

LIGHT EMITTING DIODE (LED) LUMINAIRE SPECIFICATION

**Date of Issue: January 2016
Last Updated: September 2017**



Foreword

Alberta Transportation (TRANS) wishes to use LED luminaire technology for roadway illumination. This document is intended to provide criteria for qualifying LED lighting products in a manner independent of manufacturer or source. It will help ensure the taxpayers of Alberta are provided with a long lasting, safe, effective, efficient and financially beneficial asset. Although primarily focused on the range of LED products that would replace 150 – 400W HID lighting, the criteria listed in this document will also be applied to any and all LED lighting systems that may serve to replace the 500 – 1000W HID light sources.

TRANS is keenly aware of the evolutionary nature of LED lighting technology and reserves the sole right to adjust or alter this specification as new data becomes available or in the event of significant improvement to the core technologies. If a manufacturer can't meet these specifications fully but meets the specification substantially and wants to be considered, the manufacturer must state all aspects that do not comply and how any non-compliance is addressed. TRANS will assess whether the product will be considered for further review.

Abbreviations

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
CCT	Correlated Color Temperature
CRI	Color Rendering Index
CSA	Canadian Standard Association
DUT	Device Under Test
EPA	Effective Projected Area
IES	Illuminating Engineering Society
IESNA	Illuminating Engineering Society of North America
IP	Ingress Protection
LATF	Luminaire Ambient Temperature Factor
LDD	Lumen Dirt Depreciation
LED	Light Emitting Diode
LLD	Lamp Lumen Depreciation
LLF	Light Loss Factor
MTBF	Mean Time Between Failures
NVLAP	National Voluntary Laboratory Accreditation Program
SPD	Surge Protection Device
THD	Total Harmonic Distortion
TRANS	Alberta Transportation
UPD	Unit Power Density
YI	Yellowness Index

Referenced Documents and Standards Description

ANSI / IEEE C62.41.2-2002	American National Standard for Roadway and Area Lighting Equipment – Recommended Practice on Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits
ANSI C82.77-10-2014	American National Standard for Roadway and Area Lighting Equipment – Harmonic Emission Limits – Related Power Quality Requirements
ANSI C136.2-2015	American National Standard for Roadway and Area Lighting Equipment – Dielectric Withstand and Electrical Transient – Immunity Requirements
ANSI C136.15-2015	American National Standard for Roadway and Area Lighting Equipment – Luminaire Field Identification
ANSI C136.22-2004 (R2009, R2014)	American National Standard for Roadway and Area Lighting Equipment – Internal Labeling of Luminaires
ANSI C136.31-2010	American National Standard for Roadway and Area Lighting Equipment – Luminaire Vibration
ANSI C136.37 Clause 9.2e	American National Standard for Roadway and Area Lighting Equipment – Solid State Light Sources Used in Roadway and Area Lighting
ANSI C136.41	American National Standard for Roadway and Area Lighting Equipment – Dimming Control Between an External Locking Type Photocontrol and Ballast or Driver
ASTM B117-16	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D1654-08	Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D522	Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
ASTM E313-15e1	Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates

IES DG-4	IES Design Guide for Roadway Lighting Maintenance
IES LM-79	IES Electrical and Photometric Measurements of Solid-State Lighting Products
IESNA LM-80	IES Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules
IP54, IP66	Ingress Protection Rating
RP-8-14	IES Recommended Practice for Roadway Lighting
Telcordia SR-332	Reliability Prediction Procedure for Electronic Equipment
TM21	Lumen Degradation Lifetime Estimation Method for LED Light Sources

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1 General

- .1 Each LED luminaire shall be a complete assembly consisting of: housing, power supply, LED engine, and optical system.
- .2 The LED luminaire shall be certified to the Alberta Standard LEG-ECR-2 [Current]. All aspects of the LED luminaire shall facilitate electrical connections that comply with the Canadian Electrical Code.
- .3 The luminaire shall be a high reliability system with design features and components that provide for a minimum life expectancy of 80,000 operating hours (approximately 20 years) at +10° C external ambient temperature.
- .4 The luminaire unit and all its components shall be able to operate normally under expected conditions, such as:
 - Ambient temperature from -40° C to +40° C;
 - Winds up to 160 km/h;
 - Driving rain;
 - Snow and sleet; &
 - Fog.
- .5 The luminaire fixture must not exceed a maximum EPA of 0.2m² for davit, and 0.3m² for high mast.
- .6 The luminaire weight must not exceed 16.0 kg for davit mounted, and 30.0 kg for high mast.
- .7 Direct wiring into the luminaire must be possible to allow overhead wiring connections.
- .8 All internal screws and fasteners shall be plated or stainless steel, and external fastening hardware shall be stainless steel. Captive screws are required for any component that requires maintenance after installation. Thread locking compounds shall not be used.

2 Housing

2.1 General

- .1 LED luminaire housings shall be high-pressure injection die cast aluminum, or a combination of die cast and extruded aluminum, provided that all joints are water tight. Composite systems may be considered if technical documentation regarding heat sink efficacy is supplied and the luminaire conforms to all other specification requirements.
- .2 LED luminaires shall only have passive thermal management. Heat sink will be integral to the housing.
- .3 The LED luminaire and its mounting system shall meet ANSI C136.31 3G Vibration Rating.
- .4 Housing shall be CUL or CSA rated for wet locations.
- .5 LED luminaire design shall provide means to prevent wildlife intrusion as per ANSI C136.37, clause 9.2e.
- .6 Luminaire external markers for field identification of rated wattage and type shall be provided as per ANSI C136.15-2015 at the time of purchase. Luminaire housing must allow for permanent affixing of external labels that are visible from the ground when the luminaire is mounted on a standard pole and arm.
- .7 Luminaire housing must allow for a readily visible label to be permanently affixed to the inside surface of luminaire housing. The label shall conform to ANSI C136.22-2004 (R2009, R2014) and include product information as requested at the time of purchase.

2.2 Mounting

- .1 LED luminaire shall mount to a 60mm diam (2-3/8") X 180mm long tenon.
- .2 Mounting shall have tilt-adjustability of +/- 5 degrees. If a stair-step type leveling is provided,

the adjustment increment shall not be more than 2.5 degrees.

2.3 Finishes

- .1 All roadway lighting poles shall be hot dip galvanized in accordance with CSA standard G164-M.
- .2 If powder coating is used due to aesthetic requirement, powder coating shall be tested in accordance with ASTM D522 for adhesion bend tests.
- .3 The product shall be free from wrinkles, orange peel, cracking, pinholes, fish eyes, blisters, etc. as verified by visual inspection under the manufacturer's QC program.
- .4 The manufacturer shall undertake salt/fog tests for the entire luminaire. Salt/fog testing shall be performed in compliance with the ASTM B117 standard, which defines the Standard Practice for Operating Salt Spray (Fog) Apparatus. Results in accordance with rating system in ASTM D1654-08 shall yield a rating of #5 or better at 1000 hours.

3 Power Supply/Driver

3.1 General

- .1 The driver shall be mounted internal to the housing with a quick disconnect and be easily replaceable.
- .2 The driver compartment must be rated for wet locations; it shall be either a minimum IP66 compartment or a minimum IP54 compartment with IP66 rated components.
- .3 MTBF analysis for the power supply/driver shall be undertaken in accordance with the Telcordia SR-332 at 20° C ambient temperature. MTBF shall not be less than 1.5 million hours for the operating/maximum currents of the specific LED luminaire.

3.2 Input Connections

- .1 Terminal blocks shall use either high spring tension push-in spring cage terminals or clamp type screw terminals to connect the power supply to the light engines and to the pole wiring.
- .2 The LED luminaire shall be designed with a terminal block for wiring connections to accept #14 to #8 AWG conductors and a separate bonding conductor tab.

3.3 Input Characteristics

- .1 The luminaire shall have drivers available for 120-277V, 347V and 480V systems.
- .2 The driver and related components shall operate normally for input voltage fluctuations of +/- 15%.
- .3 Luminaire shall contain a separate, easily accessible and replaceable surge protection device (SPD) compliant with ANSI/IEEE C62.41.2-2002 Rating Category C-High operation.
- .4 Luminaire and control devices under test (DUT) shall comply with ANSI C136.2-2015 dielectric withstand and electrical transient immunity requirements in the "Extreme" category.

3.4 Performance

- .1 The power supply shall operate at 0.9 power factor or better.
- .2 The power supply shall have a maximum Total Harmonic Distortion (THD) of 10% at full input power and across specified voltage range and shall conform to ANSI C82.77-10-2014.
- .3 The power supply shall operate at > 120Hz output frequency to avoid luminaire strobing effects.

3.5 Controls

- .1 LED luminaires shall provide for ANSI C136.41 standard 7 pin contact polarized twist-lock receptacle wired for future adaptive controls, and a shorting cap. Socket shall be free to reorient

the geographic directional orientation without the use of tools.

- .2 Drivers / Power Supplies shall have 0-10V dimming capability and shall be accessible via 7 pin receptacle external connector and shorting cap. Driver dimming curves must be supplied for all drivers used. Adjustability must provide for 20% - 100% luminous output control.

4 LED Engine

- .1 Luminaire output shall be at a correlated color temperature (CCT) of 4000 Kelvin (K) +/- 300 K.
- .2 Luminaire shall have a minimum color rendering index (CRI) of 70.
- .3 Failure of any individual LEDs must not impact the operation of the rest.
- .4 The LED Engine Compartment shall have an ingress protection rating of IP66 or better.
- .5 The Light Loss Factor (LLF) will be calculated as $LLF = LLD \times LDD \times LATF$, and
 - .a Lamp Lumen Depreciation (LLD) shall be supplied by the manufacturer and be based on the percentage of initial output after 80,000 operating hours calculated in accordance with IESNA LM-80 and TM-21 and verified by an NVLAP accredited lab. Extrapolations for prediction of performance beyond the test duration are limited to 6 (six) times the test duration. The TM-21 extrapolation can be obtained from a 6000 hour or longer duration test with data collection at a minimum of every 1000 hours. For data sets of test duration from 6000 hours up to 10000 hours, the data used for the curve fits shall be the last 5000 hours of data. For data longer than 10000 hours in duration, the data for the last 50% of the total duration shall be used. LM-80 and TM-21 results shall be provided in PDF and excel format.
 - .b Luminaire Dirt Depreciation (LDD) = 0.90, as per IES DG-4 for an enclosed and gasketed roadway luminaire installed in an environment with less than $150 \mu\text{g}/\text{m}^3$ airborne particulate matter and cleaned every 5 years.
 - .c Luminaire Ambient Temperature Factor (LATF) at +10° C ambient temperature shall be provided by the manufacturer.

5 Optical System

5.1 General

- .1 The optical system shall have an ingress protection rating of IP66 or better.
- .2 Any plastic materials used in the optical assembly that affects the light output and distribution shall be appropriately heat and UV resistant. Plastic materials shall have been evaluated and shall exhibit a Yellowness Index (YI), based on ASTM E313, over the useful life of the product of no more than 30%.

5.2 Lighting Distribution

- .1 Light distribution patterns provided by the manufacturers shall be equivalent to IES light distribution classifications type 2 and type 3 for davit style luminaires and type 3, 4 and type 5 equivalents for high mast style luminaires. Additional distribution pattern may be provided.
- .2 High mast optics shall be rotatable. If step type rotation is provided, then adjustment increment shall accommodate all multiples of both 30 and 45 degrees.
- .3 The LED luminaires shall have lowest possible "B" (backlight) "U" (uplight), and "G" (glare) ratings.

The maximum allowable levels shall be as per the table below.

Total Luminaire Lumens	"B" Rating	"U" Rating	"G" Rating
Up to 20,000	≤ 3	0	≤ 3
20,000 to 35,000	≤ 3	0	≤ 4

6 Additional Evaluation Criteria

- .1 The LED luminaire should have a provision for factory or field installed house-side shield to reduce light trespass.
- .2 The LED luminaire should be designed to promote run-off and deter the build-up of debris.
- .3 The LED luminaire should be designed to minimize wind noise.
- .4 The LED luminaire should be designed to minimize ice buildup and icicle formation.
- .5 Tool-less entry into the housing is preferred.
- .6 Communication and control options should be available for individual and/or group luminaire control.

*These criteria are not mandatory.

7 Quality Control and Assurance

- .1 The manufacturer shall follow an industry accepted quality management system and provide proof of certification.
- .2 Product return rates for all LED luminaire products manufactured by the LED luminaire manufacturer (as a representation of failures) over the immediately previous 3 year period shall also be provided by the supplier in a letter. Product return rates shall be the number of units returned annually due to failure defined as a percentage of the total units supplied in the corresponding sales year.
- .3 Suppliers are requested to provide details of at least one failure experienced within the previous 36 months, how it was resolved and what value the failure brings to existing products and services.

APPENDIX A

PHOTOMETRIC DATA AND ILLUMINATION ANALYSIS

The manufacturer shall provide illumination analysis for each product based on typical TRANS roadway and intersection layouts as provided in this section. The manufacturer shall provide supporting IES files and other data as indicated below.

A1 Photometric Files

- .1 The photometric file (IES file) for the subject LED luminaire must be developed by a non-proprietary independent photometric testing NVLAP certified laboratory.
- .2 All photometric files must be absolute photometric files in accordance with IES LM-79 (for each LED luminaire type) for wattage, operating current and photometric distribution. These files must be included in the submission to TRANS.

A2 AGI Modelling

- .1 For each product that the manufacturer wants evaluated, the manufacturer shall use the attached roadway profiles to conduct lighting calculations for illumination of each example scenario as per the Lighting Requirements of Design Bulletin 35. All poles in the calculation shall have 2.5m davit arms and shall be offset (pole offset) from the edge of the travel lane by the distance noted in Table 1.
 - a. For roadway illumination, provide calculation tables for road types of freeways, expressways and arterials, at “low” pedestrian conflict levels, presented in a similar format as Table 1. All calculations for straight sections of highway must cover a road length of 5 pole spaces.
 - b. For intersection illumination, provide calculation tables for intersection types of expressway-expressway, expressway-arterial, expressway-local, at “low” and “medium” pedestrian conflict levels, presented in a similar format as Table 2. Calculations for intersections must extend to the furthest points of the 18m radius curves.
- .2 All calculations shall be performed using AGI32 software. Calculations performed with lighting calculation software other than AGI32 will not be accepted. Provide calculations in both PDF and AGI file format.
- .3 Each submitted calculation shall be clearly labeled with reference to the roadway type, luminaire, and pedestrian conflict level.
- .4 Calculations shall include AGI tables for result summaries, as well as luminaire schedules and luminaire locations.
- .5 Alberta Highway Lighting Guide and TAC Guide for the Design of Roadway Lighting should be used as a source for lighting design parameters and a guide for lighting levels requirements.
- .6 Provide .IES photometric files for each luminaire used in AGI modelling.
- .7 Provide Unit Power Density (UPD) calculation in AGI modelling.
- .8 Any assumptions made during the design shall be clearly stated in order to facilitate comparisons.

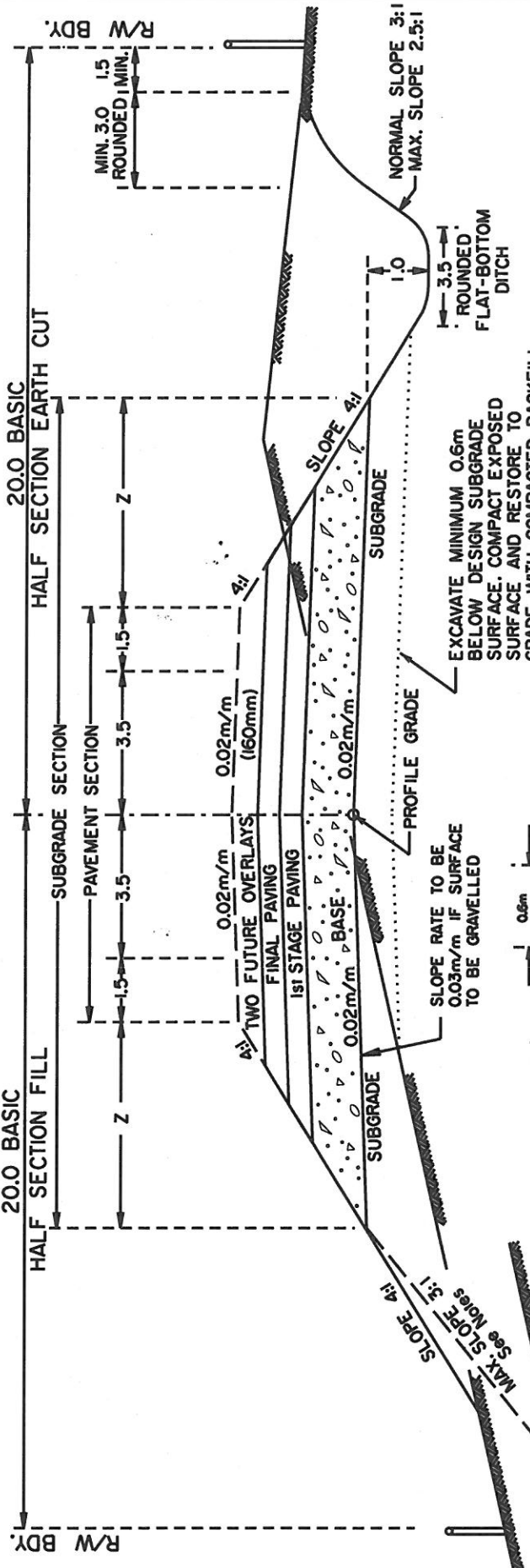
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Table 1 Design Values for Roadway and Interchange Lighting


AT Roadway Reference Drawing	No. of Lanes	Road Width (m)	Design Speed (km/h)	Pole Offset (m)	Pole Height (m)	Layout	Average Levels	Uniformity (Ave/Min)	Uniformity (Max/Min)	Lv Ratio ($L_{ave}/L_{v_{max}}$)
RAU 418.8-090	4	18.8	90	5.0	13	Staggered				
RAU 418.8-090	4	18.8	90	5.0	15	Staggered				
RAU 210-110	2	10	90	5.0	13	Staggered				
RAU 210-110	2	10	110	5.0	15	Staggered				
RAU 210-110	2	10	110	5.0	13	Single-Sided				
RAU 210-110	2	10	110	5.0	15	Single-Sided				

Table 2 Design Values for Full Intersection Lighting

AT Roadway Reference Drawing	Pole Offset (m)	Pole Height (m)	Layout	Average Levels	Uniformity (Ave/Min)	Uniformity (Max/Min)	Lv Ratio ($L_{ave}/L_{v_{max}}$)
CB6-2.3C33B	5.0m	15m	N/A				N/A

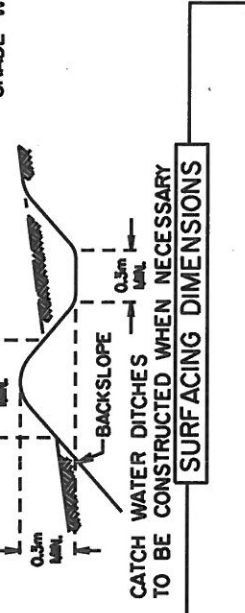


No.	REVISIONS	BY	DATE
A			
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 Date: MARCH 2014

Pavement Layout for Lighting Designs RAU-210-110

Prepared By: S.L.	Checked By: B.K.	Scale: N.T.S.
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EARTH CUT SECTION

FILL SECTION

- 4:1 SLOPES FOR AVERAGE FILLS LESS THAN 4.0m.
- 4:1 SLOPES CAN BE USED ON SHORT SECTIONS OF HIGHWAY FILL UP TO 14m IN HEIGHT (TO ELIMINATE THE NEED FOR GUARDRAIL), PROVIDING THERE ARE NO OBSTRUCTIONS WITHIN OR NEAR THE RIGHT-OF-WAY LIMITS.
- 3:1 SLOPES OR 2:1 SLOPES MAY BE USED UPON APPROVAL IN AREAS WHERE GUARDRAIL IS TO BE INSTALLED.
- THE CHOICE BETWEEN 4:1 SLOPE AND GUARDRAIL INSTALLATION ON HIGH EMBANKMENTS IS GENERALLY MADE BASED ON LIFE-CYCLE COST-EFFECTIVENESS.
- 3:1 SLOPES ARE TO BE USED ON ALL FILLS ADJACENT TO DRAINAGE STRUCTURES OVER 1200mm IN DIAMETER, CATTLE PASSES, OPEN WATER, ETC. WHERE GUARDRAIL INSTALLATION IS NECESSARY FOR HIGHWAY SAFETY.
- TRANSITION BETWEEN SLOPES SHALL BE ATTAINED BY USING UNIFORMLY VARYING SLOPES. GENERALLY THE MINIMUM LENGTH OF TRANSITION SHALL NOT BE LESS THAN 30m.
- BERM ALSO TO BE CONSTRUCTED ADJACENT TO OPEN WATER.

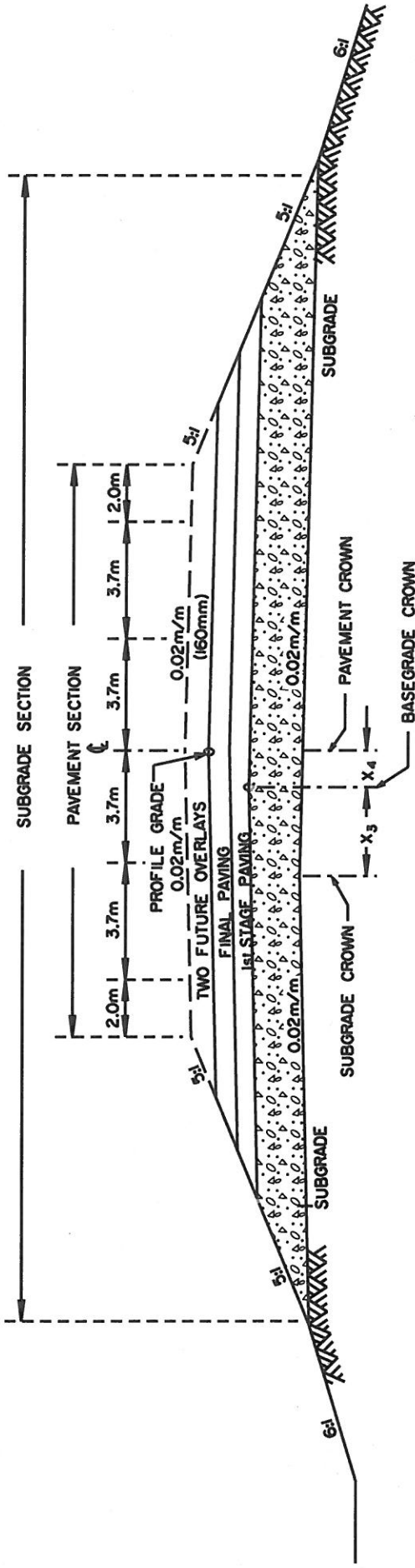
SLOPE 3:1
MAX SLOPE 3:1
 See Notes

SLOPE RATE TO BE 0.03m/m IF SURFACE TO BE GRAVELLED

EXCAVATE MINIMUM 0.6m BELOW DESIGN SUBGRADE SURFACE. COMPACT EXPOSED SURFACE AND RESTORE TO GRADE WITH COMPACTED BACKFILL.

3.5 ROUNDED 1.0 FLAT-BOTTOM DITCH

NORMAL SLOPE 3:1 MAX. SLOPE 2.5:1




NOTES:

- THE PROFILE GRADE IS ON THE CENTRELINE OF THE FINISHED TRAVEL LANES.
- SUPERELEVATION IS NORMALLY ATTAINED BY ROTATING INDIVIDUAL ROADWAYS ABOUT THE CENTRELINE OF TRAVEL LANES.

SUBGRADE AND SURFACING DIMENSIONS

A_1, A_2 = THICKNESS OF ACP (1st STAGE + FINAL STAGE PAVING)
 B_1, B_2 = THICKNESS OF BASE
 $T_1 = A_1 + B_1, T_2 = A_2 + B_2$
 P_1, P_2 = THICKNESS OF FIRST STAGE PAVING

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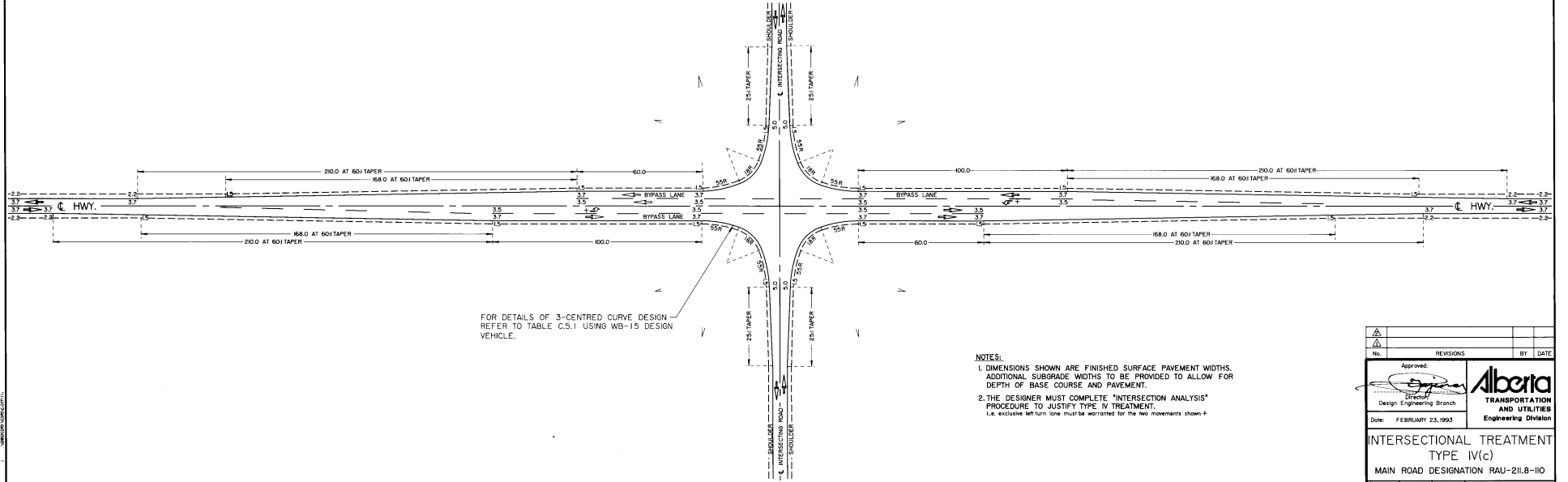

 Alberta
 Transportation

Date: MARCH 2014

Pavement Layout for Lighting Designs
RAU-418.8-90

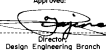
Prepared By: S.L.	Checked By: BK	Scale: N.T.S.
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INTERSECTION TREATMENT TYPE IV(c)
(TWO-LANE HIGHWAY)



FOR DETAILS OF 3-CENTRED CURVE DESIGN REFER TO TABLE C.5.1 USING WB-15 DESIGN VEHICLE.

- NOTES:
1. DIMENSIONS SHOWN ARE FINISHED SURFACE PAVEMENT WIDTHS. ADDITIONAL SUBGRADE WIDTHS TO BE PROVIDED TO ALLOW FOR DEPTH OF BASE COURSE AND PAVEMENT.
 2. THE DESIGNER MUST COMPLETE "INTERSECTION ANALYSIS" PROCEDURE TO JUSTIFY TYPE IV TREATMENT.
I.E. exclusive left turn lane must be warranted for the two movements shown +

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No.	REVISIONS	BY	DATE
Approved:  Design Engineering Branch			
Date: FEBRUARY 23, 1993			
INTERSECTIONAL TREATMENT TYPE IV(c)		TRANSPORTATION AND UTILITIES Engineering Division	
MAIN ROAD DESIGNATION RAU-211.8-110			
Prepared By: GJK	Checked By: GJK	Scale 1:1.5	Dwg No.: CS6-2.3C338

APPENDIX B

SPECIFICATION AND SUPPORTING DOCUMENTATION REQUIREMENTS CHECKLIST

Specification Reference	Description	Supporting Document required	Compliance ¹	Notes/Product Value
General				
1. Sec 1	Assembly	Product Spec Sheet		
1. Sec 2	Alberta Standata	CSA/UL Certification		
1. Sec 3	Operating Hours	Product Spec Sheet Manufacturer's estimation of rated life		
1. Sec 4	Performance – general	Product Spec Sheet		
1. Sec 5	EPA	Product Spec Sheet Provide EPA Value (m ²)		
1. Sec 6	Weight	Product Spec Sheet Provide Weight (kg)		
1. Sec 7	Direct OH Wiring	Provide Instructions for overhead wiring		
1. Sec 8	Fasteners: internal & external	Product Spec Sheet		
Housing				
2.1 Sec 1	Housing Material	Provide material grade specification (die-cast and/or extruded aluminum)		
		If composite materials; provide materials specification and heat sink details		
2.1 Sec 2	Heat Sink and Passive thermal management	Product Spec Sheet		

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2.1 Sec 3	Vibration Rating	Product Spec Sheet Provide Vibration Rating Value		
2.1 Sec 4	Wet location rating	Product Spec Sheet Provide Rating		
2.1 Sec 5	Wildlife/bird intrusion prevention	Product Spec Sheet Provide Installation Instructions		
2.1 Sec 6	External Markings	Product Spec Sheet Provide Label Details		
2.1 Sec 7	Internal Labeling	Product Spec Sheet Provide Label Details		
2.2 Sec 1	Pole/tenon Mounting	Product Spec Sheet Provide installation instructions		
2.2 Sec 2	Tilt-adjustability	Product Spec Sheet Provide installation instructions		
2.3 Sec 1	Standard Finish	Product Spec Sheet		
2.3 Sec 2	Powder Coating ²	Product Spec Sheet Provide test report		
2.3 Sec 3	Finish QA/QC	N/A		
2.3 Sec 4	Salt/Fog Test	Provide Test Report with rating		
Power Supply/Driver				
3.1 Sec 1	Driver install/replacement	Driver Specification Provide driver replacement instructions		
3.1 Sec 2	Driver Ingress Protection Rating	Provide IP ratings for driver compartment; and components (if required)		

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3.1 Sec 3	Driver Reliability MTBF hours	Manufacturer's estimation of rated life Provide MTBF test report with: case temperature, driver current and meantime between failure information		
3.2 sec 1	Terminal Block	Product Spec Sheet Wiring instructions		
3.2 Sec 2	Wire sizes – terminal block	Product Spec Sheet Wiring instructions		
3.3 Sec 1	Voltage Input - rated	Product Spec Sheet		
3.3 Sec 2	Voltage Input - Variability	Product Spec Sheet		
3.3 Sec 3	Surge Protection Device	SPD Specification & test compliance SPD replacement instruction		
3.3 Sec 4	Dielectric Withstand & Transient Immunity	Product Specification Test Report		
3.4 Sec 1	Power factor	Product Specification Provide minimum PF value		
3.4 Sec 2	Harmonic Distortion	Product Specification Provide THD %		
3.4 Sec 3	Supply output frequency	Product specification Provide output frequency value		
3.5 Sec 1	Twist lock receptacle for photoelectric control	Product Specification Installation Instructions		
3.5 Sec 2	Dimming control	Product specifications Provide instructions to implement dimming control (local/remote) Provide Min to Max (%) output		

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LED Engine				
4 sec 1	Correlated Color Temperature (CCT)	Product specifications Provide IESNA LM-79 report		
4 Sec 2	Color Rendering Index	Product Specification		
4 Sec 3	LED component failure	NA		
4 Sec 4	Ingress Protection	Provide IP rating for Light Engine Compartment		
4 Sec 5	Light Loss factor	<ul style="list-style-type: none"> • Provide LLD Value, in accordance with LM-80 and TM-21 • LDD = 0.90 per DG-4 • Provide LATF Value • Provide Calculated LLF Value 		
Optical System				
5.1 Sec 1	Ingress Protection	Provide IP rating of optical system		
5.1 Sec 2	Yellowness Index (YI)	Provide material spec and YI over useful life		
5.2 Sec 1	Light Distribution Classification (Type)	Product Specification		
5.2 Sec 2	Highmast Rotatable options	Product Specification Highmast installation instructions		
5.2 Sec 3	BUG Rating	Product Specification		
Additional Evaluation Criteria ³				
6 Sec 1	House side shield (HSS)	Product Specification HSS Installation Instruction		

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6 Sec 2	Luminaire Design	Product Specification Provide a brief description of how the design promotes run-off to deter debris build up		
6 sec 3		Product Specification Provide a brief description of how the design minimizes wind noise		
6 Sec 4		Product Specification Provide a brief description of how the design minimizes icicle formation		
6 Sec 5		Product Specification Provide a brief description of how access to the internal parts can be achieved in the field		
6 Sec 6	Communication and Control Options	<ul style="list-style-type: none"> • Product Specification • Provide a brief description of how the luminaires can be added to a central control/monitoring system • Provide information re. other highlight product features 		
Quality Control and Assurance				
7 Sec 1	Industry Accepted QMS	Provide QMS Certification		
7 Sec 2	Product return rate	Letter providing product return rate information from previous 3 years		
7 Sec 3	Experience from failure ³	Provide letter describing a failure in previous 3 years, how it was resolved and how it improved products		

APPENDIX B

Photometric Data and Illumination Analysis [Appendix A]				
A1	Lab Certification	Provide NVLAP certification		
	Absolute Photometrics	Provide LM-79 reports		
A2	Illumination Design	All example scenarios provided		
	Submissions	Provide outputs in AGi and PDF		
	Summary Tables	Include Summary Tables in Submissions		
	Lighting Design Criteria	Results meet or exceed requirements		
	Unit Power Density	Provide results in AGi and PDF reports		
	Assumptions	Provide a list of assumption made		
Warranty				
	Warranty Terms	Provide warranty information and claim process		

1. Y – yes; N – no: explain in notes; NA – Not applicable: explain in notes
2. Required only if luminaire housing is powder coated
3. This criteria is not mandatory but will help determine product suitability and will be considered during evaluation