1.3 Lighting Layout

.1 Lighting calculations are not required when using Type A1 175W MV luminaires for signs no larger than 1.8m high by 3.0 wide. The photometric performance criteria defined in the Ministry *Electrical and Signing Material Standards* ensures that the average sign illuminance for a 1.8m high by 3.0 wide sign is greater than 200 lux with a max to min uniformity within 6:1 as required by the design criteria. Signs 1.8m high by 3.0 wide (or smaller) account for the majority of overhead sign installations.

.2 Signs larger than 1.8m high by 3.0 wide require lighting calculations to determine the number of sign luminaires and to ensure that the lighting design criteria are met. Generally, signs taller than 2.4 metres, regardless of the width, require the use of one or more Type A2 250W MV luminaires (luminaires with a narrow beam pattern). Signs 2.4m high or shorter, but wider than 3.0m, require the use of one or more Type B 250W MV luminaires (luminaires with a wide beam pattern). The number of sign luminaires depends on the total width of the sign.

.3 The designer must specify on the design drawings the type of sign luminaire to be used on each sign. The designer must also show the sign luminaire aiming angles on the design drawings in order that the contractor properly orients the sign luminaires in the field. These aiming angles shall be indicated on the sign structure elevation.

.4 Sign luminaires are generally placed on the bottom of the signs. In areas sensitive to light pollution and sky glow the Ministry may require the sign luminaires to be placed on the top the signs in order to reduce the upward component of light into the sky. The designer shall determine if the project area is sensitive to these conditions.

# 309 TUNNEL AND UNDER/OVERPASS LIGHTING

## 309.1 PEDESTRIAN AND BICYCLE TUNNEL LIGHTING

### 309.1.1 Lighting Requirements

.1 Refer to *Chapter 303 – Lighting Warrants* for pedestrian and bicycle tunnel lighting warrants.

.2 Refer to *Chapter 304 – Lighting Design* for pedestrian and bicycle tunnel lighting design criteria.

### 309.1.2 Lighting Materials

.1 Pedestrian and bicycle tunnels are generally illuminated with 35W LPS Ministry pre-approved luminaires as listed in the Ministry's Recognized Products List. Photometrics for this 35W LPS luminaire is available on diskette in IESNA format from the luminaire manufacturer. Other light sources (i.e., high pressure sodium, metal halide, etc.) may also be used upon special approval of the Ministry Electrical Representative.

### 309.1.3 Pedestrian versus Bicycle Designation

.1 The recommended lighting levels for bicycle tunnels are higher than for pedestrian tunnels, therefore, the designer shall determine if the designated usage of the tunnel, as determined by the civil designers, corresponds with the designated usage for lighting purposes.

.2 For example, a tunnel may be designated as a bicycle tunnel by the project, however, barrier railings are placed at the entrances of the tunnel forcing the rider to dismount and walk the bicycle through the tunnel. For lighting purposes, this tunnel is designated as a pedestrian tunnel with its corresponding lower lighting level, not as a bicycle tunnel. For lighting purposes, tunnels shall only be designated as bicycle tunnels if the riders can travel through the tunnel by riding.

## 309.1.4 Lighting Layout

.1 For pedestrian or bicycle tunnels that are a standard walkway width, with a walkway approximately 3 m wide, a 3.0 m luminaire spacing for bicycle tunnels and a 4.5 m luminaire spacing for pedestrian tunnels will provide acceptable lighting levels on the walkway surface.

.2 Pedestrian and bicycle tunnels that are wider than standard pathways will require lighting design calculations to determine the required luminaire spacing to meets the required design criteria.

.3 Bicycle tunnel luminaires are generally illuminated to full design lighting levels during the day and 50 percent daytime lighting levels at night. Luminaires shall be controlled at night using the Ministry standard photocell and a normally closed relay located in the service panel. In special cases the Ministry may require that the lighting remain at full levels both day and night. Designers shall enquire about this requirement with the Ministry Electrical Representative.

.4 Pedestrian and bicycle tunnels require lighting at the entrances and exits of the structures. Refer to *Chapter 311* for details on walkway lighting. For tunnels that are in areas of non-continuous lighting, one post-top walkway light will be required at a strategic location near the each end of the tunnel. For tunnels that are in the vicinity of roadway lighting, adequate lighting at the tunnel entrances may be possible with strategic placement of the roadway luminaires.

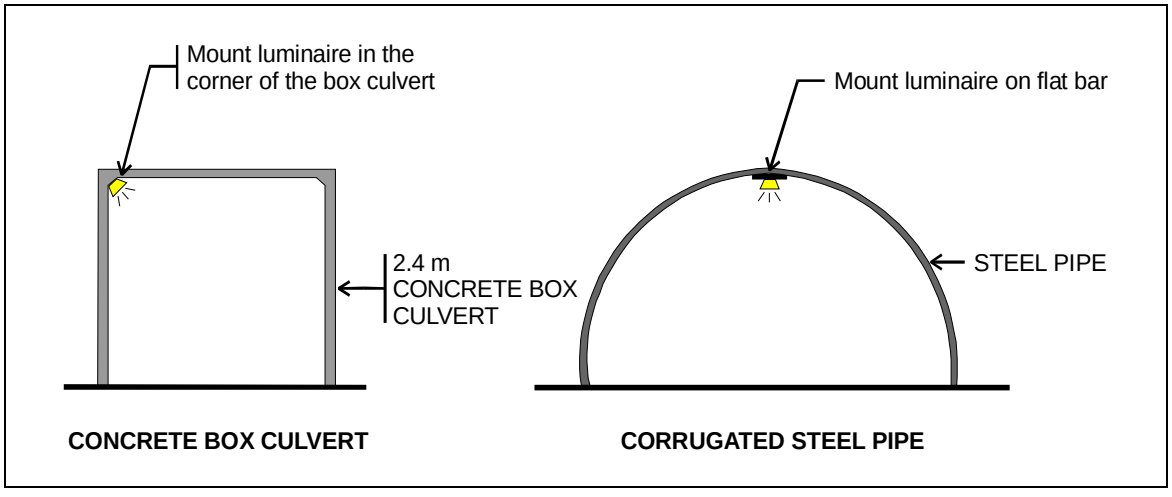



Figure 19. Typical Pedestrian and Bicycle Tunnel Lighting

## 309.2 VEHICLE TUNNEL LIGHTING

### 309.2.1 Lighting Requirements

.1 Vehicle tunnels are structures in which the length, in the direction of travel, is longer than the width of the structure. Any structures where the width is greater than the length are considered underpasses. Refer to *Chapter 309* for underpass lighting details.

.2 All vehicle tunnel projects are considered to be special projects and, as such, require project specific research into the best solutions for the lighting design. Prior to designing a tunnel lighting system, designers shall thoroughly review the project with the Ministry Electrical Representative.

.3 Refer to *Chapter 303 – Lighting Warrants* for vehicle tunnel lighting warrants.

.4 All tunnel lighting systems shall be designed to meet the lighting design criteria and requirements of *IESNA RP-22 American National Standard Practice for Tunnel Lighting.*

### 309.2.2 Lighting Materials

.1 The Ministry does not have standard lighting materials or methods for lighting vehicle tunnels. The selection of luminaire type and wattage, distribution and location is a major part of the tunnel lighting design process and should be carefully researched and reviewed with the Ministry Electrical Representative and the Ministry Manager, Electrical Services.

.2 For minor tunnel projects, luminaire types should be restricted to high-pressure sodium or metal halide.

.3 For major tunnel projects, particularly tunnels long enough to have an interior zone, all light sources should be considered including linear fluorescent systems.

.4 All luminaires used in tunnel projects shall be specifically designed and developed for tunnel applications. The use of general application lighting fixtures or industrial luminaires should be avoided.

.5 Luminaire selection shall consider, among others, the following:

.1 Luminaire efficiency

.2 Durability

.3 Maintainability

.4 Constructability

## 309.2.3 Lighting Design

.1 The lighting design and calculations shall be undertaken by using the methods outlined in *IESNA RP-22 American National Standard Practice for Tunnel Lighting*. The lighting design criteria and design methods vary depending on the size, length, and geographical area of the tunnel. The designer shall determine the lighting design criteria and select the most appropriate method for lighting the tunnel. In particular, consideration should be given to the following items:

*.1* For major tunnels the threshold luminance values, $L_{th}$, should be determined for each tunnel portal using the $L_{SEQ}$ (Equivalent Veiling Luminance) Method as outlined in *IESNA RP-22, Annex B.*

.2 For minor tunnels the threshold luminance values, $L_{th}$, may be determined by suing the standard tables included in *IESNA RP-22, Section 6, Lighting Design Criteria*, including the table of adjustment factors, however, the $L_{SEQ}$ Method may also be used to provide more site specific results.

.3 Wall luminance criteria are to be considered as important as the pavement luminance.

.4 Veiling luminance (glare) criteria must be met for all tunnel lighting designs.

.2 All lighting design applications shall be considered, including symmetrical and linear lighting systems, and asymmetrical pro-beam or counter-beam lighting systems.

*.3* Lighting system economic analyses shall be considered in all designs and a 25-year life cycle cost analysis shall be undertaken for all proposed and competing design methods as outlined in *IESNA RP-22, Section 9 Lighting System Economics.*

.4 For new tunnel projects, tunnel lighting design principles shall be presented and discussed with the structural and architectural designers of the tunnel. Architectural features of tunnel approaches and portals, and highly reflective tunnel wall and ceiling materials, can greatly affect the amount of lighting required in a tunnel, and therefore the capital and ongoing operational costs. Recommendations for these considerations are outlined in *IESNA RP-22*.

.5 Energy efficiency is a key determining factor in a tunnel lighting design given the large quantity of luminaries required for a tunnel project. In order to achieve the best energy efficiency, multi-level lighting controls will be required for all tunnel projects. Illuminance levels should be at the highest level in bright sunlight and at the lowest level in darkness. Typically major tunnels should have at least three daytime lighting levels and a separate nighttime lighting level.

.6 Lighting is required for the external approach zone and exit zone of all tunnels that warrant nighttime lighting. The lighting design criteria for these areas are outlined in *IESNA RP-22*.

.7 Research and development of new tunnel lighting design criteria and design methods are continuously ongoing by the IESNA as well as other lighting engineering research groups from Europe, such as the International Commission on Illumination (Commission Internationale de L'eclairage - CIE). All new design methods and criteria, even if not officially adopted by the IESNA, will be considered for tunnel projects, providing it can be shown that proper engineering principles are maintained and that safety is not compromised.

.8 The Ministry Electrical Representative, prior to proceeding with the detailed design, must approve the selected tunnel lighting design criteria and design method.

## 309.3 UNDERPASS/OVERPASS LIGHTING

### 309.3.1 Lighting Requirements

.1 When a highway passes under a crossroad it is called an underpass; when a highway passes over a crossroad it is called an overpass. Underpasses are usually less than 20 m long in direction of the highway travel, while overpasses may be 30 m or longer, in the direction of the crossroad travel. Underpass and overpasses are structures in which the length, in the direction of travel, is shorter than the width of the structure. Any structures where the length is greater than the width are considered tunnels. Refer to *Clause 309.2* for lighting details of vehicle tunnels.

.2 This section, and terminology, only applies to the roadways below the structure. Roads that are the along the top of the structures are covered as part of general roadway or bridge lighting

.3 Refer to *Chapter 303 – Lighting Warrants* for underpass and overpass lighting warrants.

.4 Where lighting is required, the lighting design criteria must meet those required on the entrance roadways. Refer to *Chapter 304 – Lighting Design* for underpass and overpass lighting design criteria.

.5 Daytime lighting is never required for underpasses and overpasses.

## 309.3.2 Lighting Materials

.1 Underpasses are generally illuminated with Ministry pre-approved 150W HPS wall mount luminaires as listed in the Ministry's Recognized Products List.

.2 Overpasses are generally illuminated with pole mounted luminaires, consistent with the roadway lighting adjacent to the overpass.

## 309.3.3 Lighting Layout

.1 Where possible, underpass and overpass lighting shall be provided by the strategic placement of roadway luminaire poles on either side of the structure. Sufficient lighting may be provided by the overlap of the luminaire beam spread providing that shadowing does not occur from either the poles being too high, or the structure being too low.

.2 Luminaire poles along the road beneath the structure should be located a minimum of one pole height away from the structure to provide good lighting distribution under the structure while, at the same time, limiting obtrusive glare on the roadway along the top of the structure.

.3 If the roadway luminaires located adjacent to the structure do not provide proper lighting on the roadway below the structure, wall mount luminaires may be required, located as shown on *Figure 20*.

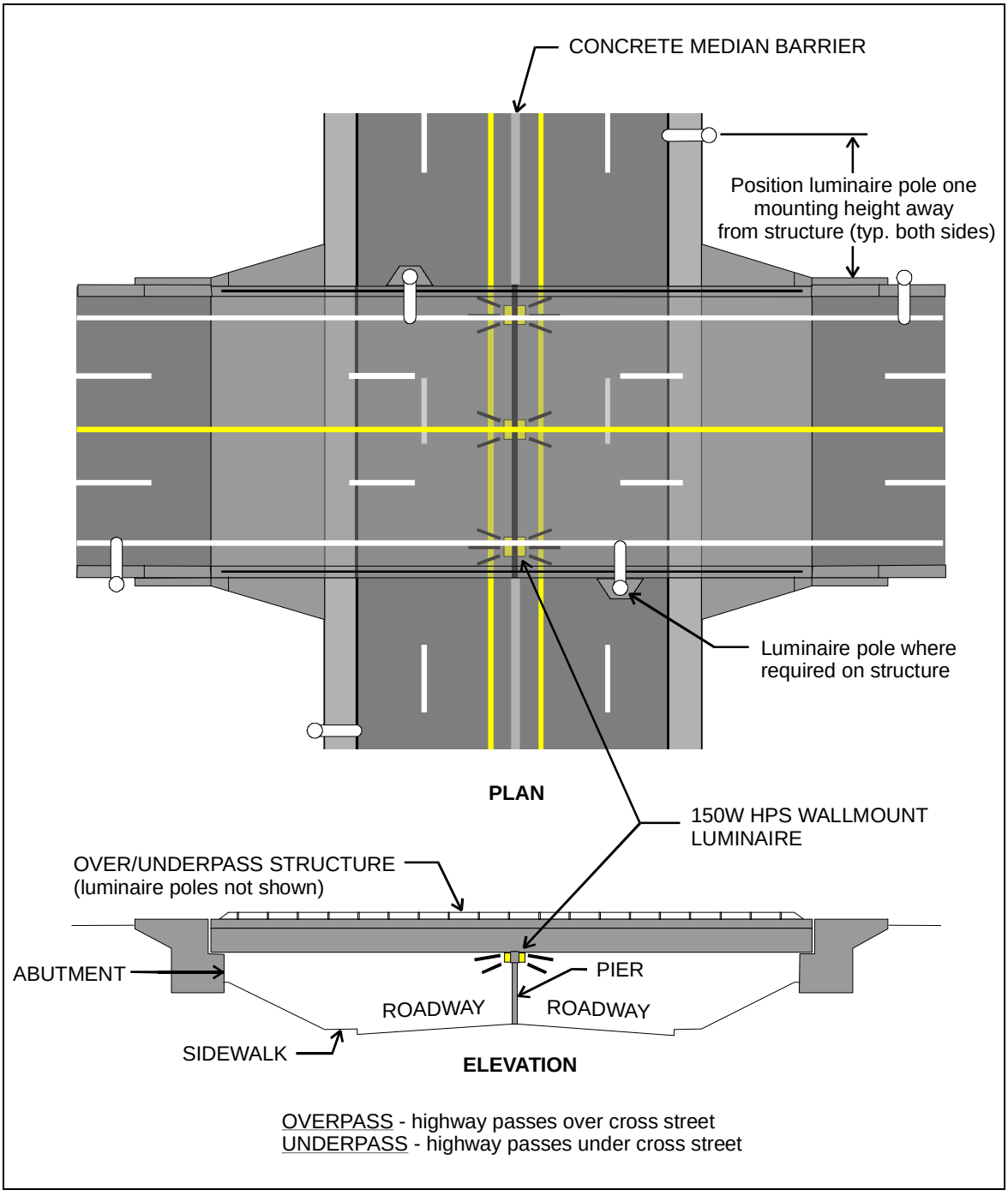



Figure 20. Typical Underpass/Overpass Lighting

# 310 BRIDGE LIGHTING

## 310.1 ROADWAY LIGHTING ON BRIDGES

### 310.1.1 Lighting Requirements

.1 All major bridge projects are considered to be special projects and, as such, have project specific requirements particular to bridges. Major bridge projects will require project specific research into the best solutions for the lighting designs. Prior to designing a major bridge lighting system, designers shall thoroughly review the project with the Ministry Electrical Representative.

.2 Minor bridge projects, including the roadways along the tops of under/overpasses, are generally treated the same as the roadway that they form part of, and require no special consideration for lighting.

.3 Refer to *Chapter 303 – Lighting Warrants* for bridge roadway lighting warrants.

.4 The design requirements for lighting along bridge roadways follow the same requirements as roadway lighting. Refer to *Chapter 304* for roadway lighting design criteria.

.5 If lighting is not warranted along a bridge, but it is expected or conceivable that lighting may be required in the future due to future road improvements, or future reclassification of the roadway or land use, it is recommended that the conduit and pole bases be considered on the bridge structure to accommodate the installation of lighting in the future. Designers shall discuss the requirement for installing pole bases and conduit on the bridge with the Ministry Electrical Representative.

### 310.1.2 Lighting Materials

.1 For most projects standard Ministry roadway lighting materials and equipment shall be used for bridge roadway lighting.

.2 In all cases the designer shall ensure pole handholes are easily accessible. Special modified pole designs may be required with handholes located in maintainable locations.

.3 Luminaires on bridges shall be specified with anti-vibration devices, which are supplied as an option by the Ministry pre-approved cobra head luminaire suppliers.

### 310.1.3 Lighting Layout

.1 If roadway lighting is required to on a bridge structure, the designer shall:

.1 Locate the luminaire poles off the side of the bridge structure, parapet, or deck.

.2 Orient pole hand holes to allow easy maintenance access from the bridge deck.

.3 Where feasible, avoid the use of junction boxes in bridges by making wiring connections in the pole hand holes.

.2 Typical luminaire pole mounting details on bridge structures are shown in *Figure 21*.

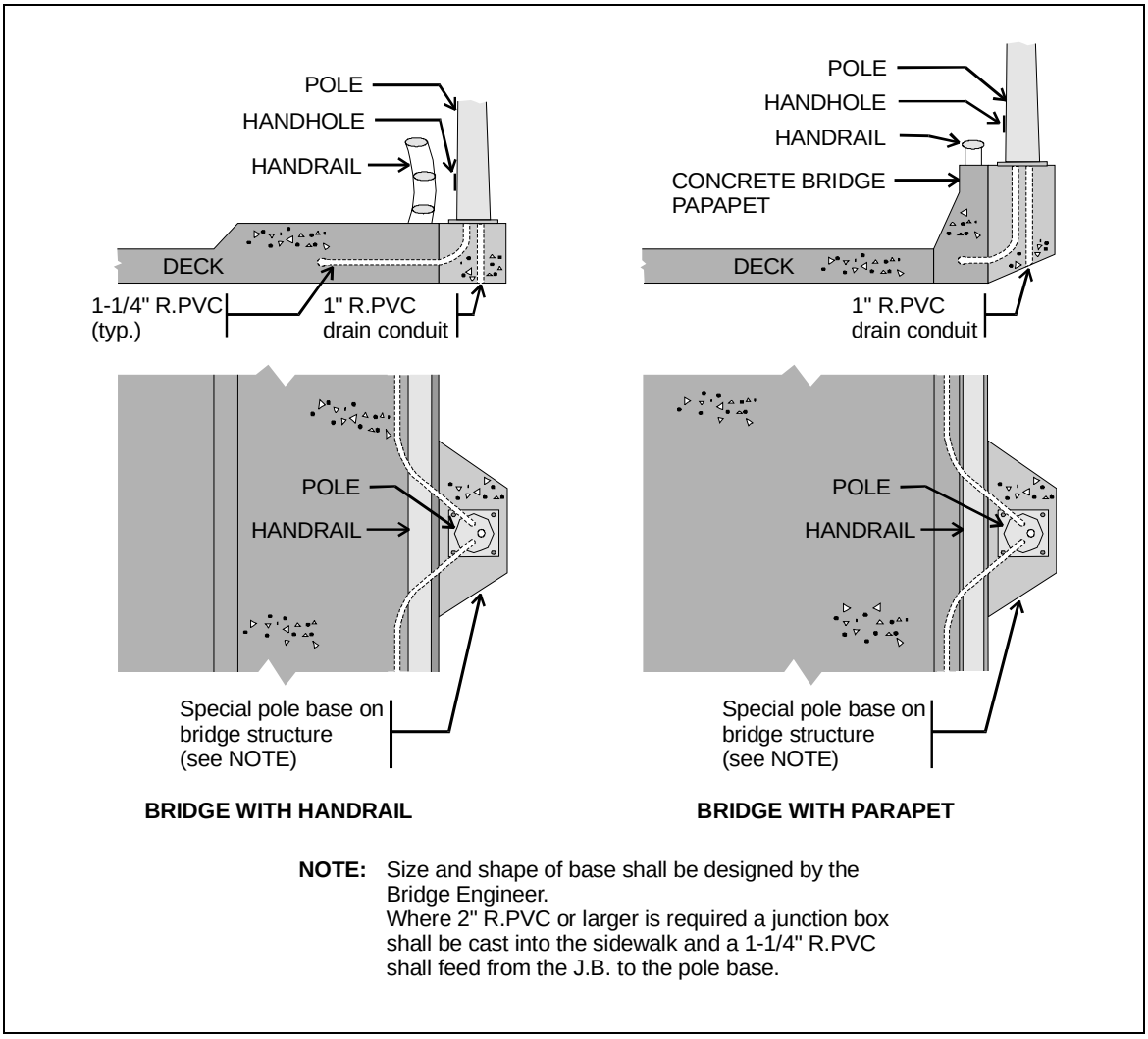



Figure 21. Typical Luminaire Pole Mounting on Bridge Structures

## 310.2 MARINE NAVIGATION LIGHTS ON BRIDGES

.1 The designer shall confirm the need and requirements for marine navigation lighting on bridges over navigable waterways with the Ministry Navigable Waterways/Rail Coordinator, Engineering Branch, Victoria.

.2 If navigation lighting is required, the navigation lights shall be:

.1 Located on each side of the bridge

.2 Positioned over the centre of the navigable channel

.3 Illuminated 24 hours a day

.3 Navigation lights shall be 175W mercury vapour (Crouse-Hinds Model No. VMVC-3-TW-175-GP, colour and voltage as required).

.4 Where possible and for ease of maintenance, the designer shall install the navigation lights on a special swing hanger and locate them near the bridge deck level.

## 310.3 AIRCRAFT OBSTRUCTION LIGHTS ON BRIDGES

.1 Designers shall confirm the need and requirements for aircraft obstruction lights on bridge towers with the Ministry Navigable Waterways/Rail Coordinator, Engineering Branch, Victoria.

.2 Aircraft obstruction lights shall be specified to suit the latest requirements of Transport Canada as defined in the latest edition of TC 312E *Aerodrome Standards and Recommended Practices*

## 310.4 LIGHTING BRIDGE PIERS

.1 The preferred method of indicating the hazard of a bridge pier is by floodlighting. However, floodlighting may not be practical for some bridge structure designs or for small bridges. If floodlighting is not practical hazard marker lighting may be required at the base of the pier.

.2 Floodlights shall be metal halide. The most efficient floodlight wattage and beam spread shall be used for the installation. Piers shall be illuminated to a level adequate for proper visibility for vessels on the water. Floodlight type and lighting levels shall meet the approval of the Ministry Electrical Representative.

.3 Marker lights shall be 175W mercury vapour (Crouse-Hinds Model No. VMVC-3-TW-175-GP, colour and voltage as required).

.4 Where possible and for ease of maintenance, the designer shall install the floodlights on a special swing hanger and locate them near the deck level.

.5 Hazard marker lights shall be located near the base of the pier to provide proper warning of the structure.

.6 Floodlights or hazard markers shall be controlled by a photocell for nighttime only operation.

.7 Floodlights shall be shielded to reduce light trespass or glare onto adjacent areas, including the reduction of disability glare in the direction of traveling watercraft.

# 311 PEDESTRIAN WALKWAY AND BIKEWAY LIGHTING

## 311.1 LIGHTING REQUIREMENTS

.1 Refer to *Chapter 303 – Lighting Warrants* for pedestrian walkway and bikeway lighting warrants.

.2 Refer to *Chapter 304 – Lighting Design* for pedestrian walkway and bikeway lighting design criteria.

## 311.2 LIGHTING MATERIALS

.1 Walkways and bikeways requiring a separate lighting system and are generally illuminated with Ministry standard 150W HPS Post Top Luminaires mounted on Type 2 - 6.5 m shafts with a post top adapter. However flat glass cobra head luminaires shall also be considered to reduce light trespass.

.2 Luminaires and poles shall be selected from the Ministry's Recognized Products List.

## 311.3 LIGHTING LAYOUT

.1 If a walkway or bikeway runs adjacent to a roadway lighting system, designers shall determine whether spill lighting from the roadway lighting system provides adequate lighting on the walkway

# 312 MISCELLANEOUS LIGHTING APPLICATIONS

## 312.1 REST AREA LIGHTING

### 312.1.1 Lighting Requirements

.1 Refer to *Chapter 303 – Lighting Warrants* for rest area lighting warrants.

.2 Refer to *Chapter 304 – Lighting Design* for rest area lighting design criteria.

.3 Lighting for on and off ramps to a freeway or expressway facility shall meet the requirements of freeway interchange ramps.

### 312.1.2 Lighting Materials

.1 Rest areas shall be illuminated using Ministry standard pre-approved flat glass cobra head luminaires and davit poles or post top luminaires and poles.

.2 Luminaires with cut-off optics and poles shall be selected from the Ministry's Recognized Products List.

### 312.1.3 Lighting Layout

.1 The Ministry lights rest areas to increase public safety and security as well as to enhance the facilities usefulness at night.

.2 Lighting levels for certain facilities may require adjustment based on site conditions as determined by the Ministry Electrical Representative. The Ministry may request designers to reduce lighting levels in areas where the adjacent highway has a low level of lighting.

.3 Information kiosk and restroom lighting systems are designed and installed by the British Columbia Building Corporation (BCBC). However, the power for BCBC lighting systems may be fed from the Ministry of Transportation services. Designers shall make allowances for load and circuit requirements for restroom and information kiosk lighting.

Confirm the load and circuit requirements with the Ministry Electrical Representative and BCBC.

.4 *Figure 22* is an example of a typical rest area facility.

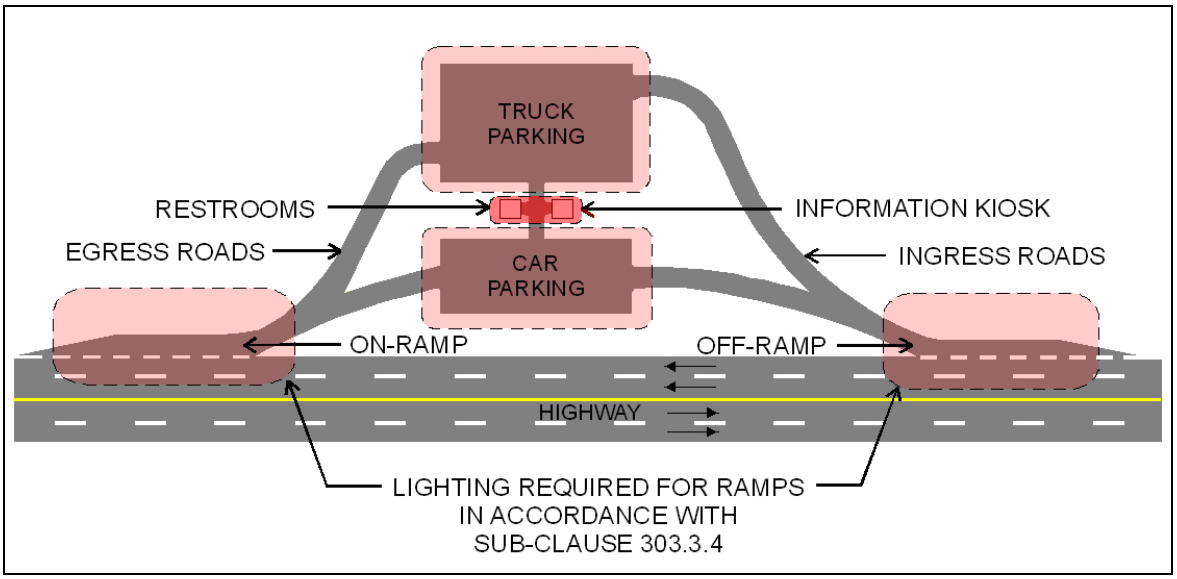



Figure 22. Example of Rest Area

## 312.2 WEIGH SCALE LIGHTING

### 312.2.1 Lighting Requirements

.1 Refer to *Chapter 303 – Lighting Warrants* for weigh scale lighting warrants.

.2 Refer to *Chapter 304 – Lighting Design* for weigh scale lighting design criteria.

.3 Lighting for on and off ramps to a freeway or expressway facility shall meet the requirements of freeway interchange ramps.

### 312.2.2 Lighting Materials

.1 Weigh scales shall be illuminated using Ministry standard pre-approved flat glass cobra head luminaires and davit poles or post top luminaires and poles. Highmast lighting may also be used for lighting large weigh scale

facilities. The use of highmast lighting for weigh scales shall meet the approval of the Ministry Electrical Representative.

.2 Luminaires and poles shall be selected from the Ministry's Recognized Products List.

.3 All roadway lighting shall be high pressure sodium, except for the inspection area and weigh scale deck, which shall be metal halide for better colour rendition.

### 312.2.3 Lighting Layout

.1 The Ministry lights weigh scales to increase worker safety, and for weigh scale operators to perform inspections of the trucks using the facility. Although the IESNA has no specific documents relating to weigh scales, recommendations for lighting designs and layouts in weigh scales can be abstracted from *IESNA RP-20 Recommended Practice for Lighting for Parking Facilities*.

.2 Lighting levels for certain facilities may require adjustment based on site conditions as determined by the Ministry Electrical Representative. The Ministry may request designers to reduce lighting levels in isolated areas with very low truck volumes.

.3 Weigh scale building lighting and controls shall generally be provided by the British Columbia Building Corporation (BCBC).

.4 Weigh scale open/closed signs and truck weight signs require sign lighting in accordance with the *Chapter 308*. Lighting may also be required for directional signs where the decision making process is overly complex or critical in reaction time. Lighting of directional signs must meet the approval of the Ministry Electrical Representative.

.5 Full-scale lighting is only required for the time of night that the weigh scale is operational. Time programmable controls shall be used to downgrade the lighting to security levels when the facility is non-operational.

.6 *Figure 23* illustrates an example of a typical weigh scale facility.

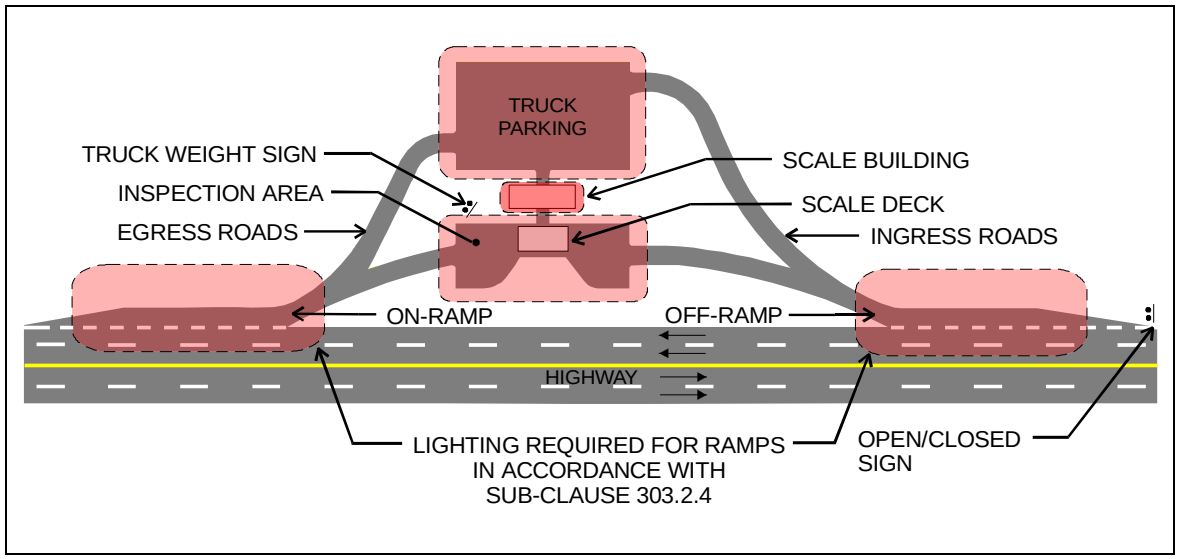



Figure 23. Example of Weigh Scale

## 312.3 BRAKE CHECK AREAS AND CHAIN-UP PULLOUTS

### 312.3.1 Lighting Requirements

.1 Refer to *Chapter 303 – Lighting Warrants* for brake check area and chain-up pullout lighting warrants.

.2 Refer to *Chapter 304 – Lighting Desi*gn for brake check area and chain-up pullout lighting design criteria.

.3 Lighting for on and off ramps to a freeway or expressway facility shall meet the requirements of freeway interchange ramps.

### 312.3.2 Lighting Materials

.1 Brake check areas and chain-up pullouts shall be illuminated using Ministry standard pre-approved flat glass cobra head luminaires and davit poles.

.2 Luminaires and poles shall be selected from the Ministry's *Recognized Products List.*

### 312.3.3 Lighting Layout

.1 The Ministry lights brake check areas and chain-up pullouts to increase safety and security as well as to enhance the facilities usefulness at night.

.2 Lighting is provided at brake check areas and chain-up pullouts for vehicle and pedestrian safety, not for task lighting. The light source for brake inspection tasks must, by law, be provided by the vehicle.

.3 Lighting levels for certain facilities may require adjustment based on site conditions as determined by the Ministry Electrical Representative. The Ministry may request designers to reduce lighting levels in areas where the adjacent highway has a low level of lighting.

## 312.4 FERRY TERMINALS

### 312.4.1 Lighting Requirements

.1 Refer to *Chapter 303 – Lighting Warrants* for ferry terminal lighting warrants.

.2 Refer to *Chapter 304 – Lighting Design* for ferry terminal lighting design criteria.

.3 Lighting for ferry terminal approach roads shall meet the requirements of continuous roadway lighting or intersection lighting.

### 312.4.2 Lighting Materials

.1 Ferry terminals shall be illuminated using Ministry standard pre-approved flat glass cobra head luminaires and davit poles or post top luminaires and poles. Highmast lighting may also be used for lighting large ferry terminal facilities. The use of highmast lighting for ferry terminals shall meet the approval of the Ministry Electrical Representative.

.2 Luminaires and poles shall be selected from the Ministry's Recognized Products List.

.3 All roadway and area lighting shall be high pressure sodium, except for the payment booth area, which shall be metal halide for better colour rendition.

## 312.4.3 Lighting Layout

.1 Road and Area Lighting

.1 The Ministry lights ferry terminals to increase driver control and safety, and for ferry terminal workers to perform their duties of loading, unloading, and directing traffic. Although the IESNA has no specific documents relating to ferry terminals, recommendations for lighting designs and layouts in ferry terminals can be abstracted from *IESNA RP-20, Recommended Practice for Lighting for Parking Facilities*.

.2 Lighting levels for certain facilities may require adjustment based on site conditions as determined by the Ministry Electrical Representative. The Ministry may request designers to reduce lighting levels in isolated areas with very low traffic volumes.

.3 Ferry terminal lighting and controls shall generally be provided by the British Columbia Ferry Corporation (BCFC).

.4 Lighting may be required for ferry terminal directional signs where the decision making process is overly complex or critical in reaction time. Lighting of directional signs must meet the approval of the Ministry Electrical Representative.

.5 Full-scale lighting is only required for the time of night that the ferry terminal is operational. Time programmable controls shall be used to downgrade the lighting to security levels when the facility is non-operational.

.2 Marine Navigation Lights

.1 Designers shall confirm the need and requirements for marine navigation lighting at ferry terminals with the Ministry Navigable Waterways/Rail Coordinator, Engineering Branch, Victoria.

.2 If navigation lighting is required, the navigation lights shall be:

.1 175W mercury vapour

.2 Located on each side of the bridge.

.3 Positioned over the centre of the navigable channel

.4 On 24 hours a day.

.3 Navigation lights shall be 175W mercury vapour (Crouse-Hinds Model No. VMVC-3-TW-175-GP, voltage as required).

.3 Pier Floodlighting

.1 The preferred method of indicating the marine hazard at a ferry terminal is by floodlighting. However, floodlighting may not be practical for some terminal structures. If floodlighting is not practical hazard marker lighting may be required at the base of the pier.

.2 Floodlights shall be metal halide. The most efficient floodlight wattage and beam spread shall be used for the installation. Piers shall be illuminated to a level adequate for proper visibility for vessels on the water. Floodlight type and lighting levels shall meet the approval of the Ministry Electrical Representative.

.3 Hazard marker lights shall be 175W mercury vapour (Crouse-Hinds Model No. VMVC-3-TW-175-GP, voltage as required).

.4 Hazard marker lights shall be located near the base of the pier to provide proper warning of the structure.

.5 Floodlights or hazard markers shall be controlled by a photocell for nighttime only operation.

.6 Floodlights shall be shielded to reduce light trespass or glare onto adjacent areas, including the reduction of disability glare in the direction of traveling watercraft.

## 312.5 TOLL PLAZAS

### 312.5.1 Lighting Requirements

.1 Refer to *Chapter 303 – Lighting Warrants* for toll plaza lighting warrants.

.2 Refer to *Chapter 304 – Lighting Design* for toll plaza lighting design criteria.

.3 Lighting for toll plaza approach roads shall meet the requirements of continuous roadway lighting or intersection lighting.

### 312.5.2 Lighting Materials

.1 Toll plazas shall be illuminated using Ministry standard pre-approved flat glass cobra head luminaires and davit poles or post top luminaires and poles. Highmast lighting may also be used for lighting large toll plaza

facilities. The use of highmast lighting for toll plazas shall meet the approval of the Ministry Electrical Representative.

.2 Luminaires and poles shall be selected from the Ministry's Recognized Products List.

.3 All roadway and area lighting shall be high pressure sodium, except for the payment booth area, which shall be metal halide for better colour rendition.

### 312.5.3 Lighting Layout

.1 The Ministry lights toll plazas to increase driver control and safety, and for facility operators to perform their tasks. Although the IESNA has no specific documents relating to toll plazas, recommendations for lighting designs and layouts in toll plazas can be abstracted from *IESNA RP-20 Recommended Practice for Lighting for Parking Facilities*.

.2 Lighting levels for certain facilities may require adjustment based on site conditions as determined by the Ministry Electrical Representative. The Ministry may request designers to reduce lighting levels in isolated areas with very low traffic volumes.

.3 The British Columbia Building Corporation (BCBC) shall generally provide toll facility building lighting and controls.

.4 Toll plaza lane control and open/closed signs may require sign lighting in accordance with the *Chapter 308* depending on the technology utilized. Lighting may also be required for directional signs where the decision making process is overly complex or critical in reaction time. Lighting of directional signs must meet the approval of the Ministry Electrical Representative.

## 312.6 CLOSED CIRCUIT TELEVISION (CCTV) LIGHTING

### 312.6.1 Lighting Requirements

.1 Refer to *Chapter 303 – Lighting Warrants* for CCTV lighting warrants.

.2 Refer to *Chapter 304 – Lighting Design* for CCTV lighting design criteria.

### 312.6.2 Lighting Materials

.1 Lighting materials for CCTV shall be consistent with roadway lighting in the area.

.2 Luminaires and poles shall be selected from the Ministry's Recognized Products List.

### 312.6.3 Lighting Design

.1 Where CCTV systems are installed along a roadway with continuous lighting, the normal roadway lighting will provide sufficient illumination for satisfactory operation of the cameras.

.2 Where lighting is specifically required only for CCTV cameras, the lighting design shall be developed to a minimum illuminance criteria method, not an average illuminance criteria method as used for ordinary roadway lighting.

.3 Only the illuminance method of lighting design is appropriate for CCTV. The luminance method, with its metric of pavement luminance, is inappropriate for CCTV due to the requirement that CCTV surveillance is for all objects (vehicles, pedestrians, etc.) not just the pavement.

.4 Uniformity is particularly important for proper CCTV operation. The sensitivity of modern digital cameras requires a high degree of uniformity.

.5 For CCTV operation in rural areas, lighting must be provided for the full field as required by the surveillance objective. This may also include multiple fields of view if the pan, tilt, and zoom are operated.

## 312.7 PARKING FACILITY LIGHTING

### 312.7.1 Lighting Requirements

.1 Refer to *Chapter 303 – Lighting Warrants* for parking facility lighting warrants.

.2 Refer to *Chapter 304 – Lighting Design* for parking facility lighting design criteria.

.3 Lighting for on and off ramps to a freeway or expressway facility shall meet the requirements of freeway interchange ramps.

### 312.7.2 Lighting Materials

.1 Parking facilities shall be illuminated using Ministry standard pre-approved flat glass cobra head luminaires and davit poles or post top luminaires and poles.

.2 Luminaires and poles shall be selected from the Ministry's Recognized Products List.

### 312.7.3 Lighting Layout

.1 The Ministry lights parking facilities to increase public safety and security as well as to enhance the facilities usefulness at night. Recommendations for lighting designs and layouts in parking facilities are outlined in *IESNA RP-20 Recommended Practice for Lighting for Parking Facilities*.

.2 Lighting levels for certain facilities may require adjustment based on site conditions as determined by the Ministry Electrical Representative. The Ministry may request designers to reduce lighting levels in areas where the adjacent highway has a low level of lighting.

.3 Full-scale lighting is only required for the time of night that the parking facility is in active operation. Time programmable controls shall be used to downgrade the lighting to security levels when the facility is not actively operating.

## 312.8 CONSTRUCTION DETOURS

### 312.8.1 Lighting Requirements

.1 Refer to *Chapter 303 – Lighting Warrants* for construction detour lighting warrants.

.2 Refer to *Chapter 304 – Lighting Design* for construction detour lighting design criteria.

## 312.8.2 Lighting Materials

.1 Where possible, construction detour lighting shall be provided in whole, or in part, by the permanent lighting installation of the project. This can many times be achieved by the early installation in a project of the electrical systems.

.2 Where construction detour lighting cannot be provided by the permanent lighting installation, or must be supplemented by additional lighting, standard Ministry style lighting can be used, and then subsequently be re-used as part of the permanent installation elsewhere in the project.

.3 If it is impractical to use Ministry style lighting equipment for the temporary construction detour, a temporary wood pole system with overhead wiring is permissible. All luminares must be flat glass for appropriate glare control.

.4 Floodlights are not permitted for temporary detour lighting unless it can be shown to the Ministry Electrical Representative's satisfaction that proper glare and light pollution controls can be achieved.

## 312.8.3 Lighting Layout

.1 All lighting designs for temporary construction detours must meet all roadway lighting design requirements, including the secondary criteria such as uniformity and glare.

.2 All temporary lighting systems in urban and sub-urban areas, as well as those in rural areas where residents have a view of the project, must be sensitive to the local concerns regarding light pollution as outlined in *Chapter 305*.