SPECIFICATION FOR ROAD LIGHTING INSTALLATION (L-S20)

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CAWANGAN KEJURUTERAAN ELEKTRIK

RINGKASAN				
No	Pindaan kpd Dokumen Utama	Tarikh	Catatan	Pengerusi J/K Penggubal
1	Baru (1)	Aug 1999	Spesifikasi Asal.	-
2	2	Feb 2013	Tambahan: Addendum No.1 revision 1 to L-S20 Specification for Road Lighting installation (August 1999)	Noorfadzilah bt Ramlee, BPRE
3		Feb 2015	Tambahan: Addendum No.2 to L-S20 Specification for Road Lighting installation (August 1999)	Noorfadzilah bt Ramlee, BPRE
4	3	Oct 2020	Tambahan: Addendum No.3 to L-S20 Specification for Road Lighting installation (August 1999) Integrated Solar LED Road Lighting System	Ir. Nooraini bt Ibrahim, JEPK UPBS
5	Revision 1: Addendum No.3	Aug 2022	Pindaan: Addendum No.3 to L-S20 Specification for Road Lighting installation (August 1999) Integrated Solar LED Road Lighting System	Ir. Nooraini bt Ibrahim, JEPK UPBS
6	Revision 4	June 2024	Pindaan: Section 1 & Section 2, L-S20 Specification for Road Lighting installation (August 1999)	Ir. Nooraini bt Ibrahim, JEPK UPBS

Nota Ringkasan bagi kemaskini Specification for Road Lighting Installation (August 1999), Revision 4 2024 adalah seperti dalam jadual di bawah:

Section	L-S20 Aug 1999	L-S20 June 2024	Ringkasan Kemaskini
1	General	General	**Telah kemaskini**
2	Road Lighting Luminaires	Road Lighting Luminaires	Addendum 1,2 & 3 telah dimasukkan sekali dan **telah dikemaskini**
3	Photometric Data	Lighting Columns	i. Photometric data telah dimasukkan dalam Section 2 ii. Section 8: Columns and Brackets telah dijadikan Section 3 dengan pindaan tajuk
4	Sample of Luminaire	Outdoor Weatherproof Feeder Pillars (Masih mengekalkan kandungan asal - sedang dikemaskini)	i. Sample of Luminaire telah dikeluarkan ii. Section 7: Outdoor Weatherproof Feeder Pillars telah dijadikan Section 4
5	Schedule and Technical Information on Luminaires	Cables And Ducts (Masih mengekalkan kandungan asal - sedang dikemaskini)	i. Schedule and Technical Information on Luminaires telah dimasukkan dalam Section 2 dan dirujuk sebagai Appendix ii. Section 9: Cables And Ducts telah dijadikan Section 5
6	Projects Based on The 'Turnkey','Design and Build' or 'Build-Operate-Transfer' (BOT) Approach	Shop Drawings (Masih mengekalkan kandungan asal - sedang dikemaskini)	i. Projects Based on The 'Turnkey','Design and Build' or 'Build-Operate-Transfer' (BOT) Approach telah dikeluarkan ii. Section 10: Shop Drawings telah dijadikan Section 6
7	Outdoor Weatherproof Feeder Pillars	Construction Requirements (Masih mengekalkan kandungan asal - sedang dikemaskini)	i. Outdoor Weatherproof Feeder Pillars dijadikan Section 4 dan **sedang dikemaskini** ii. Section 11: Construction Requirements telah dijadikan Section 7

Section	L-S20 Aug 1999	L-S20 June 2024	Ringkasan Kemaskini
8	Columns and Brackets	Testing And Test Certificates (Masih mengekalkan kandungan asal - sedang dikemaskini)	i. Columns and Brackets telah dijadikan Section 3 dengan pindaan tajuk dan **sedang dikemaskini** ii. Section 12: Testing And Test Certificates telah dijadikan Section 8
9	Cables and Ducts	Service And Maintenance (Masih mengekalkan kandungan asal - sedang dikemaskini)	i. Cables and Ducts telah dijadikan Section 5 dan **sedang dikemaskini** ii. Section 13: Service And Maintenance telah dijadikan Section 9
10	Shop Drawings	As-Installed Drawings, Manuals and Tools (Masih mengekalkan kandungan asal - sedang dikemaskini)	i. Shop Drawings telah dijadikan Section 6 dan **sedang dikemaskini** ii. Section 14: As-Installed Drawings, Manuals and Tools telah dijadikan Section 10
11	Construction Requirement	Appendices	i. Construction Requirement telah dijadikan Section 7 dan **sedang dikemaskini** ii. Appendices telah dijadikan Section 11
12	Testing And Test Certificates	-	Testing And Test Certificates telah dijadikan Section 8 dan **sedang dikemaskini**
13	Service and Maintenance	-	Service and maintenance telah dijadikan Section 9 dan **sedang dikemaskini**
14	As-Installed Drawings, Manuals and Tools	-	Service and Maintenance telah dijadikan Section 10 dan **sedang dikemaskini**

SECTION	CONTENT	PAGE

1.0 GENERAL

1.1 SCOPE

1.1.1 This section of the Specification describes and specifies requirements for the supply, delivery, installation, testing, commissioning, and handing over in approved working order and maintenance during the Defects Liability Period of the Road Lighting Installation in accordance with the Conditions of Contracts, Bill of Quantities, Drawings, Specification, etc.

1.1.2 All equipment, switchgears, apparatus and accessories for Road Lighting Installation shall comply with Malaysia Standards (MS), International Electrotechnical Commission (IEC), British Standard (BS) and the latest relevant standards.

1.2 TECHNICAL PARTICULARS

1.2.1 Tenderers shall submit at the time of tendering all catalogues, detailed technical particulars and guarantees in respect of the equipment offered, which shall be binding. No departure from these technical particulars and guarantees shall be permitted except with the written approval of the Superintendent Officer (S.O) and/or S.O's Representative.

1.3 GUARANTEES

1.3.1 The tenderers shall guarantee all equipment to be supplied under this contract against faulty design, materials and workmanship at the manufacturer's works within the Defect Liability Period (DLP).

1.4 ELECTRICAL SYSTEM

1.4.1 All equipment shall be rated for operation on a 230/400 V within the tolerance +10%, -6% as defined in MS IEC 60038. The Low Voltage (LV) System shall be 3 phase, 4 wire, 50 Hz system with solidly earthed neutral.

1.4.2 The system voltage for integrated solar LED road lighting system shall be either a 12 VDC or 24 VDC.

2.0 ROAD LIGHTING LUMINAIRES

2.1 GENERAL CONSTRUCTION OF ROAD LIGHTING LUMINAIRES

2.1.1 The road lighting luminaires shall be as specified in the bill of quantity and/or drawings and shall be of the following types:

2.1.1.1 Light Emitting Diode (LED)
2.1.1.2 Integrated Solar LED
2.1.1.3 High Pressure Sodium Vapour (HPSV)

2.1.2 The luminaire shall be complete with integral control gears as a unit and shall be designed for both side entry or post top mounting and suitable for use with HPSV tubular lamp or LED light source.

2.1.3 All components shall be suitable for continuous operation at an ambient temperature of 25 °C ± 1 °C and relative humidity of 93% ± 2%.

2.1.4 Tenderers are required to furnish comprehensive information and technical particulars as stipulated in Appendix A1 - Technical Schedule of LED Road Lighting Luminaire, Appendix B1 - Technical Schedule of Integrated Solar LED Road Lighting Luminaire and Appendix C - Technical Schedule of HPSV Road Lighting Luminaire.

2.1.5 The information required in Appendix A1, Appendix B1 and Appendix C shall be fully and correctly completed. All technical data entered therein shall be substantiated with relevant catalogues and technical data sheet from the manufacturers.

2.1.6 Computer simulation for lighting level calculation shall be prepared and submitted to meet the design criteria and lighting class required as per Appendix D - Submission of Lighting Simulation in accordance with MS 825: Code of Practice for the Design of Road Lighting. The simulation shall be generated using internationally recognised design software e.g. Dialux, Calculux, Ulysse etc.

2.1.7 The main supporting structure of the luminaire shall be constructed from die-cast or deep drawn or extrusion aluminium alloy material such that no undue deterioration in its safety, performance or appearance during normal life when operating in Malaysia's tropical climate. It shall be robustly constructed to withstand vibration in normal use.

2.1.8 The luminaire shall be designed so that condensation shall not fall on any operating part which may fail or deteriorate the performance of luminaire.

2.1.9 Hinges and clips of the top housing cover if used, shall be robust and preferably made of stainless steel. They shall be simple to operate and not be liable to accidental detachment during installation or maintenance.

2.1.10 Material used for the construction of the luminaire shall be recyclable. Glass reinforced polyester (GRP) or fibreglass reinforced polyester (FRP) material is not acceptable.

2.1.11 Attachment of the luminaire to its bracket arm shall be by means of clamps or jam bolts and designed to accommodate spigot sizes. A minimum of 2 (two) locking bolts or jam screws shall be provided. The specifications of the bracket arm shall be as shown in Table 1.

Table 1 - Size of Bracket, Diameter for Side Entry / Post Mounted and Depth of Penetration for HPSV and LED Luminaires

Rating of Lamp (W)	Diameter of Bracket (mm)	Diameter for Side Entry / Post Mounted (mm)	Minimum Depth of Penetration (mm)
≤ 300	50	40 - 80	100
> 300	50	40 - 80	110

2.1.12 The mounting arrangement and attachment of the luminaire shall withstand a windspeed of 42 meter per second (m/s) on the projected surface of the assembly without due deflection.

2.1.13 All components which carry the weight of the luminaire and internal accessories shall be provided with suitable locking devices to prevent the dislodgement of any part of the luminaire by vibration either in service or during maintenance.

2.1.14 A separate terminal for the connection of circuit protective conductor, clearly and permanently marked shall be provided. All exposed metal parts and other parts accessible when the luminaire is opened for maintenance and liable to become live in the event of an insulation fault shall be permanently and reliably connected to this earth terminal.

2.1.15 HPSV and LED Luminaires shall have product certification from accredited certification bodies.

2.2 LIGHT EMITTING DIODE (LED) ROAD LIGHTING LUMINAIRE

2.2.1 CONSTRUCTION AND COMPONENTS

2.2.1.1 The luminaires shall comply with MS IEC 60598-1 or IEC 60598-1, MS IEC 60598-2-3 or IEC 60598-2-3, MS IEC 62722-2-1 or IEC 62722-2-1 and IES LM-79 or CIE S 025.

2.2.1.2 LED luminaire shall be complete with LED light source, electronic control gear (LED driver), surge protective device (SPD) and thermal management unit. It shall be rated at 100 W, 120 W, 150 W, 180 W, 200 W, 240 W or 280 W. Harmonic distortion shall be within the limits in accordance with MS IEC 61000-3-2. However, total harmonic distortion shall be less than or equal to 20%.

2.2.1.3 The luminaires shall be designed and constructed to be capable of providing the required lighting performance. It shall enable ease of maintenance and replacement of light source, optical lens, electronic control gear (LED driver), thermal management unit, reflector and holder without the use of special tools.

2.2.1.4 All luminaires shall be new, totally enclosed and protected against contact with live or moving parts inside the enclosure. The degree of protection (IP Code) of LED luminaire shall be of minimum IP65 and comply with MS IEC 60529 or IEC 60529.

2.2.1.5 The compartment for electronic control gear (LED driver) and LED light source shall preferably be separated. Access to the electronic control gear (LED driver) compartment shall be preferably from the top. In the open position, it shall be attached in such a way that there is no likelihood of it becoming accidentally detached and thereby damaging any part of the luminaire, the bracket or the lighting column.

2.2.2 LED LIGHT SOURCE

2.2.2.1 The LED shall not be driven more than the rated LED drive current.

2.2.2.2 The lumen output or system efficacy of LED luminaires shall be of minimum 110 lm/W.

2.2.2.3 The usable lifetime or lumen maintenance of LED at 50,000 hours shall not be less than 70% (L_{70} @ 50,000 hours).

2.2.2.4 The Correlated Colour Temperature (CCT), T_{CP} for LED luminaire shall range between 2500 K ± 175 K to 3500 K with ± 175 K.

2.2.2.5 The photobiological safety class of LED luminaires or LED module shall be of Exempt Group or Risk Group 1 as per MS IEC 62471 or IEC 62471.

2.2.3 THE OPTICAL SYSTEM

2.2.3.1 The optical system shall comprise of optical lens, reflector (if any) and luminaire cover.

2.2.3.2 The optical lens shall be made of ultraviolet (UV) resistant material such as polymethyl methacrylate (PMMA), UV stabilized polycarbonate, silicon, etc. and shall be stabilised against deformation, deterioration or discolouration due to the LED light source and/or solar radiation.

2.2.3.3 The reflector (if any) shall be made of high purity anodised aluminium with at least 99.85% pure aluminium. The minimum thickness of the reflector shall be 1.0 mm.

2.2.3.4 The gasket shall be preferably of silicone and one piece weather resistant type that would not cause crazing of the luminaire cover. The gasket shall form an integral part of the luminaire cover such that any cover change will necessitate a change of the gasket.

2.2.4 THERMAL MANAGEMENT UNIT

2.2.4.1 The luminaire shall be provided with suitable thermal management unit to effectively dissipate heat generated from LED light source.

2.2.5 ELECTRONIC CONTROL GEAR (LED DRIVER)

2.2.5.1 Electronic control gear (LED driver) shall comply with IEC 61347-2-13 and comprise of electronic circuit board, converter, built-in power factor (pf) correction unit with pf ≥ 0.9 lagging, built-in SPD and THD ≤ 20%. The LED driver shall be able to withstand short circuit current, overload, over voltage and over temperature. LED driver shall be placed close to LED light source where possible to reduce electromagnetic interference.

2.2.5.2 The luminaire shall be provided with only one number of LED driver. The rated power of the LED driver shall be equal or more than the rated power of the luminaires.

2.2.5.3 The degree of protection (IP Code) of the driver shall be of minimum IP65 as per MS IEC 60529 or IEC 60529.

2.2.6 SURGE PROTECTIVE DEVICE (SPD)

2.2.6.1 The driver shall be protected against lightning surge with a two-port internal surge protective device (SPD) of not less than 10 kA nominal discharge current, I_n (8/20 µs waveform) connected in series.

2.2.6.2 The external SPD shall be installed within the lighting column after the modular termination box.

2.2.6.3 The SPD shall comply with MS IEC 61643-11 or IEC 61643-11 and the following technical specifications: -

Nominal discharge current, I_n	: ≥ 10 kA (8/20 µs waveform)
Mode of protection	: L-N, N-E
Minimum continuous operating voltage, U_c	: 275 VAC for L-N 255 VAC for N-E

2.2.7 INTERNAL WIRING

2.2.7.1 The luminaire shall be completely pre-wired with heat resistant cable marked with the word "HR 105 °C", requiring only the connection of the electrical power supply cables to the terminal and the circuit protective conductor to the earth terminal.

2.2.7.2 A separate terminal for the connection of a circuit protective conductor shall be clearly provided and marked. If a separate earth terminal is not provided, the earth continuity between incoming supply and body shall be confirmed according to the test report. The installation shall comply with MS IEC 60364 series.

2.2.7.3 If the insulation fault occurred, all exposed metal parts and other parts liable to become live shall be permanently connected to the earth terminal.

2.2.8 WARRANTY

2.2.8.1 The manufacturer shall provide a 5-year warranty certificate for the complete luminaire system to guarantee the long-life expectancy and maintenance free luminaire. Warranty declaration shall be filled and duly signed by manufacturer as per Appendix A2 - Warranty Declaration For LED Road Lighting Luminaire. Failure in the functioning and operation of the LED luminaire within the warranty period will result in the replacement of the whole luminaire or required components by the manufacturer or distributor at no cost to the government.

2.2.8.2 Luminance and illuminance test shall be carried out once a year during defect liability period (DLP), to ensure the performance of the installed system conform to the designed requirement. These tests will also confirm the lumen maintenance of the luminaire. The contractor together with luminaire supplier shall carry out the above tests and the result shall meet the design criteria as submitted in the computer simulation.

2.2.9 CONFORMITY WITH STANDARDS

2.2.9.1 The luminaires shall comply with the relevant edition of Malaysian standards or other relevant international standards as in Table 2.

Table 2 - Compliance Standards for LED Road Lighting Luminaires.

Components	Description	Relevant Standards	Name of Standard
Luminaire	Safety	MS IEC 60598-1/ IEC 60598-1 MS IEC 60598-2-3/ IEC 60598-2-3	Luminaires - Part 1: General requirements and tests. Luminaires - Part 2-3: Particular Requirements -: Luminaires for Road and Street Lighting
		MS IEC 62471/ IEC 62471	Photobiological Safety of Lamps and Lamp Systems
		MS IEC 60838-2-2/ IEC 60838-2-2	Miscellaneous lampholders - Part 2 - Particular Requirements - Connectors for LED Modules.
		MS IEC 60529/ IEC 60529	Degrees of protection provided by enclosures (IP Code)
	Performance	MS IEC 62722-2-1/ IEC 62722-2-1	Luminaire Performance - part 2-1: Particular Requirement for LED Luminaires
		IES LM-79	Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products
		CIE S 025	Test Method for LED Lamps, LED Luminaires and LED Modules
	Electromagnetic Compatibility (EMC)	MS IEC 61000-3-2/ IEC 61000-3-2	Electromagnetic Compatibility (EMC) – Part 3-2: Limits – Limits for Harmonic Current Emissions (Equipment Input Current ≤16 A per phase)

Components	Description	Relevant Standards	Name of Standard
		CISPR 15 / EN 50015	Limits and Methods of Measurement of Ratio Disturbance Characteristics of Electrical Lighting and Similar Equipment
		IEC 61547	Equipment for General Lighting Purposes – EMC Immunity Requirements
LED Module	Safety	MS IEC 62031/ IEC 62031	LED Modules for General Lighting – Safety Specifications
	Performance	MS IEC 62717/ IEC 62717	LED Modules for General Lighting - Performance Requirements
LED Chip	Performance	IES LM-80	Approved Method: Measuring Lumen Maintenance of LED Light Sources
Driver	Safety	IEC 61347-2-13	Lamp Controlgear - Part 2-13 – Particular Requirement for DC or AC supplied Electronic Controlgear for LED Modules
	Performance	IEC 62384	DC or AC supplied Electronic Controlgear for LED Modules - Performance Requirements.
SPD	Safety	MS IEC 61643-11/ IEC 61643-11	Low-voltage surge protective devices - Part 11: Surge protective devices connected to low-voltage power systems - Requirements and test methods
Lighting Design	Performance	MS 825	Code of Practice for the Design of Road Lighting.

2.3 INTEGRATED SOLAR LED ROAD LIGHTING LUMINAIRE

2.3.1 CONSTRUCTION

2.3.1.1 An integrated solar LED road lighting luminaire is an outdoor lighting luminaire system used for illuminating road or an amenity. A basic solar LED road lighting luminaire components are:

a) LED Luminaire;
b) Solar Photovoltaic (PV) Module;
c) Rechargeable Deep Cycle Battery;
d) Solar Charge Controller and
e) Lighting Column

2.3.1.2 Solar Photovoltaic (PV) module, rechargeable deep cycle battery, solar charge controller and light source of the integrated solar LED luminaire shall be in one enclosure. The Solar PV module shall provide power to charge the battery during daytime. The operation of the luminaire shall be controlled by a solar charge controller.

2.3.1.3 The configuration of integrated solar LED road lighting luminaire shall be designed to be robust and shall withstand the harsh environment condition as the system will be continuously exposed to Malaysia's tropical climate.

2.3.1.4 The rough service of integrated solar LED road lighting luminaire shall have adequate resistance to vibrations. The luminaire shall comply with the vibration test according to IEC 60598-1, Section 4.20: Rough service luminaires – Vibration requirements.

2.3.2 COMPONENTS

2.3.2.1 LED Luminaire

2.3.2.1.1 The luminaire shall be designed by using solid state lighting i.e. Light Emitting Diode (LED) as a light source.

2.3.2.1.2 The LED luminaire and its associated electrical components and technical specifications shall be as specified in Section 2.2: Light Emitting Diode (LED) Road Lighting Luminaire.

2.3.2.1.3 The LED luminaire shall be designed and constructed to be capable of providing the required lighting performance level as follows:

a) Solar PV module shall be sized such that it can provide sufficient energy to the system for the intended service life of 25 years;

b) System losses shall be considered including dust and dirt, wiring losses, electronics losses and charging losses;

c) Batteries shall be sized for a minimum life cycle of 500 cycles at 80% Depth of Discharge (DOD);

d) The average luminous flux of luminaire shall not depreciate more than 30% from initial value at 50,000 hours (L_{70} @ 50,000 hours);

e) Lighting levels which include luminance and illuminance shall be at rated levels for determining battery size for two (2) days of autonomy at 100% intensity of luminaire for 12 hours operation. If different lighting levels at different times of the night is specified with reference to PD CEN/TR 13201-1: Road Lighting - Guidelines on selection of lighting classes, detailed traffic flow analysis shall be carried out for determining luminance and time setting;

2.3.2.2 Solar Photovoltaic (PV) Module

2.3.2.2.1 The solar PV module shall be of crystalline type. Both monocrystalline and polycrystalline technology PV modules are acceptable in the system. The solar PV module shall be brand new and comply with IEC 61215-2.

2.3.2.2.2 The rated power of solar PV module shall be designed to meet the following criteria:

a) Number of hours of operation of luminaire per day;
b) Total wattage of the luminaire;
c) The peak sun hours per day shall not be more than 4.5 hours.

2.3.2.2.3 The solar PV module efficiency shall not be less than 12%. Efficiency of the solar PV module is defined as the ratio of energy output from solar PV module to input energy from the sun; maximum power, P_{mp} (W) over irradiance (in W/m^2) multiply by area (m^2) at Standard Test Condition (STC).

2.3.2.2.4 The solar PV module shall consist of the following information:

a) Name of the manufacturer of solar PV module;
b) Model number and type;
c) Month and year of manufactured;
d) I-V curve of module;
e) Peak wattage of module;
f) Open circuit voltage (V_{oc});
g) Short circuit current (I_{sc});
h) Maximum current (I_{mp});

i) Maximum voltage (V_{max});
j) Maximum power (P_{mp});
k) Serial number of the module.

2.3.2.2.5 The solar PV module shall be designed with the following features:

a) Covering material : Highly transparent, reflective, tempered solar glass;
b) Junction box : Junction box with integrated 1 minimum bypass diode, the degree of protection (IP Code) of IP65, welded contacts, fully encapsulated;
c) Plugs : Touch-proof plug connectors with polarity reversal protection, MC3 or MC4;
d) Dynamic load (wind load) : 2.4 kN/m² (2,400 Pa);
e) Permitted operating temperature : -10 ºC to +85 ºC;
f) Warranties :
   i) Linear performance warranty of 25 years.
   ii) Degradation of power shall be as in Table 3.

Table 3 - Degradation of actual power versus nominal power

Year	Degradation of actual power versus nominal power (minimum)
1	97%
2 - 24	96.3% – 80.9% (0.7 % annual degradation)
≥ 25	80.7%

2.3.2.3 Rechargeable Deep Cycle Battery

2.3.2.3.1 The batteries are used to store the power generated by the solar PV module and shall be of Lithium-ion or Lithium polymer or Lithium iron phosphate.

2.3.2.3.2 The battery shall comply with IEC 62133-2 or IEC 62619.

2.3.2.3.3 The lithium batteries shall be designed with the following features:
a) System voltage : 12 VDC or 24 VDC;
b) Operating temperature : -5 °C to 60 °C;
c) Cycle efficiency : not less than 90%;
d) Minimum life cycle : 500 cycles at 80% Depth of Discharge (DOD) in compliance with IEC 62620.
e) Sufficient autonomy : minimum of two (2) overcast or rainy days;
f) Discharge time : minimum of 12 hours

2.3.2.4 Solar Charge Controller

2.3.2.4.1 Solar charge controllers shall be used to control the charging of the batteries. Since the output from solar PV module are variable and need adjustments, solar charge controller fetches the variable voltage and current from solar PV module to suit the safety of the batteries. Solar charge controller shall comply with the latest IEC 62109-1.

2.3.2.4.2 The main functions of solar charge controllers are to prevent over-charging of batteries from solar PV module, over-discharging of batteries to the load and to control the functionalities of the load.

2.3.2.4.3 The solar charge controller shall be designed with the following features:

a) Total electronic efficiency : minimum 90% at full load;
b) Relative humidity : 92.5% ± 2.5%;
c) Terminations : Connectors (male & female);
d) Operating temperature : 0 °C to 50 °C;
e) Storage temperature : 0 °C to 70 °C;
f) Protections : Reverse current protection from battery to solar PV module;
g) No moving parts, switches or buttons;
h) Timer functions available for lighting control;
i) System voltage : 12 VDC or 24 VDC;
j) Over-voltages from PV module;
k) Protection against lightning surges (voltages and current);
l) High temperature and overload protection;
m) Open circuit protection without battery;
n) Infrared remote-control programming accessory (if specified) and
o) Internet of Things (IoT) readiness (if specified)

2.3.2.5 Lighting Column

2.3.2.5.1 Lighting column shall be as specified in Section 3: Lighting Column. It shall be designed and fabricated to withstand loading of all integrated solar LED road lighting luminaire components.

2.3.3 WARRANTY

2.3.3.1 The manufacturer or distributor shall provide a 5-year warranty certificate for the complete integrated solar LED road lighting luminaire to guarantee the long-life expectancy and maintenance free luminaire.

2.3.3.2 Warranty declaration shall be filled and duly signed by manufacturer or distributor as per Appendix B2 - Warranty Declaration For Integrated Solar LED Road Lighting Luminaire. Failure in the functioning and operation of the integrated solar LED luminaire within the warranty period will result in the replacement of the whole luminaire or required components by the manufacturer or distributor at no cost to the government.

2.3.4 CONFORMITY WITH STANDARDS

2.3.4.1 The luminaire shall comply with the relevant edition of Malaysian standards or other relevant international standards as in Table 4.

Table 4 - Compliance Standards for Integrated Solar LED Road Lighting Luminaire

Components	Description	Relevant Standards	Name of Standard
Luminaire	Safety	MS IEC 60598-1/ IEC 60598-1 MS IEC 60598-2-3/ IEC 60598-2-3	Luminaires - Part 1: General requirements and tests. Luminaires - Part 2-3: Particular Requirements -: Luminaires for Road and Street Lighting
		IEC 62471	Photobiological Safety of Lamps and Lamp Systems
	Performance	IES LM-79	Approved Method: Electrical and Photometric Measurements of Solid-State Lighting
Solar Photovoltaic (PV) Module	Design	IEC 61215-2	Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test Procedures

Rechargeable Deep Cycle Battery	Safety	IEC 62133-2 or IEC 62619	Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary lithium cells, and for batteries made from them, for use in portable applications – Part 2: Lithium systems or Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications
	Performance	IEC 62620	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for use in industrial applications
Solar Charge Controller	Safety	IEC 62109-1	Safety of power converters for use in photovoltaic power systems - Part 1: General requirements
Luminaires	Design	PD CEN/TR 13201-1	Road Lighting - Guidelines on selection of lighting classes

2.4 HIGH PRESSURE SODIUM VAPOUR (HPSV) ROAD LIGHTING LUMINAIRES

2.4.1 CONSTRUCTION AND COMPONENTS

2.4.1.1 The luminaires shall comply with MS IEC 60598-1 or IEC 60598-1, MS IEC 60598-2-3 or IEC 60598-2-3 and CIE 121.

2.4.1.2 The luminaire shall be complete with control gear (ballast and ignitor), capacitor and suitable for use with 100 W, 150 W, 250 W or 400 W High Pressure Sodium Vapour (HPSV) lamp. The power factor shall not be less than 0.85.

2.4.1.3 The luminaires shall be designed and constructed to be capable of providing the required lighting performance. It shall enable ease of maintenance and replacement of lamp, control gear, reflector and lampholder without the use of special tools.

2.4.1.4 All luminaires shall be new, totally enclosed and protected against contact with live or moving parts inside the enclosure. Full details of the IP system shall be referred to MS IEC 60529. The following degree of protection (IP Code) are required:

a) IP65 or higher for the optical compartment of the luminaires
b) IP55 or higher for the main luminaire housing and control gear compartment

2.4.1.5 Access to the interior of the luminaire shall be from the top. Bottom access is not acceptable.

2.4.1.6 The top cover or luminaire canopy giving access to the interior of the luminaire shall be firmly attached to the fixed position of the luminaire. In the open position, it shall be attached in such a way that there is no likelihood of it becoming accidentally detached and thereby damaging any part of the luminaire or the bracket.

2.4.1.7 The control gear shall be mounted firmly in the compartment, easily removable and replaceable as a unit without the use of any special tools.

2.4.1.8 Electrical connection and disconnection of the control gear from the luminaire shall be of a plug and socket type or terminal block such that the incoming supply cables need not be removed when removing the control gear.

2.4.2 THE OPTICAL SYSTEM

2.4.2.1 The design of the optical system shall incorporate a one-piece full bowl reflector and shall be replaceable as a unit, independent of the canopy. The reflector shall be made of high purity anodized aluminium with at least 99.85% pure aluminium with no iridescent mirror finished e.g. polished aluminium. The minimum thickness of the reflector shall be 1.0 mm.

2.4.2.2 The bowl shall be designed and constructed such that when in the close position, it will be firmly held. The bowl shall be easily detached from the canopy without having to use any tool and at the same time will not be detached when in the open position during maintenance. If an IP66 rating is specified for the optical compartment, the bowl shall be designed, constructed and totally sealed to the reflector to form a single removable optical unit.

2.4.2.3 The bowl shall be made of clear or prismatic glass material. In the case of prismatic bowls, the fluted surface shall form the inner surface to facilitate cleaning.

2.4.2.4 The gasket shall be a one-piece tropicalised weather resistant type made of suitable soft resilient material that will not cause crazing of the bowl.

2.4.3 LAMP

2.4.3.1 The lamp shall comply with MS IEC 62035 or IEC 62035 and MS IEC 60662 or IEC 60662.

2.4.3.2 The characteristic of the lamp shall be as in Table 5.

Table 5 - HPSV lamp characteristic.

Lamp (W)	Lamp Cap Type	Correlated Colour Temperature, T_{cp}	Lumen Output (lm)	
			Initial, at 100 hrs.	After 2000 hrs.
100	E40	2000 K – 2100 K	9500	9200
150	E40	2000 K – 2100 K	14500	13500
250	E40	2000 K – 2100 K	28000	26500
400	E40	2000 K – 2100 K	48000	46000

2.4.3.3 The lamp shall not take longer than 4 minutes after the initial ‘switch on’ to attain 80% of its guaranteed lumen output at the rated voltage 230 V +10%, -6% and frequency 50 Hz. The re-ignition period after an interruption of the supply shall not be longer than 1 minute to attain 80% of its lumen output.

2.4.3.4 The average luminous flux of the lamp shall not depreciate more than 10% of initial value after 10,000 operating hours.

2.4.3.5 The average mortality rate for the lamp shall not be greater than 10% at 12,000 operating hours.

2.4.3.6 If Eco-HPSV (Eco-sodium) lamp is specified, the characteristic of the lamp shall be as in Table 5.

2.4.4 LAMPHOLDER

2.4.4.1 The lampholder shall comply with MS IEC 60238 or IEC 60238.

2.4.4.2 The lampholder shall be made of non-metallic, heat resistant material and be rigidly fixed onto the optical compartment.

2.4.4.3 The lampholder shall be of E40 type complete with an appropriate brake system to prevent loosening of the lamp.

2.4.4.4 The lampholder together with its supports and brackets shall withstand normal usage throughout the life of the luminaire.

2.4.4.5 A fully inserted lamp shall be rigidly held with its axis substantially coincident with that of the lampholder under the normal conditions of wind, vibration and mechanical shock.

2.4.4.6 The rated pulse voltage for the E40 lampholder shall not be greater than the ignition voltage of the ignitor.

2.4.5 BALLAST

2.4.5.1 The ballast shall be of reactor type and terminals shall be of screw connector type and comply with MS IEC 61347-1 or IEC 61347-1, IEC 61347-2-9 and MS IEC 60923 or IEC 60923.

2.4.5.2 The ballast shall be solidly filled with polyester compound and enclosed in a sheet steel or die-cast aluminium container or vacuum impregnated with polyester resin of not less than thermal Class H.

2.4.5.3 The lamp current crest factor of the ballast shall not exceed 1.8 for ± 6% voltage variations.

2.4.5.4 At normal operating temperature, the maximum ballast losses, as per MS IEC 60923 or IEC 60923 shall be as in Table 6.

Table 6 - Maximum ballast losses for HPSV Lamp

Lamp (W)	Ballast Loss (W)
100	16
150	18
250	27
400	39

2.4.5.5 The rated maximum operating temperature of the ballast winding (t_w) shall not be less than 130 °C whereas the maximum winding temperature rise (Δt) shall not be more than 70 °C.

2.4.6 IGNITOR

2.4.6.1 The ignitor shall comply with MS IEC 61347-1 or IEC 61347-1, MS IEC 61347-2-1 or IEC 61347-2-1 and MS IEC 60927 or IEC 60927.

2.4.6.2 The ignitor shall be fully electronic, timed, superimposed multiple-pulse type which does not require the use of tapped ballast to ignite the HPSV lamp.

2.4.6.3 The ignitor shall be fully encapsulated and totally sealed against the ingress of moisture.

2.4.6.4 The ignitor shall have a casing temperature rating of not less than 90 ºC.

2.4.6.5 The case of the unit shall carry a label showing the connections and the operating voltage. The ignitor shall be mounted with nut and lock washer.

2.4.7 CAPACITOR

2.4.7.1 The capacitor shall comply with MS IEC 61048 or IEC 61048.

2.4.7.2 The capacitor shall have a minimum voltage rating of 250 V and a casing temperature rating not less than 85 ºC and shall be of sufficient capacity to raise the power factor of the circuit to not less than 0.85 lagging. The capacitor shall be housed in extruded aluminium or thermoplastic canisters and mounted with nut and lock washer.

2.4.7.3 The capacitor shall not be fused but incorporate a safety discharge resistor.

2.4.8 INTERNAL WIRING.

2.4.8.1 The luminaire shall be completely pre-wired, requiring only the connection of the electrical power supply cables to the terminal and the circuit protective conductor to the earth terminal.

2.4.8.2 The control gear looping cables shall be of heat resistant copper-core flexible cable and marked with the word “HR 105 °C” on the insulation and securely clipped.

2.4.8.3 Polytetrafluorethylene (PTFE) insulation or the equivalent, rated to a minimum of 250 °C shall be used for leads to the lampholder.

2.4.9 CONFORMITY WITH STANDARDS

2.4.9.1 The luminaire shall comply with the relevant latest edition of Malaysian standards or other relevant international standards as in Table 7.

Table 7 - Compliance Standards for HPSV Luminaires.

Components	Description	Relevant Standards	Name of standard
Luminaires	Safety	MS IEC 60598-1/ MS IEC 60598-2-3 IEC 60598-1/ IEC 60598-2-3	Luminaires - Part 1: General requirements and tests. Luminaires - Part 2-3: Particular Requirements - Section 3: Luminaires for Road and Street Lighting
	Performance	CIE 121	The Photometry and Goniophotometry of Luminaires
Lamp	Safety	MS IEC 62035	Discharge lamps (excluding fluorescent lamps) - Safety specifications
	Performance	MS IEC 60662	High-pressure sodium vapour lamps - Performance specifications
Lampholder	Safety	MS IEC 60238/ IEC 60238	Edison screw Lampholders Edison Screw Lampholders (First Revision) (IEC 60238:2004, IDT)
Ballast	Safety	MS IEC 61347-1/ IEC 61347-1 IEC 61347-2-9	Lamp controlgear - Part 1: General and safety requirements. Lamp controlgear - Part 2-9: Particular requirements for electromagnetic controlgear for discharge lamps (excluding fluorescent lamps)
	Performance	MS IEC 60923 / IEC 60923	Auxiliaries for lamps - Ballasts for discharge lamps (excluding tubular fluorescent lamps) - Performance requirements

Ignitor	Safety	MS IEC 61347-1/ IEC 61347-1 MS IEC 61347-2-1/ IEC 61347-2-1	Lamp controlgear - Part 1: General and safety requirements. Lamp controlgear - Part 2-1: Particular requirements for starting devices (other than glow starters)
	Performance	MS IEC 60927/ IEC 60927	Auxiliaries for lamps - Starting devices (other than glow starters)- Performance requirements
Capacitor	Safety	MS IEC 61048/ IEC 61048	Auxiliaries for lamps - Capacitors for use in tubular fluorescent and other discharge lamp circuits - General and safety requirements

APPENDIX A1

TECHNICAL SCHEDULE OF LED ROAD LIGHTING LUMINAIRE

Project: ……

	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
A1	**GENERAL**			
1	Distributor		Please attach letter	
2	Letter of Warranty		Please attach letter	
A2	**LUMINAIRE**			
1	Manufacturer		Please attach catalogue	
2	Brand & Model		Please attach catalogue	
3	Rated power	W	100/ 120/ 150/ 180/ 200/ 240/ 280	
4	Rated voltage & frequency	V	230 +10%, -6%, 50 Hz	
5	Total harmonic distortion (THD)		< 20%	
6	Ambient temperature		25 °C ± 1 °C	
7	Mounting type		Side entry or post top mounting	
8	Gross weight	kg	Please attach catalogue	
9	Materials casing / body		Die-cast or deep drawn or extrusion aluminium alloy	
10	Ingress protection		IP65	
11	Jam bolts for clamping/securing/lock spigot to bracket arm		Minimum of 2 (two) locking bolt or screws provided	

	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
A3	**LIGHT SOURCE**			
1	Type of LED		Please attach catalogue	
2	Brand & Model of LED		Please attach catalogue	
3	Efficacy	lm/W	≥ 110	
4	Wattage	W	100/ 120/ 150/ 180/ 200/ 240/ 280	
5	Correlated Colour Temperature (CCT), T_{CP}	K	2500 – 3500 (± 175)	
6	Rated Lifetime		L70 @ 50,000hours	
A4	**THE OPTICAL SYSTEM**			
1	Optical lens		UV Resistant material	
2	Reflector		99.85% pure aluminium material with a minimum thickness of 1mm	
3	Silicone Gasket		Silicon or one piece weather resistant type	
A5	**LED DRIVER**			
1	Manufacturer		Please attach catalogue	
2	Brand & Model		Please attach catalogue	

	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
3	Rated power	W	Rated power of LED driver shall be equal or more than the rated power of the luminaires.	
4	Rated voltage & frequency	V	230 +10%, -6%, 50 Hz	
5	Built-in power factor correction unit		≥ 0.9	
6	Protection features		withstand short circuit current, overload, over voltage and over temperature.	
7	Quantity of driver per luminaire		One LED driver per luminaires.	
8	Degree of Protection		IP65	
A6	**SURGE PROTECTIVE DEVICES (SPD)**			
1	Manufacturer		Please attach catalogue	
2	Brand & Model		Please attach catalogue	
3	Type of SPD		Two-port SPD	
4	Norminal discharge current, In	kA	≥ 10	
A7	**INTERNAL WIRE AND EARTHING TERMINAL**			
1	Completely pre-wired			
2	Permanently and reliably connected to earthing terminal			

	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
A8	**WARRANTY**			
1	Warranty period for the complete luminaire (LED Driver, Optical System, Housing, Thermal Management)		5 year warranty certificate	
2	Luminance test to meet requirement in MS 825		Once a year during DLP	

APPENDIX A2

WARRANTY DECLARATION FOR LED ROAD LIGHTING LUMINAIRE

PROJECT:

Declaration by Manufacturer / Distributor:

We hereby guarantee that the complete LED road lighting luminaire supplied is maintenance free and come complete with 5 years' warranty. Should any of the LED road lighting luminaires fail to function at any time within the warranty period we, the distributor / manufacturer, will duly replace the LED road lighting luminaire complete with necessary components at our own cost.

Signature of distributor / manufacturer:

Name of Authorized Personnel:

Official stamp:

Date:

* Warranty certificate is attached

APPENDIX B1

TECHNICAL SCHEDULE OF INTEGRATED SOLAR LED ROAD LIGHTING LUMINAIRE

Project: ……

	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
B1	**GENERAL**			
1	Distributor		Please attach letter	
2	Letter of Warranty		Please attach letter	
B2	**LED LUMINAIRE**			
1	Manufacturer		Please attach catalogue	
2	Brand & Model		Please attach catalogue	
3	Efficacy	lm/W	≥ 110	
4	Rated Power	W		
5	Correlated Colour Temperature (CCT), T_{CP}	K	2500 – 3500 (± 175)	
6	Control Features		a) Automatic dusk to dawn function b) PIR function not allowed c) Dimming function (minimum pre-set required) i)…… hours/ …... % ii)….. hours/ …… % iii)….. hours/ ….. %	
7	Rated Lifetime		L70 @ 50,000hours	

	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
B3	**SOLAR PV MODULE**			
1	Manufacturer		Please attach catalogue	
2	Brand & Model		Please attach catalogue	
3	Module capacity	W	Minimum module capacity shall be designed using 4.5 peak sun hours as a reference	
4	PV module type		Monocrystalline or Polycrystalline	
5	Minimum module efficiency at Standard Test Condition (STC)	%	≥ 12	
6	I-V curve of module		Please attach Solar PV datasheet	
7	Maximum current (I_{mp})	A	Please attach Solar PV datasheet	
8	Maximum voltage (V_{mp})	V	≥ 18.8 As per system voltage Please attach Solar PV datasheet	
9	Maximum power (P_{mp})	W	$P = I_{mp} \times V_{mp}$	
10	Lifetime	year	≥ 25	

	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
B4	**RECHARGEABLE DEEP CYCLE BATTERY**			
1	Manufacturer		Please attach catalogue	
2	Brand & Model		Please attach catalogue	
3	Battery type		Please attach catalogue	
4	Cycle efficiency	%	≥ 90	
5	Battery capacity & quantity	Wh	a) Please provide detail calculation b) Battery shall be designed to ensure sufficient supply for the whole operation of Solar LED luminaire (from dusk to dawn) c) Capacity shall be designed as per type of LED luminaire & solar PV module offered in Part A2 and according to 2 days autonomy & 80% DOD *Note : Battery capacity (Ah) varies based on the rated battery voltage*	
6	Operating temperature	°C	-5 °C to 55 °C	
7	Charging mode		Included	
8	Days of autonomy	day	≥ 2	
9	Discharge time	hour	≥ 12	

	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
B5	**SOLAR CHARGE CONTROLLER**			
1	Manufacturer		Please attach catalogue	
2	Brand & Model		Please attach catalogue	
3	Electronic protections		Please attach catalogue	
	a) Solar input		over-voltage warning, reverse polarity	
	b) Load output		overload, high temperature, reverse polarity	
4	Efficiency		≥ 90%	
5	Humidity		92.5% ± 2.5%	
6	Operating temperature range	^{0}C	0 ^{o}C to 50 ^{o}C	
7	System voltage	V	12 VDC or 24 VDC	
8	Maximum charging current	A	Please provide detail calculation	

APPENDIX B2

WARRANTY DECLARATION FOR INTEGRATED SOLAR LED ROAD LIGHTING LUMINAIRES

PROJECT:

Declaration by Manufacturer / Distributor:

We hereby guarantee that the complete integrated solar LED road lighting luminaires supplied is maintenance free and complete with 5 years' warranty. Shall any part of the integrated solar LED road lighting luminaires fail to function at any time within the warranty period we, the manufacturer / distributor, shall duly replace the integrated solar LED road lighting luminaires complete with necessary components, labour and installation at our own cost.

Signature of manufacturer / distributor:

Name of Authorized Personnel:

Official stamp:

Date:

* Warranty certificate is attached

APPENDIX C

TECHNICAL SCHEDULE OF HPSV ROAD LIGHTING LUMINAIRE

Project: ……

	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
C1	**GENERAL**			
1	Distributor		Please attach letter	
2	Letter of Warranty		Please attach letter	
C2	**LUMINAIRE**			
1	Manufacturer		Please attach catalogue	
2	Brand & Model		Please attach catalogue	
3	Rated power	W	100/150/250/400	
4	Rated voltage & frequency	V	230,+10%, -6%, 50 Hz	
5	Degree of Protection			
	a) Optical Compartment		IP65	
	b) Control Gear Compartment		IP55	
C3	**OPTICAL SYSTEM**			
1	Sealing Gasket		One piece of tropicalised weather resistant material	
2	Reflector		99.85% pure aluminium	
3	Cover Bowl		Glass	
4	Lampholder		E40, Non-metallic, heat resistant material	
C4	**PHOTOMETRY**		Please attach Photometry Report	

	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
C5	**HPSV LAMP**			
1	Manufacturer		Please attach catalogue	
2	Country of manufacture		Please attach catalogue	
3	Brand & Model		Please attach catalogue	
4	Lamp type		E40	
5	Wattage	W	100/150/250/400	
6	Rated life	hours	Please attach catalogue	
7	Luminous flux after 100 hours	lm	9500/14500/28000/ 48000	
8	Correlated Colour Temperature (CCT), T_{CP}	K	2000-2100	
9	Operating voltage	V	Please attach catalogue	
10	Operating lamp current	A	Please attach catalogue	
11	Maximum starting current	A	Please attach catalogue	
12	Time to re-strike after power interruption	minutes	≤ 1	
C6	**BALLAST**			
1	Manufacturer		Please attach catalogue	
2	Country of manufacture		Please attach catalogue	
3	Brand & Model		Please attach catalogue	
4	Wattage	W	100/150/250/400	
5	Maximum loss	W	16/18/27/39	

	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
6	Rated maximum operating temperature of ballast winding - t_w	°C	> 130	
7	Maximum winding temperature rise - Δt	°C	< 70	
8	Lamp current crest factor		1.8 ± 6%	
9	Expected life	hours	Please attach ballast datasheet	
C7	**IGNITOR**			
1	Manufacturer		Please attach catalogue	
2	Country of manufacture		Please attach catalogue	
3	Brand & Model		Please attach catalogue	
4	Construction		fully electronic, timed, superimposed multiple-pulse type	
5	Wattage	W	100/150/250/400	
6	Peak ignition voltage	kV	Please attach catalogue	
7	Maximum casing temperature	°C	> 90	
C8	**CAPACITOR**			
1	Manufacturer		Please attach catalogue	
2	Country of manufacture		Please attach catalogue	
3	Brand & Model		Please attach catalogue	
4	Rated Voltage	V	> 250	
5	Capacitance	F	Please attach catalogue	
6	Material of canister		Extruded aluminium / thermoplastic	

APPENDIX D

SUBMISSION OF LIGHTING SIMULATION

The Electrical Contractor is required to submit computer plots of road sections as stated in Appendix D2-1 - Luminance Measurement Grid

The electrical contractor shall also filled up the appendices below: -

1) APPENDIX D1-1 - Design Criteria

2) APPENDIX D1-2 - Description of The Layout

3) APPENDIX D2-1 - Luminance measurement Grid

4) APPENDIX D2-2 - Illuminance measurement Grid

5) APPENDIX D2-3 - Longitudinal Uniformity for Each Lane

6) APPENDIX D3-1 - Tabulated Summary of Lighting Level Calculation Data (Luminance) For Road Lighting Installation

7) APPENDIX D3-2 - Tabulated Summary of Lighting Level Calculation Data (Illuminance) For Road Lighting Installation

The computer plots shall also be attached.

All the above plots and data shall be certified by the respective manufacturer/supplier.

_____.
Electrical Contractor's Signature

_____.
Company's Stamp

Name :_____.

Designation :_____.

APPENDIX D1-1

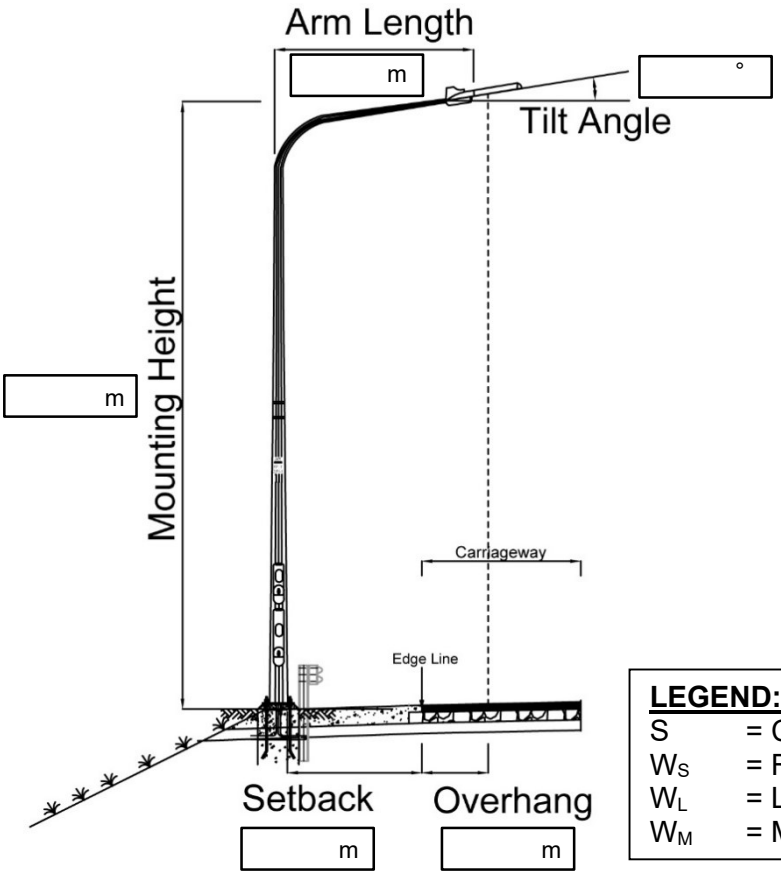
DESIGN CRITERIA

*Road Lighting Class	:	M_____ / C_____
*Road Surface Type	:	Asphalt / Concrete
*Luminance Coefficient, Q_o	:	_____
*Maintenance Factor, MF	:	_____
*Column Height, H	:	_____ m
*Column spacing, S	:	_____ m
*Luminaire Type	:	_____
*Luminaire Wattage	:	_____ W
*Luminaire Efficacy	:	≥_____ lm/W
*Arm Length	:	_____
*Overhang	:	_____
*Setback	:	_____

*To be filled by designer

APPENDIX D1-2

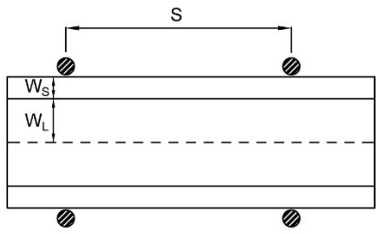
DESCRIPTION OF THE LAYOUT



LEGEND:

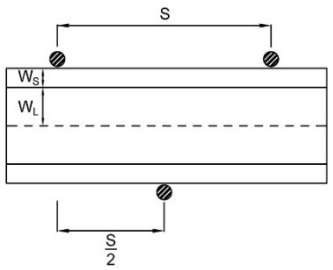
S	= Column Spacing (m)
W_S	= Road Sholder Width (m)
W_L	= Lane Width (m)
W_M	= Median Width (m)

Single Sided / Opposite Arrangement



S =_____m
W_S =_____m
W_L =_____m

Staggered



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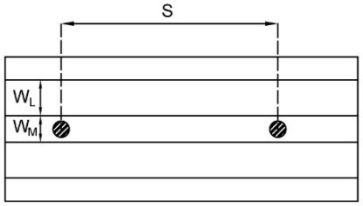
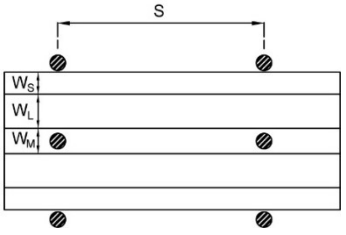
W_S =_____m
W_L =_____m

Central Median



S =_____m
W_L =_____m
W_M =_____m

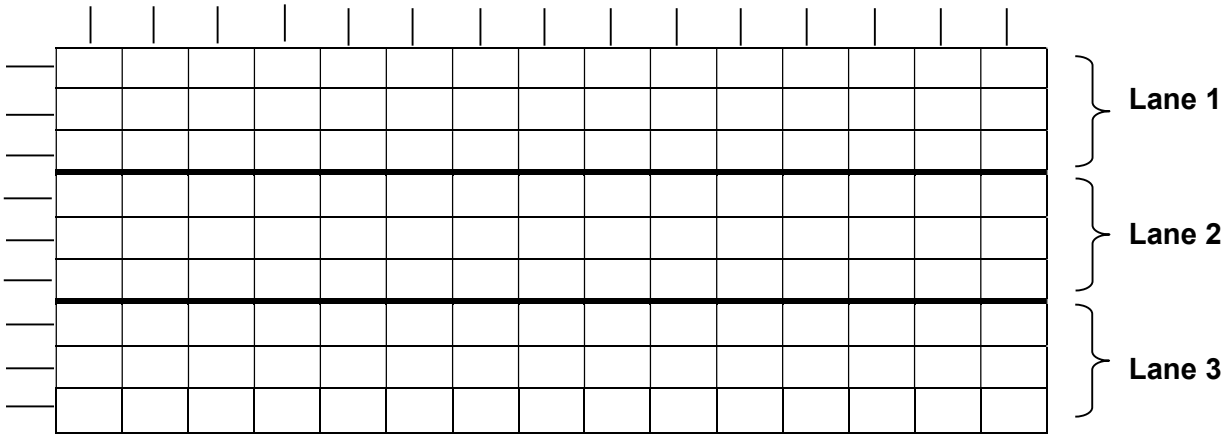
Combination



S =_____m
W_S =_____m
W_L =_____m
W_M =_____m

APPENDIX D2-1

LUMINANCE MEASUREMENT GRID



L_{ave} = _____ cd/m^2 $U_o = L_{min}/L_{ave}$ = _____ %

L_{min} = _____ cd/m^2 $U_l = L_{min}/L_{max}$ = _____ %

L_{max} = _____ cd/m^2 SR = _____

_____ _____

Manufacturer/Supplier's Signature Electrical Contractor's Signature

_____ _____

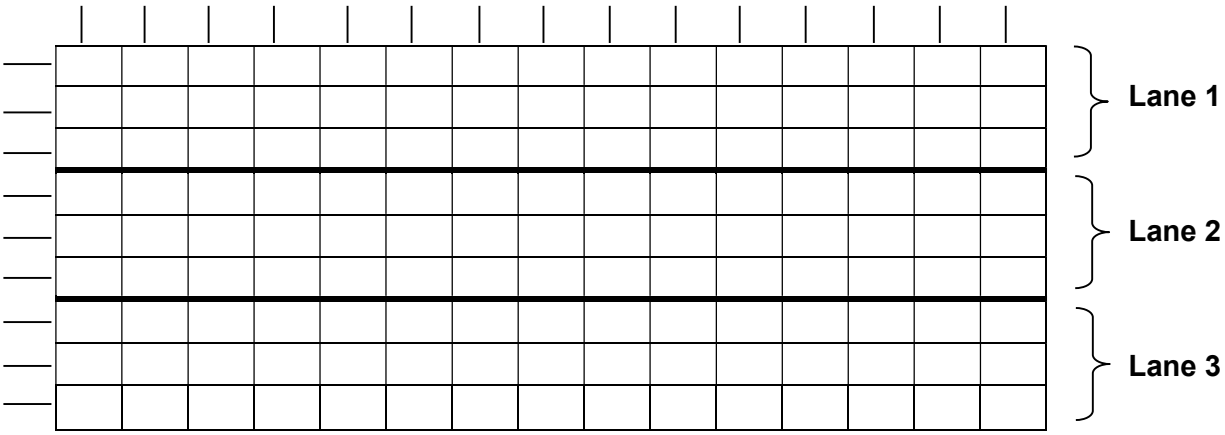
Company's Stamp Company's Stamp

Name : _____ Name : _____

Designation : _____ Designation : _____

APPENDIX D2-2

ILLUMINANCE MEASUREMENT GRID



E_{ave} = _____lux E_{max} = _____lux

E_{min} = _____lux $U_o = E_{min}/E_{ave}$ = _____%

_____ _____

Manufacturer/Supplier's Signature Electrical Contractor's Signature

_____ _____

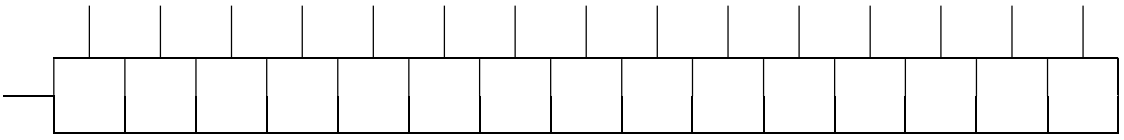
Company's Stamp Company's Stamp

Name : _____ Name : _____

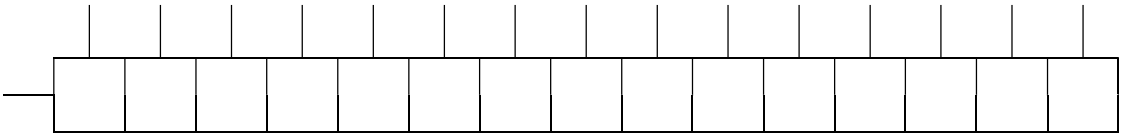
Designation : _____ Designation :_____

APPENDIX D2-3

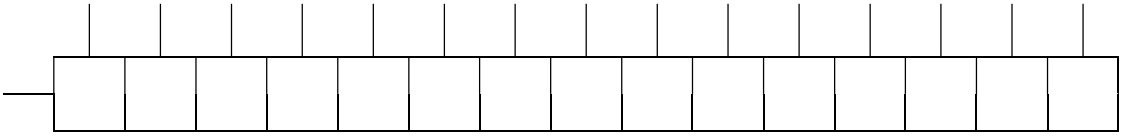
LONGITUDINAL UNIFORMITY FOR EACH LANE



$U_{l1} = L_{min} / L_{max} =$ _____ %



$U_{l2} = L_{min} / L_{max} =$ _____ %



$U_{l3} = L_{min} / L_{max} =$ _____ %

_____	_____
Manufacturer/Supplier's Signature	Electrical Contractor's Signature
_____	_____
Company's Stamp	Company's Stamp
Name : _____	Name : _____
Designation : _____	Designation :_____

APPENDIX D3-1
TABULATED SUMMARY OF LIGHTING LEVEL CALCULATION DATA (LUMINANCE) FOR ROAD LIGHTING INSTALLATION

Project:

Luminaire Brand / Model : .....

Please key in the results from the computer print-out or exact calculated values into the table below.											
VARIOUS ROAD CROSS-SECTIONS/ JUNCTIONS NUMBER	WATTAGE	MOUNTING HEIGHT	SPACING (m)	Luminance (cd/m^2)					GLARE	SR	COMPUTER SIMULATION REFERANCE
				(L_{av}) (cd/m^2)	(L_{min}) (cd/m^2)	(L_{max}) (cd/m^2)	Uo = (L_{min}/L_{av})	Ul = (L_{min}/L_{max})	THRESHOLD INCREMENT	SURROUND RATIO	

NOTES: -
1. The Tenderer shall provide the required data for all sections/junctions of the Road Lighting Installation.
2. The Tenderer shall make duplicate copies of this Form to be filled as necessary.
3. The cross-sections / junctions numbers are given in the Tender Document.

Supplier's Signature,
Company's Stamp

Electrical Contractor's Signature,
Company's Stamp

: ..... Date: ..... : .....

APPENDIX D3-2
TABULATED SUMMARY OF LIGHTING LEVEL CALCULATION DATA (ILLUMINANCE) FOR ROAD LIGHTING INSTALLATION

Project:

Luminaire Brand / Model No.: ……

VARIOUS ROAD CROSS-SECTIONS/ JUNCTIONS NUMBER	WATTAGE	MOUNTING HEIGHT	SPACING (m)	Illuminance (lux)				COMPUTER SIMULATION REFERANCE
				(E_{av})	(E_{min})	(E_{max})	Uo = E_{min} / E_{ave}	

NOTES: -
1. The Tenderer shall provide the required data for all sections/junctions of the Road Lighting Installation.
2. The Tenderer shall make duplicate copies of this Form to be filled as necessary.
3. The cross-sections / junctions numbers are given in the Tender Document.

Supplier's Signature,
Company's Stamp

: ……

Date: ……

Electrical Contractor's Signature,
Company's Stamp

: ……