SECTION 7

Street Lighting

7.0 STREET LIGHTING

7.1 General

Roadway lighting refers to lighting of roads, walkways, lanes, and bikeways. Lighting is generally required in all urban and suburban areas. In other areas, lighting requirements are in accordance with warrants as indicated in the TAC Guide for the Design of Roadway Lighting.

These guidelines are not intended to be a substitute for sound engineering knowledge and experience. Roadway lighting designs should be prepared under the direction of the Design Engineer.

7.2 Codes, Rules, Standards and Permits

Roadway lighting systems are to be designed in general conformance with the following:

7.2.1 Codes

BC electrical code, the most recent and adopted edition issued by the BC Safety Authority.

7.2.2 Rules

- WorkSafeBC;
- Canadian Standards Association;
- Utility Companies; and
- Regulations issued by municipal, provincial and federal authorities.

7.2.3 Standards

- ANSI/IES RP-8, American National Standard for Roadway Lighting;
- IES-DG-5 Recommended Lighting For Walkways and Class 1 Bikeways;
- TAC:
  - Guide for the Design of Roadway Lighting – 1983;
  - Illuminations of Rural Intersections;
- AASHTO - Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals;
- CAN/CSA S6-OO Canadian Highway Bridge Design Code;
- CAN3-CSA22.3 No. 7 Undergrounding Systems;
- CAN3-CSA22.3 No. 1 Overhead Systems; and
- Master Municipal Construction Document (MMCD) Specifications and Standard Detail Drawings, plus Supplementary Specifications and Standard Drawings.

7.2.4 Permits

Electrical permits are required for any new electrical installations and as required by the BC Safety Authority for maintenance work.

7.3 Roadway Classifications

Roadway classifications for lighting purposes are in accordance with ANSI/IES RP8. The following four basic classifications are covered by these guidelines. Highway classifications such as freeway and expressway are excluded.

• **Major:**	Serves as the principal network for through-traffic flow. The routes connect areas of principal traffic generation. The equivalent term under the TAC guidelines is "arterial".
• **Collector:**	Services traffic between major and local streets. These streets are used mainly for the dual purpose of land access and for traffic movements within residential, commercial and industrial areas.
• **Local:**	Used primarily for direct access to residential, commercial, industrial or other abutting property, and is not intended to carry through traffic.
• **Walkways and Bikeways:**	Adjacent to or independent from roadways.

The basic classifications are further divided according to the levels of vehicle/pedestrian interaction as follows:

- High (H): Areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the street during darkness. Commercial areas such as those adjacent to shopping centers, hotels, central business districts and village town centers;
- For Walkways and Bikeways this classification is further divided as follows:
  - P: Pedestrians and bicycles only; and
  - S: Sidewalk adjacent to roadway.
- Medium (M): Areas where lesser numbers of pedestrians utilize the street at night. High density multi-family residential and local commercial industrial and public areas;
- Low (L): Areas with very low volumes of night pedestrian usage. Medium density multi-family, single family and rural residential areas;.
- For Walkways and Bikeways, this classification is further divided as follows:
  - MDR: Medium density residential;
  - LDR: Low density residential; and
  - SR: Semi-rural or rural.

7.4 Design Methods

Acceptable design methods and criteria are indicated below. The details are shown in Figure 7.1.

7.4.1 Illuminance

Illuminance refers to the average maintained horizontal illumination level measured in lux. Recommended levels are related to pavement types as detailed in RP-8. Additional design criteria include uniformity ratio and veiling luminance (disability glare).

The illuminance method of design is suitable for all roadway classifications, particularly collector and local roads and bikeways and lanes.

7.4.2 Luminance

Luminance refers to the average light intensity reflected off the roadway measured in candelas per square meter (cd/m^2). Uniformity ratios and veiling luminance are also included in the design criteria. The luminance design method is suitable for most roadway classifications, particularly major roads, freeways and parkways. Recommended luminance levels have not been established for walkways and bikeways.

7.4.3 Small Target Visibility (STV)

Small target visibility design was introduced in the 2000 edition of RP-8.

The STV design method determines the visibility of an array of targets on the roadway considering the following factors:

- Luminance of the targets;
- Luminance of the immediate background;
- Adaption level of the adjacent surroundings; and
- Disability glare.

The weighted average of the visibility level (VL) of the targets results in the STV.

The uniformity ratio is also considered. Suitability of the STV design method is similar to that of luminance method.

7.5 Verification

While the above design methods are all acceptable as indicated, the illuminance method is currently the only one for which the actual lighting level can be readily verified in the field using economical measurement equipment and procedures. The Design Engineer should obtain approval of the design method from the City Engineer before proceeding with detailed design.

7.6 Light Sources

Unless otherwise directed or approved by the City Engineer, use LED (light emitting diode) fixtures. These fixtures have low power consumption and long and predictable lifetimes which relates to lower operating costs. Typically LED fixtures with a light level equivalent to 100W, 150W and 250W HPS lamps are used. LED fixtures must have a 0-10v dimmable ballast.

Specialty lighting in designated areas may be approved on a case by case basis.

7.7 Light Loss Factor (LLF)

The light loss factor is a combination of several factors representing deterioration of the lamp and luminaire over their life-spans. These factors include environmental conditions as well as operating factors. Ambient environmental conditions range from 1-Very Clean to 2-Clean, 4-Moderate, 8-Dirty, and 16-Very Dirty.

Refer to Table 7.1 for Recommended Light Loss Factors. Unless otherwise approved, use Ambient Category 2 and a Cleaning Interval of 5 years.

Table 7.1
Light Loss Factors

Lamp Type	**Ambient Category**	**Cleaning Interval In Years**		
		1.25	**2.5**	**5**
Clear HPS (150-1000w)	1	0.71	0.70	0.69
	2	0.69	0.68	0.66
	4	0.66	0.64	0.61
	8	0.60	0.56	0.50
	16	0.48	0.43	0.32

7.8 Pavement Surface Classifications

The IES it has identified four pavement classifications which define the surface reflectance characteristics of common pavements.

Typically R-3 is representative of the most common pavement (asphaltic concrete) type used in Canada. Pavement reflectance is required for calculating Roadway Illuminance. Refer to the standards (RP-8-00) for definitions of roadway surface classifications.

7.9 Intersection Lighting

Increased lighting levels are required at intersections and mid-block crosswalks. Refer to Table 7.2 for details.

Table 7.2
Intersection Lighting Design Criteria

Illuminance Criteria - Class R-3 Road Surface					
Intersection Classification	Mid-Block Road Classification	Average Maintained Illumination At Pavement By Pedestrian Area Classification (Lux)			Uniformity (Eavg/Emin)
		High	Medium	Low	
Major	Major arterial	34	26	18	3:1
Primarily Major	Minor Arterial Downtown Commercial	29	22	15	3:1
Mixed	Primary Collector Hillside	25	19	13	3:1
Primarily Local	Neighbourhood Collector	21	16	10	4:1
Local	Local Industrial	18	14	8	6:1

7.10 Calculations

7.10.1 Lighting System

Lighting system design generally requires a computer model which uses RP-8 calculation methods. Examples of a suitable computer program are LUMEN MICRO and AGI32.

Manual calculations may be approved by the City Engineer for small, simple or rural systems.

7.10.2 Electrical Details

Design requirements include:

- Maximum voltage drop in branch feeders: 3%;
- Allow for possibility of future extensions circuits;
- Conductor sizes: maximum #6 RW90; minimum #10 RW90;
- Circuit load not to exceed 80% of feeder breaker rating;
- Use single pole breakers;
- Use VA load of the luminaire ballast; and
- Include loads for pole receptacle (300 W/receptacle) for tree lights and traffic signal controllers.

7.10.3 Submission Of Design Details

Calculation and design details are to be submitted to the City Engineer as follows:

- Completed designed summary sheet similar to Figure 7.2
- Design drawings to include summary table and circuit loading schedule showing the following information:
  - Roadway classification;
  - Lighting level (lux or cd/m^2);
  - Uniformly ratio (Avg/Min);
  - Luminaire and lamp details;
  - Phases;
  - Lighting load in VA;
  - Receptacle loads;
  - Tree light loads;
  - Main and branch breaker sizes; and
  - Number of luminaires on each circuit.

7.11 Poles

7.11.1 Type and Details

Poles higher than 9.0 m shall have pole shafts and davits separated with bolted flange connections. Poles 9.0 m or shorter are to be one piece.

Post-top poles, where approved, are to be 6.0 m, or 7.5 m high.

Pole Details are to be in accordance with Standard Drawings and Specifications and as follows:

- Octagonal, tapered, unpainted, galvanized steel;
- Where poles are to be coloured, they shall be galvanized first and then a powder coating process is to be used;
- Davits to be 2.5 m with 60 mm dia. x 180 mm tenon;
- Pole to have 100 mm x 175 mm handhole with cover plate, tamper-proof bolt, and backing bar; and
- Handhole to be located on the non-traffic side of pole

For rural roads, if approved by the City Engineer and the utility company, lights may be installed on power poles.

7.11.2 Locations

Poles are to be located at the outer edges, or in special circumstances, in the median of the roadway. Acceptable location patterns include staggered, opposite, and one side arrangements, depending on the roadway classification and system design details. Suitable pole arrangements are typically as follows:

- One Side: Local Roads; Bike and Walkways; and Urban Trails.
- Staggered: Collector Roads; and Major Roads.
- Opposite: Major Roads with Medians.

Maintain clearances from features and utilities as follows:

- 1.5 m: Pole to curb return or driveway let-down; and
- 3.0 m: Overhead electrical lines. Dimension varies with the voltage; refer to power company for details.

7.11.3 Offsets

Standard pole offsets for roadways with barrier curbs or other forms of protection of poles from vehicle traffic should be based on the clear zone requirements as set out in the Roads Section of this manual or as follows:

Road Configuration	Pole Centreline to Curb Face Offset
Width 14 m or more and sidewalk adjoining curb	0.5 m
Width 11 m or less and sidewalk adjoining curb	2.0 m
Sidewalk separated from curb	1.5 m

For roads without curbs or other barriers, use the clear zone requirements as set out in the Roads Section of this manual or use frangible pole bases.

7.12 Luminaires

Luminaires are to be energized at 120 volt only.

Luminaires are to have a minimum Ingress Protection Rating of 65.

Cobra head luminaires are to be full cutoff with distribution as follows:

Roadway	IES Distribution
Width less than 14 m	Type II
Width 14 m or greater	Type III
Cul-de-sacs	Type IV or V
Urban trails or walkways in treed areas	Type V

Ballasts are to be as follows:

- Constant Wattage Isolated Winding (CWI); and
- High Power Factor type.

7.13 Power Supply and Distribution

Roadway lighting systems are typically serviced from a 120/240 volt single phase 3 wire system.

Power is generally supplied by the power company through an unmetered service when servicing only streetlights and traffic signals. Where tree lights and pole receptacles are included, the power company may require a metered service.

Where new lighting systems are replacing existing lights on power poles, submit a list of the poles from which lights are to be removed.

Unmetered services are to have a maximum 60 Amp 2 or 3 Pole main breaker in a service base in accordance with MMCD standard detail drawings and specifications. A 100 amp service is required where a traffic signal is also being serviced.

Services are to be underground dip type.

Power distribution requirements include:

- Wiring to be installed in Rigid PVC conduit; minimum 53 MTD (metric trade designator);
- Wiring to be stranded copper with RW90 insulation;
- Wiring to be colour coded per BC Electrical Code (BCEC);
- Conduit burial depth to be per the CEC and MMCD standard drawings; and
- A 78 MTD conduit may be required for future communication needs; confirm with the local authority.

Figure 7.1
Design Criteria - Roadway Lighting

Roadway	Pedestrian Conflict Area	Maintained Luminance Criteria				Maintained Illuminance Criteria (R3 Pavement)				Small Target Visibility (Luminance)			
		Average	Uniformity Ratio (U/R)		Veiling Luminance (Lv)	Avg	Uniformity Ratio (U/R)		Veiling Luminance (Lv)	Weighted Average	Median <7.3m	Median ≥7.3m	Uniformity Ratio (U/R)
		cd/m²	Ave/Min (Max)	Max/Min (Max)	Lv max/ Lv avg	Lux	Ave/Min (Max)	Max/Min (Max)	Lv max/ Lv avg	Lv max/ Lv avg	Lav (cd/m²)	Lav (cd/m²)	Max/Min (Max)
Major	*H	1.2	3:1	5:1	0.3	17	3:1	4:1	0.3	4.9	1.0	0.8	6.0
	*M	0.9	3:1	5:1	0.3	13	3:1	6:1	0.3	4.0	0.8	0.7	6.0
	*L	0.6	3.5:1	6:1	0.3	9	3:1	6:1	0.3	3.2	0.6	0.6	6.0
Collector	*H	0.8	3:1	5:1	0.4	12	4:1	6:1	0.4	3.8	0.5	0.5	6.0
	*M	0.6	3.5:1	6:1	0.4	9	4:1	6:1	0.4	3.2	0.4	0.4	6.0
	*L	0.4	4:1	8:1	0.4	6	4:1	6:1	0.4	2.7	0.4	0.4	6.0
Locals	*H	0.6	6:1	10:1	0.4	9	6:1	6:1	0.4	2.7	0.4	0.4	10.0
	*M	0.5	6:1	10:1	0.4	7	6:1	12:1	0.4	2.2	0.3	0.3	10.0
	*L	0.3	6:1	10:1	0.4	4	6:1	12:1	0.4	1.6	0.3	0.3	10.0
Walkways Bikeways	*H**					20 10	4:1 4:1						
	*M					5	4:1						
	*L***					2 3 4	10:1 6:1 4:1						

* H,M and L designations refer to High, Medium and Low levels of potential vehicle/pedestrian conflict, See Roadway Classifications

** Upper number denotes Mixed Vehicle and Pedestrian (sidewalk adjacent to roadway).
Lower number denotes Pedestrian Only.

*** Upper number denotes Rural or Semi-Rural area.
Middle number denotes Low Density Residential.
Lower number denotes Medium Density Residential.

Figure 7.2
Lighting Design Summary Sheet

Project Name			Page___ of ___	
Contract No.	Lighting Reference Drawing(s)			
Consultant	Project Number		Date	
SPECIFIC ROAD DESCRIPTION	From (Station or Block)		To (Station or Block)	
LIGHTING REQUIREMENTS				
Roadway Classification				
Pedestrian Conflict Area				
Roadway Design Speed				
LIGHTING DESIGN CRITERIA	Level	Uniformity		Veiling Luminance
	L_{avg} (Lux or cd/m$^{2)}$	$E_{avg/min}$	$E_{min/max}$	Lv_{max}/L_{avg}
GENERAL CONFIGURATION				
Roadway Width (m)				
Median Width (m)				
Pole Offset of Classification (A,B,C)				
Pole Height (m)				
Pole Davit Length (m)				
Calculated Luminaire Mounting Height (m)				
Pole Arrangement				
Pole Cycle Distance				
LIGHTING CONFIGURATION				
Full Luminaire Description (with options)				
Complete Catalogue or Identification Number				
Photometric File Number				
Light Loss Factor				
Luminaire Tilt or spin (if applicable)				
Lamp Wattage			Type	
PREDICTED LIGHTING PERFORMANCE	Level (Lux or cd/m$^{2)}$	Uniformity		Veiling Luminance
	L_{avg}	$E_{avg/min}$	$E_{min/max}$	Lv_{max}/L_{avg}
ACTUAL LIGHTING PERFORMANCE (as measured in field at completion)	Level (Lux or cd/m$^{2)}$	Uniformity		Veiling Luminance
	L_{avg}	$E_{avg/min}$	$E_{min/max}$	$Lv_{max/Lavg}$
NOTES AND COMMENTS				