



SPECIFICATION FOR ROAD LIGHTING INSTALLATION (L-S20)

CKE.LS.01.20.(03).2020

JKR 20300-0126-23

**CAWANGAN KEJURUTERAAN
ELEKTRIK**

	SPECIFICATION FOR ROAD LIGHTING INSTALLATION	CKE.LS.01.20.(03).2020 Date Issued: Aug 1999
		Revision: 1
		Date: August 2022

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) Road Lighting Luminaires - LED	Noorfadzilah bt Ramlee, BPR E
3		Feb 2015	Tambahan: Addendum No.2 to L-S20 Specification for Road Lighting Installation (August 1999) Appendix D1	Noorfadzilah bt Ramlee, BPR E
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

*** Helaian ini hanya untuk rekod sahaja. Tidak perlu disertakan bersama dokumen tender.



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SPECIFICATION FOR ROAD LIGHTING INSTALLATION

1.0 GENERAL

- 1.1 This section of the Specification describes and specifies requirements for the supply, delivery, storage, assembly, installation, erection, testing, commissioning, handing over in approved working order and maintenance during the Defects Liability Period of the Road Lighting Installation in accordance with the Specification, Notes, Bill of Quantities (B.Q.), Conditions of Contract and Drawings.
- 1.2 The Road Lighting Installation shall include all luminaires, fittings, brackets, spigots, other supporting devices, columns, feeder pillars, bases, cables, switchgears and all necessary ancillary equipment, foundations, ducting and all other necessary equipment for a complete road lighting system in accordance with the details shown on the Drawings, Bill of Quantities.(B.Q.), Notes, Appendices and as specified herein.

2.0 ROAD LIGHTING LUMINAIRES

2.1 General

The luminaire shall be complete with integral control gears as a unit and shall be designed for both side entry and post top mounting and suitable for use with 100W/150W/250W/400W High Pressure Sodium Vapour (HPSV or SON) Tubular Lamp and on a supply voltage of 240 Volt, +5%, -10%, 50 Hz.

2.2 Conformity With Standards

The luminaire and its associated electrical components shall comply with and be tested to the following IEC Standards together with all current amendments.

ITEM	STANDARD
Luminaire	IEC 60598 Parts 1 & 2
Lamp	IEC 60662
Lampholder	IEC 60598 Part 1
Ballast	IEC 60922 & IEC 60923
Ignitor	IEC 60926 & IEC 60927
Capacitor	IEC 61048/61049
Others	Relevant IEC Standards

2.3 Construction And Components

2.3.1 General

- i. The luminaire shall be so designed and constructed that it is capable of providing the service for which it is intended. Sound engineering principles shall be adopted throughout and the luminaire shall be designed to enable ease of maintenance and replacement of lamp, control gear, reflector and lampholder without the use of special tools.
- ii. The main supporting structure of the luminaire shall be constructed from die-cast aluminium alloy material such that no undue deterioration in its safety, performance or appearance during normal life when operating in all climatic conditions prevailing in a tropical country such as heavy rains, high winds, high humidity and hot day-time temperatures. It shall be robustly constructed to withstand vibration in normal use.
- iii. The luminaire shall be designed so that condensation shall not fall on any operating part which may fail or deteriorate as a result.
- iv. All luminaires shall be new, totally enclosed and protected against contact with live or moving parts inside the enclosure. The following Index of protection (IP) are required:-

IP 55 or higher for the optical compartment of the luminaires.

IP 43 or higher for the main luminaire housing and control gear compartment.

Full details of the IP system can be referred to in IEC 60529.

- v. Access to the interior of the luminaire shall be from the top. Bottom access is not acceptable.
- vi. Material used for the construction of the luminaire shall be recyclable. Glass/Fibre glass reinforced polyester (GRP/FRP) material is not acceptable.
- vii. Hinges and clips of the top housing cover if used, shall be robust and made of stainless steel and simple to operate and shall not be liable to accidental detachment during installation or maintenance.
- viii. The top cover or luminaire canopy giving access to the interior of the luminaire shall in the closed position, 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 or the column.
- ix. Attachment of the luminaire to its bracket arm shall be by means of clamps or jam bolts and designed to accommodate spigot sizes as shown in the table. A minimum of 2 (two) locking bolts / jam screws shall be provided.
- x. The minimum depth of penetration of the bracket arm shall be as shown in the table. The mounting arrangement and attachment of the luminaire shall be such as to withstand a

windspeed of 150 km per hour on the projected surface of the assembly without due deflection.

Rating of Lamp	Diameter of Bracket (mm.)	Diameter for Side Entry (mm.)	Min.Depth of Penetration (mm.)
100 Watt	50	40 - 60	100
150 Watt	50	40 - 60	100
250 Watt	50	40 - 60	100
400 Watt	50	40 - 60	110

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

2.3.2 The Optical System

- i. 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 at least 99.85% pure aluminium with a minimum thickness of 1 mm., be electrically brightened, anodised and chemically treated to give high reflectance.
- ii. The optical compartment shall be tested and certified to IP 55 or higher.
- iii. The luminaire shall incorporate provisions to enable adjustments to shift the main light distribution towards the axis of the road to suit different road widths. Such adjustments shall be simple and positive and shall be firmly retained in clearly identified positions. Photometric data shall be supplied for the particular distribution recommended in a given installation. These data may be supplied in computer diskettes together with software in the CIE format.
- iv. The bowl shall be designed and constructed such that when in the closed 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 opened 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.
- v. The bowl shall be made of glass or acrylic material. Where acrylic material is used, it shall be stabilised against deformation, deterioration or discolouration due to the lamp and/or solar radiation.
- vi. The bowl shall be clear or prismatic. In the case of prismatic bowls, the fluted surface shall form the inner surface to facilitate cleaning.

- vii. 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. The gasket shall form an integral part of the bowl such that any bowl change will necessitate a change of the gasket.

2.3.3 Lamp

- i. The lamp to be accommodated in the luminaire shall be 100/150/250/400 watt tubular clear type High Pressure Sodium Vapour (HPSV) lamp.
- ii. The lamp shall comply with the requirements of IEC 60662 together with all current amendments.
- iii. The minimum lumen output specifications of the lamp shall be as follows:-

Lamp	Lamp Cap Type	Colour Corrected Temperature C.C.T	Lumen Output (Lm)	
			Initial, at 100 hrs.	After 2000 hrs.
100 Watt	E 40	2000 K - 2100 K	9500	9200
150 Watt	E 40	2000 K - 2100 K	14500	13500
250 Watt	E40	2000 K - 2100 K	28000	26500
400 Watt	E40	2000 K - 2100 K	48000	46000

- iv. 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 240 Volts, +5%, -10% and frequency 50 Hertz. The re-ignition period after an interruption of the supply shall not be longer than 1 minute to attain 80% of its lumen output.
- v. The average luminous flux of the lamp shall not depreciate more than 10% of initial value after 10,000 switched operating hours.
- vi. The average mortality rate for the 100/150/250/400 watt HPSV lamp shall not be greater than 10% at 12,000 switched operating hours.

2.3.4 Lampholder And Associated Supports And Brackets

- i. The lampholder shall be made of non-metallic, heat resistant material and be rigidly fixed onto the optical compartment.
- ii. The lampholder shall be an E40 type for the 100/150/250/400 watt HPSV lamp. The lampholder shall be complete with an appropriate brake system to prevent loosening of the lamp.

- iii. The lampholder together with its supports and brackets shall withstand normal usage throughout the life of the luminaire.
- iv. A lamp fully inserted shall be rigidly held with its axis substantially coincident with that of the lampholder under the normal conditions of wind, vibration and mechanical shock.
- v. The E40 lampholder shall be rated for 4.5kV pulse.

2.3.5 Electrical Control Gear

A. General

- i. The luminaire shall be furnished complete with integral electrical control gear comprising of inductive ballast, capacitor and ignitor.
- ii. The electrical control gear shall be mounted on a suitable module unit and shall be easily removable and replaceable as a unit without the use of any special tools.
- iii. Electrical connection and disconnection of the electrical control gear unit from the luminaire shall be through a plug and socket type connection/terminal block such that incoming supply cables need not be removed when removing the electrical control gear module.

B. Ballast

- i. 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' (180 °C in accordance with IEC 60085).
- ii. The ballast shall be reactor type and comply fully with IEC 60922 - "Ballast for Discharge Lamps : General and Safety Requirements" and IEC 60923 - "Ballast for discharge lamps (excluding tubular fluorescent lamps) - Performance Requirements".
- iii. The rated voltage of the ballast shall be 240 Volt, 50 Hz (Nominal) and shall be suitable for operation on a 240 Volt, +5%, -10%, 50 Hz supply system. All terminals shall be of screw connector type.
- iv. The lamp current crest factor of the ballast shall not exceed 1.8 for $\pm 6\%$ voltage variations. At normal operating temperature, the maximum ballast losses, as per IEC 60923 shall not exceed 16 Watt for the 100 Watt HPSV lamp, 18 watts for the 150 watt HPSV lamp, 27 watts for the 250 watt HPSV lamp and 39 watts for the 400 watt HPSV lamp.
- v. 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.

C. Ignitor

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- i. The ignitor shall be solid state, fully electronic, timed, superimposed multiple-pulse type which does not require the use of tapped ballast to ignite the HPSV lamp.
 - ii. The ignitor shall be fully encapsulated and totally sealed against the ingress of moisture.
 - iii. The ignitor shall have a casing temperature rating of not less than 90 °C.
 - iv. The case of the unit shall carry a label showing the connections and listing the operating voltage and the precautions to take during its removal. The ignitor shall be mounted with nut and lock washer.
 - v. The ignitor shall comply with and be tested to IEC 60926 and IEC 60927 together with all current amendments.

D. Capacitor

- i. The capacitors shall comply with and be tested to IEC 61048/61049.
- ii. The capacitors shall have a minimum voltage rating of 250 Volt and a casing temperature rating not less than 85 °C and shall be of sufficient capacity to raise the power factor of the circuit to not less than 0.85 lagging. The capacitors shall be housed in extruded aluminium or thermoplastic cannisters and mounted with nut and lock washer.
- iii. Capacitors shall not be fused but incorporate a safety discharge resistor.

2.3.6 Internal Wiring, Terminal Block And Earthing Terminal

A. Internal Wiring

- i. The luminaire shall be completely pre-wired, requiring only the connection of the electrical power supply cables to the terminal and the earth continuity conductor to the earthing terminal.
- ii. The control gear looping cables shall be non-hygroscopic heat resistant copper-core flexible cable, with a temperature rating of not less than 105 °C and marked on the insulation and securely clipped. The minimum size of the cable shall not be less than 1 sq. mm.
- iii. PTFE insulation or the equivalent, rated to a minimum of 250 °C shall be used for leads to the lampholder.

B Terminal Block

- i. A readily accessible barriered terminal block with the 'live' and 'neutral' connections clearly and indelibly marked for the connection of incoming supply cables shall be provided as close as possible to the point of entry of the supply cables. The terminal block shall be made of non-inflammable material.

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- ii. A means of clamping the electrical supply cables shall be provided in the luminaire to relieve the terminations of strain where they are connected to the terminals. The cable clamp arrangement shall not damage the insulation of the cables.

C Earthing Terminal

- i. A separate terminal for the connection of an earth continuity conductor, clearly and indelibly marked shall be provided.
- ii. 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 earthing terminal.

3.0 PHOTOMETRIC DATA

The following Photometric Data relevant to each luminaire type shall be provided together with the Tender submission.

- i) Isolux Diagram
- ii) Utilization Factor Curves
- iii) Polar Curves of the following C-Planes : 0°/180°; 90°/270°; maximum intensity plane.
- iv) Downward Light Output Ratio.
- v) Downward and Upward Flux Fractions

Tender documents without the appropriate Photometric Data will be disqualified.

4.0 SAMPLE OF LUMINAIRES

- 4.1 Tenderers may be required to submit a sample each of the various luminaires offered after the closing date of the tender submission. Such luminaires submitted shall be furnished complete with control gear, lamp, wiring, etc. as per the tenderer's offer in the tender document together with supply cable and a 13 Ampere plug, ready for test.
- 4.2 The name and address of the tenderer shall be affixed onto the samples of the luminaire.
- 4.3 Delivery of the 'SAMPLES' shall be within a period of ONE WEEK immediately following the request from JKR.
- 4.4 Tenderers who fail to submit the 'SAMPLES' of the luminaires within this stipulated period shall be disqualified.
- 4.5 Tenderers shall arrange to collect back the samples on notification.

5.0 SCHEDULE AND TECHNICAL INFORMATION ON LUMINAIRES.



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- 5.1 Tenderers are required to furnish the comprehensive information and technical particulars as stipulated in the APPENDICES A, B, C and D.
 - 5.2 The information required in each Appendix shall be completed fully and correctly and all technical data entered therein shall be substantiated with relevant pamphlets and test certificates from the manufacturers or the recognized testing authorities.
 - 5.3 Failure to fulfil the above said requirements shall result in the disqualification of the tender.

6.0 PROJECTS BASED ON THE 'TURNKEY', 'DESIGN AND BUILD' OR 'BUILD-OPERATE-TRANSFER' (B.O.T.) APPROACH.

- 6.1 In the case of 'Turnkey' or 'Design and Build' or 'Build-Operate-Transfer' (B.O.T.) type projects, the Road Lighting System shall be designed in accordance with the recommendations set forth in the CIE 115 - 1995 "Recommendations For The Lighting Of Roads For Motor And Pedestrian Traffic". The Tenderer shall obtain the consent of JKR for the classifications of "Description of Road", "Conflict Areas" and "Lighting Class" from JKR for the whole road system prior to designing the layout of the Road Lighting System.
- 6.2 This Specification applies to such projects.

7.0 OUTDOOR WEATHERPROOF FEEDER PILLARS

7.1 General

The Feeder Pillars shall be supplied completely assembled with control gear and all internal electrical and mechanical interconnections and structural parts for voltages up to and including 1000 volts A.C. It shall comply with and be tested to the requirements of IEC 60439 - 1 and IEC 60439 - 5.

7.2 Fabrication

The Electrical Contractor shall submit design drawings showing the plan, elevations, sections, layout and construction details of the feeder-pillar for the approval of the S.O's Representative prior to fabrication. The plinth, foundation work, ducting, etc. shall be included in the design drawing.

The feeder-pillar housing shall comprise of a drip canopy with sufficient overhang, rigid welded channelled steel framework as specified in the Drawings and/or Bill of Quantities

and/or Notes. Anti-corrosive treatment shall be applied to the pillar and it shall be painted. A non perishable resilient gasket shall be provided all around the edge of the feeder door.

On the front and rear sides of the feeder-pillar, the following sign and lettering of 90 mm height shall be stencilled in red paint:

BAHAYA VOLTAN**ELEKTRIK****415 V**

Side panels and front and back doors shall be fabricated from 12 swg sheet steel as specified in the Drawings. The feeder pillar shall rest on an angle iron base where suitable holes have been prepared to accommodate foundation bolts and to secure the feeder-pillar onto the concrete foundation.

The door of the feeder pillar shall be rigidly reinforced bonded and hinged internally to the main frame to prevent unauthorised access. The feeder pillar shall be of lockable type as approved by the S.O's Representative. The feeder-pillar shall be self-ventilated and weatherproof, and such ventilation openings shall be protected by wire mesh to prevent the entry of vermins, rodents and birds.

A suitable size wire mesh glass window shall be provided to facilitate reading of the kWH meter.

A pocket of suitable size for housing A4 size documents shall be fitted onto the inside of feeder-pillar as specified in the Drawings.

The hinged door must be earthed using copper braid as shown in the Drawings.

If a stainless steel feeder pillar is specified, all material including framework, panels, bolts and nuts used in the manufacture shall be totally stainless steel. The side panels and front and back doors shall be fabricated from 14 SWG stainless steel. No additional anti-corrosion and paint treatment are required unless otherwise stated.

7.3 Factory Inspection

The Electrical Contractor shall make arrangements for a joint inspection and to witness the electrical tests at the factory prior to transportation to the site of the feeder pillars. All costs incurred shall be deemed to be included in the tender price. Test certificates shall be issued upon completion of all tests.

7.4 Foundation

The site for the foundation of the feeder-pillar shall be excavated and filled where required, compacted and levelled before the reinforced concrete base is constructed to a minimum of

300 mm. (or otherwise specified) above the finished ground level and 700 mm. below the finished ground level. Cable entry ducts shall also be provided as specified in the Drawings.

7.5 Earthing

The earthing system for the feeder-pillar shall comply with the requirements of MS IEC 60364, BS 7671:1992 (formerly known as the IEE Wiring Regulations), JKR, JBEG and in accordance with the Drawings.

Each feeder-pillar shall be effectively earthed by using 16mm. diameter copper jacketed steel core rods, 25mm x 3mm copper tape and heavy duty inspection chamber with removable cover, etc.

7.6 Switching Circuit

The time switch supplied for the control of the luminaires etc, shall be of the synchronous/step motor wound handset dial, plug-in type. It shall incorporate a 24 hours spring reserve. The time switch shall be suitably rated and operational on 220/240 V, 50 Hz supply.

7.7 Contactors

The contactor supplied shall comply to IEC 60947-4 with uninterrupted ratings, mechanical duty class 2 and utilisation category of minimum AC3. The contactor coils shall be fully tropicalised and wound for continuous operation for 240/415 V, 50 Hz supply. The contacts of the contactor shall be rated for the breaking capacity on the connected load.

7.8 By-pass Switch and Selector Switch

A single and three phase by-pass switch as applicable shall be connected in parallel with the contactor for use in the event of the failure of the contactor. This by-pass switch shall be manufactured to B.S. 5419 and shall be capable of breaking the load connected without undue wear or damage. A four position selector switch shall be provided to select the mode of operation and shall be appropriately labelled.

7.9 Miniature Circuit Breakers.

Unless otherwise indicated in the Drawings and/or Bill of Quantities, miniature circuit breakers (MCBs) shall have breaking capacity not less than 6 kA (rms) and of B-type with Class 3 energy limiting characteristics. They shall comply with IEC 60898, fully tropicalised and suitable for use on a 240/415 V, 50Hz A.C. system and in an ambient temperature of 40°C.

They shall be quick-make, quick-break and trip free type complete with de-ion arc interrupters. The tripping elements shall be of thermal magnetic type with inverse time delay overcurrent

and instantaneous short circuit characteristics. The response to overload shall be independent of variations on ambient temperature.

They shall be manually operated by means of toggle type handle having visual indication of whether the breaker is opened, closed or tripped. Multiple breakers shall be provided with a common trip mechanism for simultaneous operation of all the poles.

7.10 Termination

All cables terminated into the various components including incoming and outgoing cables must be terminated through compression glands and heat shrinkable sleeves.

8.0 COLUMNS AND BRACKETS.

8.1 General

Unless otherwise specified, all columns and brackets shall be tapered octagonal or tapered round type, made up of hot dip galvanised steel interchangeable sections or pre-stressed spun concrete columns or fibreglass reinforced material to comply in all respects to the Drawings, Bill of Quantities and Notes. They shall be manufactured to comply with the relevant sections of the latest edition of B.S. 5649 (EN 40) or ANSI C-136.20 and ASTM D4923-89, or other approved international standards. The base plate, if any, (for planted type columns), brackets arms and spigots shall be manufactured as separate units suitable for mounting or fixing onto the columns. The data for the columns and brackets shall be provided in Appendix 'E'.

8.2 Design loading

The columns shall be designed to withstand loading comprising of:

- i. Loads of wind speed up to 35m/sec.
- ii. The loads due to the weight of the column and accessories, luminaires and associated control gear, the bracket arms and spigots.
- iii. Other applied loads

8.3 Fabrication

8.3.1 Hot Dip Galvanised Steel Columns

Each column section shall be mechanically formed and longitudinally welded by continuous automatic gas shielded electric arc process (M.I.G. Process) or continuous automatic electric resistance welding, to B.S. 5135:1984. The sections shall be constructed so as to overlap each other by a minimum of 1.5 times the diameter of the immediate lower section (external across

face dimension) and to be easily assembled on site by using simple tools without employing welding. The manufacturer shall provide a mark on the finished column sections indicating the minimum overlapping position of 1.5 times the external across-face dimension.

8.3.2 Pre-stressed Spun Concrete Columns

- i. Pre-stressed Concrete wires and reinforcement

Pre-stressed Concrete (PC) wires, Non Tension (NT) wires and Spiral wires shall be cut to correctly coincide with the shapes and dimensions specified in the Drawings. The PC

wires and reinforcement wires shall be arranged so that they are uniformly distributed in the cross-section of the concrete column.

All steel reinforcement shall have a concrete cover of not less than 9mm.

Pre-stressed concrete columns shall also comply to BS 607 : Part 2 1970.

ii. Moulding

Moulds used shall be sufficiently rigid in order to withstand the pre-stressing forces. The PC wires shall be tensioned in advance, before the compaction process.

iii. Concrete

The quality of the concrete and the curing process used shall be such that the compressive strength of the concrete at 28 days in age is greater than 49.0 N/mm^2 in accordance with the tests stipulated in JIS A 1132 and JIS A 1108.

8.3.3 Fibreglass Reinforced Columns

i. Type 1.

Each column section shall be mechanically formed by a centrifugation process. Textile glass fabrics shall be used as reinforcement with the majority of fibre. Fibre only shall be used to stabilize the fabric for extraordinary longitudinal alignment for main reinforcement of the tension direction. On one side of the fabric a chopped strand mat shall be provided to shear strength required in case of impact, compression or torsion. The column section shall be produced and cured in a one-way operation, including the resin and colour pigmentation process.

ii. Type 2.

The columns shall be made from continuous E-glass roving, encapsulated in a high temperature cured, corrosion resistant, epoxy resin matrix. The glass shall be wound under tension, and at required angles to provide suitable axial and transversal mechanical properties. The columns shall be cured by a process which allows the epoxy resin to migrate to the surface of the column giving it an exceptionally smooth and uniform finish. The glass content shall be approximately 65% by weight.

8.4 Material

8.4.1 Hot Dip Galvanised Steel Columns.

The column and accessories shall be fabricated from the following materials :

COMPONENT	MATERIAL
Column and Door	Steel to BS EN 10025 Grade Fe 510C or BS EN 10025 Fe 430C or BS 1387:1985 or JIS G3452:1978

Bracket Arm and Spigot	Steel to BS EN 10025 Fe 430C or BS 1387:1985 or JIS G3452:1978
Base Flange	Steel to BS EN 10025 Fe 360A
Base Plate	Steel to BS EN 10025 Fe 360A

8.4.2 Pre-stressed Spun Concrete Columns

The column and accessories shall be manufactured/fabricated from the following materials.

COMPONENT	MATERIAL
Column	1) Concrete grade 50 (50 N/mm ²) 2) P.C Wire shall conform to JIS G 3536 3) N.T Wire & reinforcement bar shall conform to JIS G 3532 4) Spiral wire shall conform to JIS G 3532
Door & Spigot	Steel to BS EN 10025 Grade Fe 510C or BS EN 10025 Fe 430C or BS 1387 : 1985 or JIS G 3452 : 1978
Bracket Arm	Steel to BS EN 10025 Fe 430C or BS 1387 : 1985 or JIS G 3452 : 1978
Base Plate	Steel to BS EN 10025 Fe 360A

8.4.3 Fibreglass Reinforced Columns

i. Type 1

The column and accessories shall be fabricated from the following materials :

COMPONENT	MATERIAL
Column and Door	Fibreglass mat and thermoplastic polyester resin combination
Bracket Arm and Spigot	Bracket arm -seamless steel with polyurethane coating.



	Spigot - galvanised steel
Base Flange	Galvanised steel

Pigmentation Of Colour:

The colour pigmentation of the columns shall be guaranteed for at least 15 years of use.

Electrical Properties:

The columns shall comply with the following electrical properties:

Surface resistivity		DIN 53482	$\sim 10^{13} \Omega$
Resistivity		DIN 53482	$\sim 10^{15} \Omega$
Creep resistance	VDE 0303	DIN53480	KA3c
Dielectric strength	VDE0303	DIN53481	about 30 kV/mm
Insulation class		II	

The flame retardancy properties shall be similar to that of the type 2 composite columns.

Mechanical Properties:

The columns shall comply with the following mechanical properties:

Tensile strength	DIN 53455	$\sim 2.500 \text{ kp/cm}^2$
Flex elongation	DIN 53455	$\sim 7.5\%$
Flexural strength	DIN 53452	$\sim 1.700 \text{ kp/cm}^2$
Flex E-modulus	DIN 53452	$\sim 70.000 \text{ kp/cm}^2$
Impact strength	DIN 53453	$\sim 50 \text{ kp/cm}^2$
Heat distortion temperature	DIN 53458	above maximum of standard.

ii. Type 2.

The column and accessories shall be facricated from the following materials:

COMPONENT	MATERIAL
Column and Door	E-glass roving and epoxy resin matrix. The door may also be fabricated from aluminium or galvanised steel.
Bracket Arm and Spigot	Bracket arm - Same material as column or galvanised steel. Spigot/tenon - aluminium
Base Flange	Galvanised steel

Flame Resistance:

Columns shall not contain chlorine halogen gases or other toxic materials in excess of trace levels which shall always be within the safe OSHA limits. When the column material is subjected to 3 consecutive 60 second flame applications, it shall self extinguish within 5 seconds after the last flame application. Flame resistance shall be in accordance with ASTM D635.

The fibreglass reinforced material shall be non-conductive.

8.5 Protection Against Corrosion

8.5.1 Hot Dip Galvanised Steel Columns

Individual sections of the column, base-plate, door, spigots and bracket arms shall be protected against corrosion by hot dip galvanising, internally and externally in accordance with B.S. 729:1971 or ASTM Standard A123. All welding work shall be done before galvanising.

The treatment prior to galvanising shall include degreasing, rinsing, pickling, further rinsing and fluxing.

The minimum average weight of the zinc coating shall be 460 g/m² for any individual test area. The galvanised column and spigots/bracket arms shall be of prime finish and of good uniformity, i.e. free from injurious defects, such as blister, flux or any uncoated spot.

The planted section of the column shall be factory-coated with bitumen using the hot dipping process conforming to AASHTO M 190.

8.5.2 Pre-stressed Spun Concrete Columns

All exposed metal parts of the concrete columns shall be treated and protected against corrosion.

8.5.3 Fibreglass Reinforced Columns

Fibreglass reinforced columns shall not erode, rot or corrode and shall not deteriorate in the Malaysian tropical climate coupled with high sunshine and heavy rainfall, together with other severe environmental conditions of salt-laden air, acid rain, acid soil and marshy soil and shall be finished in a UV-resistant surface.

A range of colour finish shall be available for the columns, with no colour fading over time.

Unless otherwise specified, the finish of the column shall be smooth.

8.6 Bracket Arms

Bracket arms shall be of suitable outreach as indicated in the Drawings and/or the B.Q. Unless otherwise indicated in the Drawings and/or B.Q. the bracket arms shall be arranged to give a 5 degree uplift. A spigot of approved material and of appropriate dimensions for the luminaire shall be welded or suitably attached at the base of the bracket arms. In the case of a steel bracket arm, after welding and related work, the bracket arm shall be treated as per clause 8.5 before being hot-dip galvanised.

8.7 Spigots

Steel spigots or spigots made of other approved material shall be supplied and installed as indicated in the Drawings and/or B.Q. and treated as per clause 8.5 in the case of steel.

8.8 Doors, Door Openings and Opening for Wiring to Decorative Signs/Lights

A hinged weather-proof flush-type or overlapping door, hinged on the upper side with provision to hold the fully opened (180° from the closed position) hinged door in place, shall be provided complete with an anti-vandal locking device over the door opening of each column as shown in the relevant Drawings. The door openings shall have internal reinforcement to compensate for the loss of stiffness of the column caused by forming the door openings.

In addition, an opening of 16 mm. diameter complete with rubber plug shall be provided on the column at a height of 5.6 m above the finished ground level for wiring to decorative lighting/signs. The opening shall be located on the same side of the column as the door opening.

8.9 Baseboard

A piece of galvanised perforated steel baseboard shall be included in the base compartment for cable termination of the control gear assembly. The baseboard shall have suitable dimensions as indicated in the Drawings and securely fixed in position inside the column.

8.10 Earthing Terminal

Columns shall be provided with a corrosion-resistant earthing terminal having substantial contact surface for the attachment of an earthing lead. The terminal shall be provided close to the door opening inside the columns. Where a bolt is used, it shall be at least 6 mm. in diameter and 20mm. in length and provided with two suitable washers and nuts. Unless otherwise specified, the bolt, nuts and washers shall be made of stainless steel.

8.11 Service Slots

For the planted type column, the service slot shall be on the same side and vertically below the service door.

For the flange mounted type of column, the cable entry shall be through the flange plate having a hole of suitable diameter as shown in the Drawings and a suitable duct for cable entry shall also be provided at the concrete base.

8.12 Flange and Anti-sink Base Plate

8.12.1 Hot Dip Galvanised Steel Columns

For the flange mounted type of column, a flange plate of substantial thickness as shown in the Drawings shall be welded onto the column. As for the planted type column, a detachable anti-sink base plate shall be supplied. The anti-sink plate, bolt, and nut etc. shall be hot-dip galvanised after manufacture and treated as in clause 8.5.

8.12.2 Pre-stressed Concrete Columns

For concrete columns, a flange plate shall be assembled and cast together with concrete during the manufacturing process.

8.12.3 Fibreglass Reinforced Columns

i. Type 1.

For the flange mounted type column, a flange plate with a rod adapted to the column shall be assembled. The base plate/concrete shell, bolt, and nut etc. shall be hot dip galvanised steel assembled on concrete foundation as per Drawings.

Prefabricated foundation shall be constructed to the column manufacturer's recommendations.

ii. Type 2.

In the case of the flange-mounted column, a hot-dipped galvanised steel base plate of thickness and dimensions as shown in the Drawings shall be welded to the attachment collar. The attachment collar shall be bonded and mechanically secured to the inside of

the column. All required anchor bolts, nuts and washers shall be galvanised steel type and supplied by the column manufacturer.

In the case of the planted column, the base of the column shall be enlarged via two integral anti-rotation bosses, located 180° from each other and appropriately centred above the column butt. These bosses shall be large enough to effectively prevent rotation and pull-out of the column and shall be formed by the column manufacturer.

8.12.4 Where the concrete base for the flange mounted columns are included in the Electrical Contractor's work, the bolts and nuts for mounting the flanged mounted columns shall be supplied by the column manufacturer.



8.13 Factory Testing of the Columns

A sample of all types of columns and bracket arms shall be tested at the factory of manufacture in the presence of the S.O.'s Representatives. The tests shall comprise of :

8.13.1 Hot Dip Galvanised Steel Columns

- a) Dimensional and Weight Measurements of column and bracket.
- b) Temporary Deflection Test :

The column is to be mounted horizontally and rigidly supported for the distance equivalent to the planting depth from the base, and loaded, as a cantilever at a point from the top of the column (excluding the bracket arm). The temporary deflection measured at the point of application of load shall not exceed 150 mm. and the load to cause 150 mm. deflection at the top of the column (excluding the bracket arm) shall not be less than the following figures:

COLUMN MOUNTING HEIGHT (m)	6	7	8	9	10	11	12
Load to cause 150 mm deflection at top of column (excluding bracket arm) ($\geq N$)	1340	1120	1230	800	700	550	480

The deflection test shall be carried out with the column placed in the two weakest positions.

- c) Galvanising Test :

The columns and brackets shall be subjected to the galvanising thickness test as laid down in BS 729:1971.

- d) Bitumen Test :

The bitumen coating on the column base shall be subjected to thickness test.

- e) Material Test :

Steel material used for the manufacturing of columns and brackets shall be subjected to test for compliance with BS EN 10025 (Grade 43C or Grade 50C). The supplier shall state the test method and the reference standards together with the tender. The test method and the reference standards shall be subject to the approval of the S.O.'s Representative.

- f) Welding Test :

The welded portions of the columns and brackets shall be subjected to the welding test as stipulated in the British Standard B.S. 5135 or equivalent Standard approved by the S.O.'s Representative.

The minimum percentage penetration for the longitudinal seam weld shall be 60%.

g) Mechanical Property Test :

A small piece of steel plate of adequate size shall be cut off from the base of the sample column for this test.

The tensile strength and yield of the sheet metal shall be measured. The test results shall comply with the limits specified in BS EN 10025 for Grade 510C and 430C steel as follows :

	<u>Fe 510C</u>	<u>Fe430C</u>
Tensile Strength (N/mm ²)	490 to 640	430 to 580
Yield Strength (Min. N/mm ²)	355	275

8.13.2 Pre-stressed Concrete Columns

i. Bending Strength Test

This test shall be carried out in accordance with JIS A 5309.

When the design load of 1.5kN is applied, cracks exceeding 0.25 mm in width shall not appear. When the design load is removed there shall be no cracks exceeding 0.05mm in width.

ii. Breaking Test

This test shall be carried out in accordance to JIS A 5309. The load is applied to the column in one of the two loading directions until the column is broken. The breaking load shall be more than twice the design load.

iii. Inspection

a) Quantity of Column to be Inspected

Inspection of the appearance, shape and dimensions shall be performed on all columns.

Inspection of the concrete cover shall be performed on the column that was subjected to the breaking test.

The bending strength test shall be conducted on three column sampled from a batch of 1000 columns or part thereof.

The breaking test shall be performed on one of three columns used in the bending strength test.

b) Determination of Acceptability

All columns shall comply to the specification with respect to appearance, shape and dimensions.

When all the three columns subjected to the bending strength test comply with the specification, then all the columns in the batch shall be accepted.

When one column does not conform with the specification during the bending strength test, the test shall be repeated one or two sampled columns. When both columns conform to the specification, all columns in the batch shall be accepted except for the initially rejected column.

When test column does not comply to the specification, the test shall be repeated with two more sampled columns.

When both columns conform, all the columns in the batch shall be accepted except for the initially rejected column.

8.13.3 Fibreglass Reinforced Columns

Fibreglass Reinforced Columns shall be tested to the relevant sections of the applicable BS, VDE, DIN, ANSI/AASHTO as the case requires, to ensure compliance with the mechanical properties, strength, stiffness, flame retardancy, accepted deflection tolerances and breaking point loading including testing under full wind loading condition.

8.13.4 All test and measuring equipment shall be provided by the column manufacturer and all such test and measuring equipment shall be certified to have been calibrated by an accredited laboratory for testing and calibration. Proof of validity of the calibration shall be submitted to the S.O's Representative for approval prior to making arrangements for the factory testing.

8.13.5 A verified Test Report for the tests on the columns shall be submitted by the manufacturer.

8.13.6 All expenses incurred for the tests shall be borne by the Electrical Contractor and shall be deemed to have been included in the Contract Price.

8.14 Terminal Block

The terminal block shall be of a type manufactured for use in road lighting installation. They shall have facilities for double fusing loop-in loop-out terminals. The cut-out bases shall have a supply cable contact block rating of at least 50A and shall be capable of accepting circular cable cores up to 25 mm² copper 2 core or 4 core as required. The cut-out shall be provided with adequate shrouding to prevent cross phasing with live metal parts.

8.15 Cable Terminations and Internal Wiring

An appropriate type of earthing clamp shall be provided to bond the armouring of the cables which shall be effectively earthed.

Cable glands c/w hot-dipped galvanised mild steel L-bracket shall be used for all armoured cable termination.

The cables, including the earthing cable, from the road lighting cut-outs to the luminaires shall not be less than 2.5 mm² pvc. They shall be bundled together with cable ties and terminated with lugs.

8.16 Erection of Columns

Columns shall be installed in accordance with the manufacturer's recommendation and as per Drawings. The Electrical Contractor shall peg out the positions of the columns for the approval of the S.O.'s Representative before planting the columns or before the construction of the concrete bases in the case of flange mounted columns.

The columns shall be erected such that the service doors shall face the opposite side to the oncoming traffic except at parapets of bridges and retaining walls. At such locations the orientation of the service doors shall be determined by the S.O.'s Representative. After erecting the column, the backfill shall be compacted by means of a suitable ramming equipment and the uprightness of the columns shall be verified with the use of a plumb line or equivalent device.

9.0 CABLES AND DUCTS

Road lighting cables and their installation shall be in compliance with the latest JKR Specification for Low Voltage Underground Cable, and to any additional notes mentioned in the Drawings and Notes to Tenderers.

Ducts for road crossing, etc. shall be laid in accordance with the Drawings, B.Q. and appropriate sections of the Specification.

Cables in the central median shall be laid close to the columns and as far away as possible from the edge of the pavement. The minimum distance from the edge of the pavement shall be 1 metre or as directed by the S.O.'s Representative.

Cables along the road shoulders shall be laid as far away as possible from the usable shoulder width or as directed by the S.O.'s Representative.

Data for voltage drop calculations for all the road lighting circuits shall be give in the format of Appendix F - "Voltage Drop Calculation For The Road Lighting Installation", together with the detailed calculations.

10.0 SHOP DRAWINGS

Two sets of prints of shop drawings for construction and/or installation shall be submitted to the S.O.'s Representative for approval. The Electrical Contractor shall prepare and submit shop drawings for the whole work or parts of the work at least two weeks before the work begins. If the shop drawings submitted are not acceptable by the S.O.'s Representative, the Electrical Contractor shall amend and re-submit the shop drawings within two weeks from the date of return of the shop drawings. No work including fabrication of the feeder pillars shall be carried out without the shop drawings being approved by the S.O.'s Representative.

The shop drawings shall include and show the following:

The dimensioned general arrangements, layouts and positions of columns and luminaires, feeder pillars, and all others necessary for the complete road lighting installation as specified in the Drawings and/or Bill of Quantities;

Circuits and switching arrangements including schematic line diagrams of the installation;

The dimensioned general arrangements and layouts of the equipment and the schematic line diagram of the feeder pillars;

Cable routes for all cables laid underground, in ducts and trenches;

The dimensioned general arrangements and layout of earthing system including routes for earthing conductors and positions of earth electrodes.

The cost of all these shop drawings, whether or not provided in the Bill of Quantities, is deemed to be included in the Contract.

11.0 CONSTRUCTION REQUIREMENTS

Adequate warning signs including flashing lights, luminous signs and flagmen shall be provided for the safety of the road user and general public. The general arrangement and location of temporary warning signs shall be in strict accordance with ARAHAN TEKNIK (JALAN) 2C/85 and amendments, published by Cawangan Jalan, Ibu Pejabat JKR Malaysia, Kuala Lumpur. All workers on the site shall be appropriately dressed with luminous jackets and the work area adequately cordoned. No night work shall be permitted without the prior approval of the S.O's Representative. All warning signs shall conform to standard JKR requirements. Adequate illuminated, flashing and luminous warning signs shall be provided during the night time.

The maximum trenching distance and working area for the day shall be determined after prior consultation with the S.O's Representative. The mobile trenching method shall be employed as far as is practicable and all excavations, installation of ducting/sand/cabbling/bricks/accessories, backfilling, compacting and cleaning up shall be executed in one coordinated operation to expeditiously complete the work and therefore minimise inconvenience and danger to the public. The carriageway and road shoulder area including all work area shall be cleared of all debris and cleaned after each day's work

All excess excavated material and construction material shall be removed from the site and no such material shall be permitted to be left by the road side without the consent of the S.O's Representative.

12.0 TESTING AND TEST CERTIFICATES

On completion of the installation work on site and before the Certificate of Practical Completion is issued, the Electrical Contractor shall at his own expense, arrange for all necessary tests to be carried out on the installation by competent person as part of the tests required of him for the whole installation under this contract. The tests to be carried out shall be as prescribed in the Electricity Regulations 1994, B.S. 7671: 1992 including all amendments (formerly known as the IEE Wiring Regulations), IEC 60364 and other tests deemed necessary by the S.O.'s Representative.

In the event the installation fails any of these tests, the Electrical Contractor shall, at his own expense, take such measures as are necessary to remedy the defects and the installation shall not be considered as completed until it complies with the requirements of all such tests.

The tests to be carried out by the Electrical Contractor shall consist of the following tests (where applicable) :-

- a) Continuity of final circuit conductors.
- b) Continuity of protective conductors including main and supplementary equipotential bonding.
- c) Insulation resistance.

- d) Insulation of site-built assemblies.
- e) Protection by electrical separation.
- f) Protection by barriers or enclosures provided during erection.
- g) Insulation of non-conducting floors and walls.
- h) Polarity.
- i) Earth fault loop impedance.
- j) Earth electrode resistance.
- k) Functional testing of all types of switches and switchgear.
- l) Alignment and uprightness of the columns and the tilting angle of the bracket arms.
- m) Luminance and illuminance readings in accordance with the computer plots.

Two sets of Supervision and Completion Certificate and Test Certificate including copies of all the test results and drawings as prescribed in the Electricity Regulations 1994 shall be submitted to the S.O.'s Representative within two weeks after the completion of the testing. The aforesaid Certificates shall be properly bound in hard cover and titled.

13.O SERVICE AND MAINTENANCE

During the Defects Liability Period, the Electrical Contractor shall be responsible for the service and maintenance for the complete installation. All works shall be carried out by competent person. All labour, transport, equipment, materials, tools and parts necessary to service the installation and/or rectify the defect due to manufacturing/installation faults shall be supplied/executed at the Electrical Contractor's cost.

The Electrical Contractor shall provide a three-monthly report in the manner of Appendix G.

The service and maintenance to be performed and defects to be rectified and made good shall include but not limited to the following :-

- a) Replacing or making good all luminaires, lamps, ballasts, capacitors, ignitors, control gears, switches, socket outlets, isolators, mcb, mccb, fuses, time switches, contactors, relays, meters, etc.
- b) Replacing all consumable items that do not meet the manufacturer's guaranteed or declared lifespan.
- c) Straightening columns and replacing missing doors, covers and locking devices.



- d) Replacing and making good all loose/damaged cable terminations, damaged cables, mechanical support linkages, earth electrode chambers and covers, etc.
- e) Making good damage to roads, buildings, drains, cables, pipes, concrete areas, paved areas, turfed areas, etc. which was his responsibility to make good but which had not been properly rectified.
- f) All other works deemed necessary by the S.O.'s Representative.

All works shall be carried out as soon as the Electrical Contractor is informed by the S.O.'s Representative or the owner and shall be completed within a reasonable time except under emergency situation as stipulated in the Supplementary Conditions for Electrical Work. If the Electrical Contractor fails to comply with the above requirements, the S.O.'s Representative reserves the right to engage a third party to carry out the work, in which case, the Electrical Contractor shall be responsible for all the expenses incurred.

14.0 AS-INSTALLED DRAWINGS, MANUALS AND TOOLS

Within three calendar months after the practical completion of the project, one set of true to scale negative (110/115 gm./sq.m. ISO A0 or A1 size) and four sets of prints for each of the following drawings shall be submitted :-

- a) Site plan
- b) Schematic Wiring Diagrams and Control Circuit Drawings
- c) Road Lighting Layout Plans
- d) Layout plan of cable routes and earthing points, with reference to easily recognisable landmarks, buildings and structures.

These drawings shall be properly stencilled and shall have at the lower right corner the Electrical Contractor's name and address, date of commissioning, scale, drawing number (the drawing number shall be obtained from the S.O.'s Representative), title and the following particulars:-

JABATAN KERJA RAYA MALAYSIA
CAWANGAN ELEKTRIK
CONTRACT NO:
TENDER NO :

If the drawings submitted are not acceptable to the S.O.'s Representative, the Electrical Contractor shall amend and resubmit the drawings within two weeks from the date of notification by the S.O.'s Representative.

If required and specified elsewhere, in addition to the aforesaid negatives and prints, the as-installed drawings shall be stored in electronic media or any other media as specified. The



electronic media shall be floppy disks and/or CD as specified which can be readily retrieved by computer. The software programme shall be AutoCAD of a release specified or of the latest release. Two sets or copies of the as-installed drawings in the format required, appropriately titled and stored in container or casing, shall be submitted.

In addition, four sets of the following manuals/brochures and documents, suitably bound, shall be submitted to the S.O's Representative:

- a) Installation manual
- b) Operation manual
- c) Service and Maintenance Manual
- d) Parts List
- c) Product data and catalogues
- d) Product Test Certificates

Each of the above sets of prints together with the manuals shall be in a stiff cover ring file. In addition, a set of A4 size schematic drawings shall be laminated and placed inside the pockets of the Feeder Pillars.

Special tools required for the operation, service and maintenance of the feeder pillars and switchgear, columns and other equipment shall also be provided.

The cost of all these prints, manuals and tools shall be deemed to be included in the Contract Price.



APPENDIX A-1

SCHEDULE OF LUMINAIRE (400W HPSV/SON)

ITEM	DESCRIPTION	DATA/MATERIAL
A	MAKE	
1	Manufacturer	
2	Country of manufacture	
3	Brand of Luminaire	
4	Model of Luminaire	
B	MATERIAL	
5	Lamp Compartment	
6	Control Gear Compartment	
7	Sealing Gasket	
8	Reflector	
9	Cover Bowl	
10	Lampholder	
11	Bowl Retainer Catch	
C	PHOTOMETRY	
12	Standard Position	
13	Facilities for Directional Light Control	
14	Optical Compartment (Degree of Protection)	
15	Control Gear Compartment (Degree of Protection)	

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APPENDIX A-1**SCHEDULE OF LUMINAIRE (400W HPSV/SON)**

ITEM	DESCRIPTION	DATA/MATERIAL
16	Relevant Standard of Conformity	
17	Total Light Output Ratio - TLOR	
18	Downward Light Output Ratio-DLOR	
19	Direction of maximum intensity measured from the downward vertical (Cd/1000 lm)	
20	Maximum intensity at 80° from the downward vertical (Cd/1000 lumen)	
21	Maximum intensity at 88° from the downward vertical (Cd/1000 lumen)	
22	Maximum intensity above the horizontal (Cd/1000 lumen)	
23	Relevant pamphlets to substantiate the above mentioned data and test certificates to be enclosed	

.....
T/t, Nama & Cop Pengilang.....
T/t, Nama & Cop Kontraktor Elektrik**APPENDIX A-2**

SPECIFICATION FOR ROAD LIGHTING INSTALLATION

Hak Cipta :1999 Cawangan Elektrik JKR Malaysia

**SCHEDULE OF LUMINAIRE (250W HPSV/SON)**

ITEM	DESCRIPTION	DATA/MATERIAL
A	MAKE	
1	Manufacturer	
2	Country of manufacture	
3	Brand of Luminaire	
4	Model of Luminaire	
B	MATERIAL	
5	Lamp Compartment	
6	Control Gear Compartment	
7	Sealing Gasket	
8	Reflector	
9	Cover Bowl	
10	Lampholder	
11	Bowl Retainer Catch	
C	PHOTOMETRY	
12	Standard Position	
13	Facilities for Directional Light Control	
14	Optical Compartment (Degree of Protection)	
15	Control Gear Compartment (Degree of Protection)	

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APPENDIX A-2



SCHEDULE OF LUMINAIRE (250W HPSV/SON)

ITEM	DESCRIPTION	DATA/MATERIAL
16	Relevant Standard of Conformity	
17	Total Light Output Ratio - TLOR	
18	Downward Light Output Ratio-DLOR	
19	Direction of maximum intensity measured from the downward vertical (Cd/1000 lm)	
20	Maximum intensity at 80° from the downward vertical (Cd/1000 lumen)	
21	Maximum intensity at 88° from the downward vertical (Cd/1000 lumen)	
22	Maximum intensity above the horizontal (Cd/1000 lumen)	
23	Relevant pamphlets to substantiate the above mentioned data and test certificates to be enclosed	

.....
T/t, Nama & Cop Pengilang

.....
T/t, Nama & Cop Kontraktor Elektrik



APPENDIX A-3

SCHEDULE OF LUMINAIRE (150W HPSV/SON)

ITEM	DESCRIPTION	DATA/MATERIAL
A	MAKE	
1	Manufacturer	
2	Country of manufacture	
3	Brand of Luminaire	
4	Model of Luminaire	
B	MATERIAL	
5	Lamp Compartment	
6	Control Gear Compartment	
7	Sealing Gasket	
8	Reflector	
9	Cover Bowl	
10	Lampholder	
11	Bowl Retainer Catch	
C	PHOTOMETRY	
12	Standard Position	
13	Facilities for Directional Light Control	
14	Optical Compartment (Degree of Protection)	

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APPENDIX A-3

SCHEDULE OF LUMINAIRE (150W HPSV/SON)

ITEM	DESCRIPTION	DATA/MATERIAL
15	Control Gear Compartment (Degree of Protection)	
16	Relevant Standard of Conformity	
17	Total Light Output Ratio - TLOR	
18	Downward Light Output Ratio-DLOR	
19	Direction of maximum intensity measured from the downward vertical (Cd/1000 lm)	
20	Maximum intensity at 80° from the downward vertical (Cd/1000 lumen)	
21	Maximum intensity at 88° from the downward vertical (Cd/1000 lumen)	
22	Maximum intensity above the horizontal (Cd/1000 lumen)	
23	Relevant pamphlets to substantiate the above mentioned data and test certificates to be enclosed	

.....
T/t, Nama & Cop Pengilang

.....
T/t, Nama & Cop Kontraktor Elektrik

**APPENDIX A-4****SCHEDULE OF LUMINAIRE (100W HPSV/SON)**

ITEM	DESCRIPTION	DATA/MATERIAL
A	MAKE	
1	Manufacturer	
2	Country of manufacture	
3	Brand of Luminaire	
4	Model of Luminaire	
B	MATERIAL	
5	Lamp Compartment	
6	Control Gear Compartment	
7	Sealing Gasket	
8	Reflector	
9	Cover Bowl	
10	Lampholder	
11	Bowl Retainer Catch	
C	PHOTOMETRY	
12	Standard Position	
13	Facilities for Directional Light Control	
14	Optical Compartment (Degree of Protection)	
15	Control Gear Compartment (Degree of Protection)	

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APPENDIX A-4

SCHEDULE OF LUMINAIRE (100W HPSV/SON)

ITEM	DESCRIPTION	DATA/MATERIAL
16	Relevant Standard of Conformity	
17	Total Light Output Ratio - TLOR	
18	Downward Light Output Ratio-DLOR	
19	Direction of maximum intensity measured from the downward vertical (Cd/1000 lm)	
20	Maximum intensity at 80° from the downward vertical (Cd/1000 lumen)	
21	Maximum intensity at 88° from the downward vertical (Cd/1000 lumen)	
22	Maximum intensity above the horizontal (Cd/1000 lumen)	
23	Relevant pamphlets to substantiate the above mentioned data and test certificates to be enclosed	

.....
T/t, Nama & Cop Pengilang

.....
T/t, Nama & Cop Kontraktor Elektrik

APPENDIX B

SPECIFICATION FOR ROAD LIGHTING INSTALLATION

↳ Hak Cipta :1999 Cawangan Elektrik JKR Malaysia

**SCHEDULE OF TECHNICAL DATA - HPSV LAMPS**

ITEM	DESCRIPTION	400W	250W	150W	100W
1	Manufacturer				
2	Country of manufacture				
3	Model number				
4	Lamp type				
5	Wattage				
6	Efficacy (Lumen/Watt)				
7	Operating position				
8	Rated life (Hours)				
9	Luminous flux after 100 burning hours				
10	Colour temperature (K)				
11	Operating voltage				
12	Operating lamp current				
13	Max. starting current				
14	Waveband in which 80% of the spectral energy distribution will occur				
15	Time to reach 80% of max. luminous flux after switching				
16	Time to re-strike after power interruption				
17	Light depreciation after 5000 burning hours				
18	Mortality rate after 5000 burning hours				
19	Relevant Standards of conformity				
20	Relevant pamphlets to substantiate the above-mentioned data and test certificates to be enclosed				

.....
T/t, Nama & Cop Pengilang.....
T/t, Nama & Cop Kontraktor Elektrik**APPENDIX C**



SCHEDULE OF TECHNICAL DATA - CONTROL GEAR

BALLAST FOR THE FOLLOWING HPSV LAMPS

ITEM	DESCRIPTION	400W	250W	150W	100W
1	Manufacturer				
2	Model number				
3	Country of manufacture				
4	Nominal wattage				
5	Losses (in watts)				
6	Rated max. operating temperature of ballast winding - t_w ($^{\circ}\text{C}$)				
7	Max. winding temperature rise - Δt ($^{\circ}\text{C}$)				
8	Impedance				
9	Resistance				
10	Inductance				
11	Lamp current crest factor				
12	Power factor before correction				
13	Power factor after correction				
14	Expected life				

.....
T/t, Nama & Cop Pengilang

.....
T/t, Nama & Cop Kontraktor Elektrik

...cont. pg. 37/49

APPENDIX C

SCHEDULE OF TECHNICAL DATA - CONTROL GEAR

SPECIFICATION FOR ROAD LIGHTING INSTALLATION

↳ Hak Cipta :1999 Cawangan Elektrik JKR Malaysia

**IGNITOR FOR THE FOLLOWING HPSV LAMPS**

ITEM	DESCRIPTION	400W	250W	150W	100W
1	Manufacturer				
2	Model number				
3	Country of manufacture				
4	Nominal voltage				
5	Peak ignition voltage				
6	Losses (in watts)				
7	Max. housing temperature (°C)				
8	Max. operating temperature (°C)				
9	Conventional or electronic superimposed pulse type				
10	Timed type (Yes / No)				
11	Guaranteed life (no. of strikes)				

CAPACITOR FOR THE FOLLOWING HPSV LAMPS

ITEM	DESCRIPTION	400W	250W	150W	100W
1	Manufacturer				
2	Model number				
3	Country of manufacture				
4	Capacitance				
5	Material of container				

.....
T/t, Nama & Cop Pengilang.....
T/t, Nama & Cop Kontraktor Elektrik**APPENDIX D****SUBMISSION OF COMPUTER PLOTS.**



Electrical Contractors are required to submit computer plots of typical road sections as per format described in the layouts given.

APPENDIX D1 (1 to 4) - Computer Calculation Format For Road Lighting Installation
(To be submitted for various typical layout and sections as given in the Tender Document or obtained from JKR)

APPENDIX D2 (1 to 2) - Tabulated Summary Of Lighting Level Calculation/Data For Road Lighting Installation

The computer plots shall also be attached.

In addition, the photometric data of item 3.0 shall be submitted.

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

.....
Tandatangan dan Nama Kontraktor Elektrik

.....
Cop Kontraktor Elektrik

.....
Tarikh

APPENDIX D1-1

DESCRIPTION OF THE LAYOUT

Cross section (transversally)

* Road surface type : R

$$L_{ave} = 2 \text{ cd/m}^2$$

$$U_o = L_{min}/L_{ave} \quad 40\%$$

$$U_l = L_{min}/L_{max} \quad 70\%$$

T.I. 15% (Threshold Increment)

* Q_o :

* Maintenance factor :

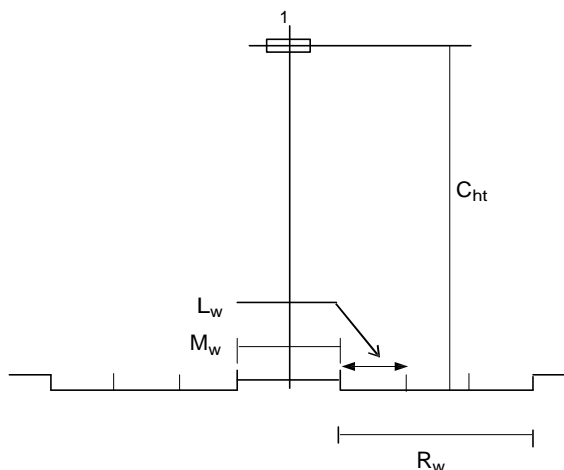
* Source : HPSV(Son-T)Watts

* Flux (klm) : klm

Tilting Angle : 5°

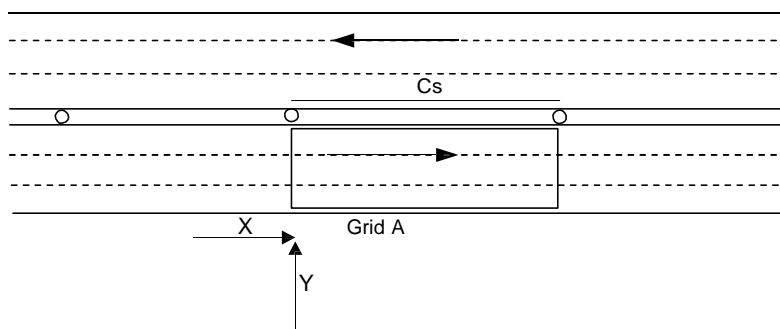
* Overhang :

SR (Surround Ratio) 0.5



Position of the calculation grids

Plan view [m]



LEGEND:

C_{ht} - Column height (m)

C_s - Column spacing (m)

L_w - Lane width (m)

M_w - Median width (m)

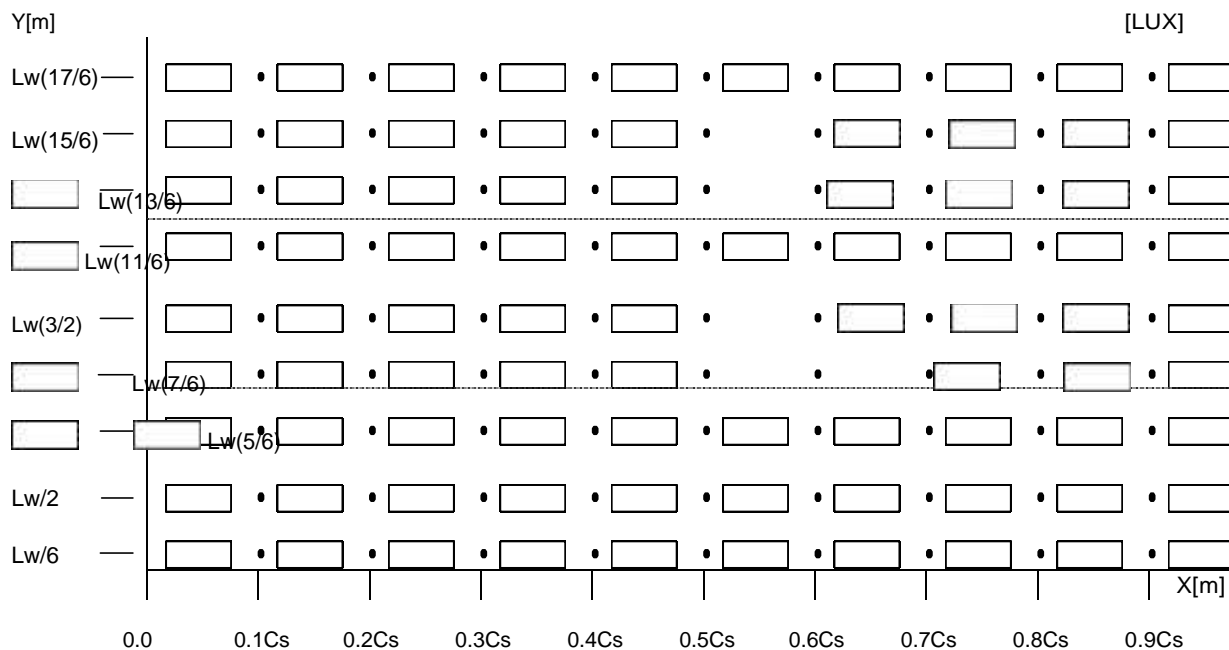
R_w - Road width (m)

* - Data to be filled in by JKR/Designer



APPENDIX D1-2

ILLUMINANCE ON THE 'GRID A' (TYPICAL FOR 3 LANE ROAD)



Eave = _____ Lux

Uo = Emin/Eave = _____ %

Emin = _____ Lux

Ug = Emin/Emax = _____ %

Emax = _____ Lux

Type of luminaire :

Data for 30 points per lane.

LEGEND :

Cs - Column spacing in metres

Lw - Lane width in metres

Tandatangan Pengilang

Tandatangan Kontraktor Elektrik

Cop Pengilang

Cop Kontraktor Elektrik

Nama: _____

Nama: _____

Jawatan: _____

Jawatan: _____

APPENDIX D1-3

LUMINANCE ON THE 'GRID A' (TYPICAL FOR A 3-LANE ROAD)

(Observer's position : X= - 60.0m Y= Lw/2 H= 1.5m)

Y[m]											[CD/M ²]
Lw(17/6)											
Lw(15/6)											
Lw(13/6)											
Lw(11/6)											
Lw(3/2)											
Lw(7/6)											
Lw(5/6)											
Lw/2											
Lw/6											

											X[m]
0.0	0.1Cs	0.2Cs	0.3Cs	0.4Cs	0.5Cs	0.6Cs	0.7Cs	0.8Cs	0.9Cs		

Lave = _____ cd/m²

Uo = Lmin/Lave = _____ %

Lmin = _____ cd/m²

UI = Lmin/Lmax = _____ %

Lmax = _____ cd/m²

Type of luminaire :

Data For 30 Points Per Lane

LEGEND :

Cs - Column spacing in metres

Lw - Lane width in metres

Tandatangan Pengilang

Tandatangan Kontraktor Elektrik

Cop Pengilang

Cop Kontraktor Elektrik

Nama:

Nama:

Jawatan:

Jawatan:

APPENDIX D1-4

LONGITUDINAL UNIFORMITY FOR EACH LANE (FOR A 3-LANE ROAD)

Observer on the axis $Y = +Lw/2$ m

X =	0.0	0.1Cs	0.2Cs	0.3Cs	0.4Cs	0.5Cs	0.6Cs	0.7Cs	0.8Cs	0.9Cs	[m]
-----	-----	-------	-------	-------	-------	-------	-------	-------	-------	-------	-----

[illegible]
$$Ugl_1 = L_{min}/L_{max} = \underline{\hspace{2cm}}\%$$

Observer on the $Y = +Lw(3/2) m$

X =	0.0	0.1Cs	0.2Cs	0.3Cs	0.4Cs	0.5Cs	0.6Cs	0.7Cs	0.8Cs	0.9Cs	[m]
-----	-----	-------	-------	-------	-------	-------	-------	-------	-------	-------	-----

[illegible]
$$U_{gl_2} = L_{min}/L_{max} = \underline{\hspace{2cm}}\%$$

Observer on the $Y = +Lw(15/6)$ m

X =	0.0	0.1Cs	0.2Cs	0.3Cs	0.4Cs	0.5Cs	0.6Cs	0.7Cs	0.8Cs	0.9Cs	[m]
-----	-----	-------	-------	-------	-------	-------	-------	-------	-------	-------	-----

[illegible]
$$Ugl_3 = Lmin/Lmax = \underline{\hspace{2cm}}\%$$

Tandatangan Pengilang

Tandatangan Kontraktor Elektrik

Cop Pengilang

Cop Kontraktor Elektrik

Nama:

Nama:

Jawatan: _____

Jawatan: _____

SPECIFICATION FOR ROAD LIGHTING INSTALLATION



APPENDIX D2-1

TABULATED SUMMARY OF LIGHTING LEVEL CALCULATION/DATA (LUMINANCE) FOR ROAD LIGHTING INSTALLATION

PROJEK :

NO. RUJUKAN : PKR(L)

Luminaire Brand / Model No. :

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 CALCULATION NUMBER
				(L av) (cd/m ²)	(L min) (cd/m ²)	(L max) (cd/m ²)	U _o = (Lmin/Lav)	U _i = (Lmin/Lmax)	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 coss-sections/junctions numbers are given in the Tender Document.

Tandatangan, Nama,
Alamat dan Cop
Pembekal :

Tandatangan, Nama,
Alamat dan Cop
Kontraktor Elektrik :



APPENDIX D2-2

TABULATED SUMMARY OF LIGHTING LEVEL CALCULATION/DATA (ILLUMINANCE) FOR ROAD LIGHTING INSTALLATION.

PROJEK :

NO. RUJUKAN : PKR(L)

Luminaire Brand / Model No. :

Please key in the results from the computer print-out or exact calculated values into the table below.									
VARIOUS ROAD CROSS-SECTIONS/ JUNCTIONS #	WATTAGE	MOUNTING HEIGHT	SPACING (m)	Illuminance (lux)					COMPUTER CALCULATION NUMBER
				(E av)	(E min)	(E max)	Uo= Emin/Eave	Ug= Emin/Emax	

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.

Tandatangan, Nama,

Alamat dan Cop

Pembekal : Tarikh :

Tandatangan, Nama,

Alamat dan Cop

Kontraktor Elektrik :

APPENDIX E

TECHNICAL SCHEDULE OF COLUMNS AND BRACKET ARMS

ITEM	DESCRIPTION	DATA
1	COLUMN	
a	Name of manufacturer	
b	Address & country of manufacturer/fabricator of column	
c	Type of column *Delete whichever not applicable.	Hot-Dipped Galvanised Steel / * Pre-Stressed Spun Concrete /* Fibreglass Reinforced Type 1/Type2* Others.*
d	Compliance with relevant section of *Delete whichever not applicable.	BS 5649 (EN40)* ANSI C-136.20 & ASTM D 4923-89* Others (Specify)*.....
e	Name of hot-dip galvanising company	
f	Address & country of manufacturer of steel tubes	
g	Galvanising standards & minimum. weight per m ² . (g/ m ²)	
h	Overall height of column (m)	
i	Tapering ratio	
j	Weight of columns (kg) - Whole Upper section Lower section	
k	Thickness of steel column (mm.) / Concrete wall thickness (mm)	
l	Name of company applying bituminous paint	
m	Address of company applying bituminous paint	
n	Dry film thickness of bituminous paint (mm)	
o	Equivalent weight of bituminous coating per sq.m. (g/m ²)	
p	Longitudinal seam weld minimum penetration (%)	
q	Reference standard of welding test (Latest relevant B.S.)	

.....
T/t, Nama & Cop Pengilang

.....
T/t, Nama & Cop Kontraktor Elektrik

...cont. pg. 46/49

APPENDIX E



TECHNICAL SCHEDULE OF COLUMNS AND BRACKET ARMS

ITEM	DESCRIPTION	DATA
2	BRACKET ARM	
a	Name of manufacturer	
b	Address & country of manufacturer	
c	Material of bracket arm	
d	Name of hot dip galvanising company	
e	Bracket arm projection (m)	
f	Grade of steel used/standards complied	
g	Weight of bracket (kg)	
h	Thickness of steel bracket (mm)	

.....
T/t, Nama & Cop Pengilang

.....
T/t, Nama & Cop Kontraktor Elektrik



APPENDIX F

VOLTAGE DROP CALCULATION FOR THE ROAD LIGHTING INSTALLATION

PROJEK :

FEEDER PILLAR No. (To be filled for each Feeder Pillar) :

REFERENCE DATA :-

LUMINAIRES WATTAGE : CURRENT (Amps.) PER LUMINAIRE : CABLE SIZE AND TYPE :

VOLTAGE DROP FOR THE ABOVE CABLES.

ITEM	CIRCUIT No.	Please insert the data below for each phase. (Refer Tender Drawings)			TOTAL VOLT DROP (Volts)	CATATAN
		PHASE	QTY*	TOTAL WATTS		
1	Circuit 'a'	R				
		Y				
		B				
2	Circuit 'b' (if any)	R				
		Y				
		B				
3	Circuit 'c' (if any)	R				
		Y				
		B				

NOTES :-

1. The total voltage drop along the one complete circuit for each phase must not exceed 20 volts.
2. The Tenderer shall attach together with this Form the complete voltage drop calculation.
3. All calculation shall be in accordance with the Tender Drawings.
4. * - State the quantity of luminaires in this particular circuit.

Tandatangan, Nama, Alamat dan Cop Kontraktor
Elektrik:

.....
.....
.....

Tarikh :

APPENDIX G

SERVICE AND MAINTENANCE FOR THE ROAD LIGHTING SYSTEM (For use during the Defects liability Period)

PROJEK :

NO. RUJUKAN : PKR(L)

Period of Service and Maintenance : (...../...../..... to/...../.....) (dd/mm/yyyy)

Schedule of work to be carried out at 3 monthly intervals.

ITEM	DESCRIPTION	ACTION	REMARK
A	COLUMNS (Please specify column number/circuit under REMARK' for any defects found)		
	1 Column Number or circuit label	<input type="text"/>	
	2 Ensure all columns straight	<input type="text"/>	
	3 Ensure all service door covers intact	<input type="text"/>	
	4 Replace missing service doors	<input type="text"/>	
	5 Clear debris around base/foundation	<input type="text"/>	
	6 Check Labels present and clean	<input type="text"/>	
	7 Check for column damage	<input type="text"/>	
	8 Others (please specify)	<input type="text"/>	
B	BASE SECTION - CABLE TERMINATION		
	1 Check all cable termination for signs of loose contact and corrosion	<input type="text"/>	
	2 Clean and tighten where necessary	<input type="text"/>	
	3 Replace faulty MCBs, junction boxes for each column	<input type="text"/>	
C	LUMINAIRES		
	1 Check functionality	<input type="text"/>	
	2 Replace faulty lamp		

...cont. pg. 49/49

APPENDIX G

SERVICE AND MAINTENANCE FOR STREET LIGHTING SYSTEM (For use during the Defects liability Period)

PROJEK :

Period of Service and Maintenance : (...../...../..... to/...../.....) (dd/mm/yyyy)

Schedule of work to be carried out at 3 monthly intervals.

ITEM	DESCRIPTION	ACTION	REMARK
3	Replace faulty ignitor	<input type="checkbox"/>	
4	Replace faulty capacitor	<input type="checkbox"/>	
5	Replace faulty ballast	<input type="checkbox"/>	
6	Clean luminaire bowl (once in 12 months)	<input type="checkbox"/>	
D	FEEDER PILLARS		
1	Check and clean Feeder Pillars - both internally and the surrounding area.	<input type="checkbox"/>	
2	Check and replace faulty components - MCBs, timeswitches, relays, cabling, luminaires, contactors, changeover switch, etc.	<input type="checkbox"/>	
E	TESTING AND RECORDS		
1	Test system/installation and record all test results, inspection and work done	<input type="checkbox"/>	

PERAKUAN KONTRAKTOR ELEKTRIK

Kami mengaku telah melaksanakan kerja-kerja penyelenggaraan seperti tercatat dalam kedua-dua muka surat borang Appendix G.

Adalah disahkan kerja-kerja di atas telah dilaksanakan dan perkara-perkara bertanda *(asterisk) perlu/akan diambil tindakan oleh Kontraktor Elektrik

Tandatangan

Kontraktor Elektrik :

Nama :

Alamat &

Cop rasmi :

Tandatangan Pegawai JKR :

Nama :

Jawatan :


Tarikh :

Tarikh :

**ADDENDUM NO. 1 REVISION 1
TO
L-S20 : SPECIFICATION FOR ROAD
LIGHTING INSTALLATION
(August 1999)**

SECTION A2.0: ROAD LIGHTING LUMINAIRES – LED

This addendum is additional to Section 2.0 of L-S20 :
SPECIFICATION FOR ROAD LIGHTING INSTALLATION (August 1999)
and shall be read together with the complete specifications.

	ADDENDUM NO.1	CKE.LS.01.20.(02).2013 Date Issued: Aug 1999
SECTION: A2.0	ROAD LIGHTING LUMINAIRES - LED	Revision of addendum: 0
		Date: Feb 2013
		Page: SA2 - 1 of 9

A2.1 General

Luminaires utilising Light Emitting Diode (LED) as light source are also known as Solid State Lighting (SSL).

Solid State Lighting (SSL) i.e LED luminaire system shall be complete with electronic control gear (driver), thermal management unit, surge & overvoltage protection and design for side entry suitable for supply voltage of 230 Volt, +10%, -6%, 50 Hz.


Computer simulation for lighting level calculation shall be supplied (prepared and submitted) to meet the design criteria and lighting class required (APPENDIX D1 – 1.1A) 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, Ulysee etc.)

A2.2 Conformity With Standards


All products proposed must have product certification from accredited certification bodies.

LED luminaire shall be tested to comply with the current prevailing standards as below and of latest version:-

No.	Item	Relevant IEC Standards	Name of standard
1.0	Luminaire		
1.1	Safety	MS IEC 60598-2-3	Luminaires - Part 2-3: Particular Requirements – Section 3: Luminaires for Road and Street Lighting
1.2	Performance	MS 62722-1	Luminaire Performance – part 2-1 : Particular Requirement for LED Luminaires
1.3	Performance	IES LM-79-08	Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products
1.4	Performance	IES TM 21-11	Projecting Long Term Lumen Maintenance of LED Light Sources
2.0	Control Gear (LED Driver)		
2.1	Safety	MS IEC 61347-2-13 IEC 61347-2-13	Lamp Control Gear – Part 2-13 – Particular Requirement for DC

	ADDENDUM NO.1	CKE.LS.01.20.(02).2013 Date Issued: Aug 1999
SECTION: A2.0	ROAD LIGHTING LUMINAIRES - LED	Revision of addendum: 0
		Date: Feb 2013
		Page: SA2 - 2 of 9


No.	Item	Relevant IEC Standards	Name of standard
			or AC supplied Electronic Control Gear for LED Modules.
2.2	Performance	MS IEC 62384 IEC 62384 ed 1.1	DC or AC supplied Electronic Control Gear for LED Modules – Performance Requirements
3.0	Lamp Holder		
	Safety	MS IEC 60838-2-2 (IEC 60838-2)	Miscellaneous lampholders – Part2-2 – Particular Requirements – Connectors for LED Modules.
4.0	LED		
4.1	Term & Defination	MS IEC 62504 IEC 62504 (Ed. 1)	General Lighting: LEDs and LED Modules – Terms and Defination.
4.2	Performance (General)	IEC / PAS 62707 Ed. 1	LED – Binning – Part 1: General Requirements and White Grid
4.3	Performance (Modules)	MS 62717	LED Modules for General Lighting – Safety Requirements
4.4	Peformance (Lamps)	IEC/TR 61341	Method of Measurement of Centre Beam Intensity and Beam Angle (s) of Reflector Lamps
4.5	Performance (Light Source)	IES LM-80-08	Approved Method: Measuring Lumen Maintenance of LED Light Sources
4.6	Safety (Modules)	MS IEC 62031 IEC 62031(Edition 1.0) AMD.1.ed 1	LED Modules for General Lighting – Safety Specifications
4.7	Safety (Lamps)	IEC 61231	International Lamps Coding Systems
4.8	Safety (Eye Protection)	IEC 62471 ed 1.0	Photobiological Safety of Lamps and Lamp Systems
4.9	Safety (Eye Protection)	IEC/TR 62471-2	Photobiological Safety of Lamps and Lamp Systems – Part 2:Guidance on Manufacturing Requirements Relating to Non-Laser Optical Radiation Safety
10.0	Connector		
	Safety	IEC 61984	Connectors – Safety Requirement and Test

	ADDENDUM NO.1	CKE.LS.01.20.(02).2013 Date Issued: Aug 1999
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No.	Item	Relevant IEC Standards	Name of standard
11.0	EMC		
11.1	Performance	IEC 61547 Edition 2.0	Equipment for General Lighting Purposes – EMC Immunity Requirements
11.2	Performance	IEC 61000-3-2 Edition 3.2	Electromagnetic Compatibility (EMC) – Part 3-2: Limits – Limits for Harmonic Current Emissions (Equipment Input Current 16 A per phase)
11.3	Performance	CISPR 15:2005 (BS EN 50015)	Limits and Methods of Measurement of Ratio Disturbance Characteristics of Electrical Lighting and Similar Equipment
12.0	Lighting Design		
12.1	Performance	MS 825	Code of Practice for The Design of Road Lighting

A2.3 Construction And Components


- a) The luminaire shall be so designed and constructed that it is capable of providing the service for which it is intended. Sound engineering principles shall be adopted throughout and the luminaire shall be designed to enable ease of maintenance and replacement of light source, optical lens, electronic control gear, thermal management unit, reflector and holder without the use of special tools.
- b) The main supporting structure of the luminaire shall be constructed from die-cast aluminium alloy material such that no undue deterioration in its safety, performance or appearance during normal life when operating in all climatic conditions prevailing in a tropical country such as heavy rains, strong winds, high humidity and hot day-time temperatures. It shall be robustly constructed to withstand vibration in normal use.
- c) The luminaire shall be designed so that condensation shall not fall on any operating part which may fail or deteriorate the performance of luminaire.

	ADDENDUM NO.1	CKE.LS.01.20.(02).2013 Date Issued: Aug 1999
SECTION: A2.0	ROAD LIGHTING LUMINAIRES - LED	Revision of addendum: 0
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		Page: SA2 - 4 of 9

- d) All luminaires shall be new, totally enclosed and protected against contact with live or moving parts inside the enclosure. Ingress Protection Index (IP) of LED luminaire shall be minimum IP65. Full details of the IP system can be referred to in MS IEC 60529.
- e) The compartment for electronic control gear and light module shall preferably be separated. Access to the electronic control gear (driver) compartment shall preferably be from the top.
- f) Material used for the construction of the luminaire shall be recyclable.
- g) Hinges, screws and clips if used, shall be robust and made of stainless steel, simple to operate and shall not be liable to accidental detachment during installation or maintenance.
- h) 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 column.
- i) Attachment of the luminaire to its bracket arm shall be by means of clamps or jam bolts and designed to accommodate spigot size of the luminaires. A minimum of two (2) locking bolts / jam screws shall be provided.
- j) The minimum penetration depth of the bracket arm is 100mm. The mounting arrangement and attachment of the luminaire shall be such as to withstand a windspeed of 42 m/s on the projected surface of the assembly without due deflection.
- k) All parts 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.
- l) All parts shall operate well within the ratings with due consideration for the local conditions (high humidity of 80% RH, hot (live) ambient temperature of 35°C).
- m) Interchangeability of consumable components is preferred for maintenance purposes.

A2.3.1 Light Source

- a) The light source for LED luminaires shall be of high powered LED type. The LED light module shall not be driven more than the rated LED drive current.

	ADDENDUM NO.1	CKE.LS.01.20.(02).2013 Date Issued: Aug 1999
SECTION: A2.0	ROAD LIGHTING LUMINAIRES - LED	Revision of addendum: 0
		Date: Feb 2013
		Page: SA2 - 5 of 9

- b) The lumen output of LED luminaires (system efficacy) shall be minimum 90 lm/W. The usable lifetime of LED (lumen maintenance) at 36,000 hours shall not be less than 80% (L80 @ 36,000 hours). The system efficiency shall take into consideration the LED efficacy, driver efficiency, optical efficiency and thermal efficiency and shall not be less than 80%.
- c) The Correlated Colour Temperature (CCT) for LED luminaire shall range between 2500K to 3500K.
- d) Photobiological safety of LED module or LED luminaires shall not be more than Risk Group 1 (as per IEC 62471).

A2.3.2 The Optical System

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

a) Optical Lens

The optical lens shall be made of UV resistant material (eg. poly methyl methacrylate (PMMA), UV stabilized polycarbonate, silicon, etc) and shall be stabilised against deformation, deterioration or discolouration due to the lamp and/or solar radiation (UV).

b) Reflector


The reflector if any shall be made of at least 99.85% pure aluminium with a minimum thickness of 1 mm, be electrically brightened, anodised and chemically treated to give high reflectance.

c) Luminaire Cover (Secondary Optics)

Luminaire cover shall be provided to protect the optical lens from accumulation of dust and for easy cleaning of the luminaire. It shall be made UV resistant material suitable for outdoor used (in accordance with standard UL746C or equivalent).

For covers that is designed as light diffuser/disperser, it shall be made of clear tempered glass.

- d) The gasket used shall be silicone, one piece weather resistant type that will 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.

	ADDENDUM NO.1	CKE.LS.01.20.(02).2013 Date Issued: Aug 1999
SECTION: A2.0	ROAD LIGHTING LUMINAIRES - LED	Revision of addendum: 0
		Date: Feb 2013
		Page: SA2 - 6 of 9

A2.3.3 Thermal Management Unit

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

A2.3.4 Electronic Control Gear (LED Driver)

- a) Electronic control gear (LED driver) shall comprise of electronic circuit board, converter, built-in power factor correction unit (0.9), internal surge protective device (SPD) and THD <20%. The driver shall be able to withstand short circuit current, overload, over voltage and over temperature. The driver shall have self cooling system. LED driver shall be placed close to LED where possible to reduce electromagnetic interference.
- b) The input range of the driver shall function correctly at the supply voltage and shall allow for normal variation and surges (230V, +10%, -6%, 50 Hz).
- c) The working temperature for the driver shall suit the local condition.
- d) Ingress Protection Index (IP) of the driver shall be minimum IP65 as per MS IEC 60529.

A2.3.5 Surge Protective Device (SPD)

- a) Internal/Built-In SPD


The driver shall be protected against lightning surge with an internal surge protector devices (SPD) of not less than 15kA with a let-through voltage of less than 350V test at 2kV, 1.2/50µSec open circuit and 1kA, 8/20µSec short circuit.

- b) External SPD

To enhance the driver life span and prolong the internal SPD performance, the external SPD may be installed within the column after the modular termination box for safety and ease of maintenance.

If required, the external SPD shall be rated not less than 20kA with a let- through voltage of less than 850V tested at 6kV, 1.2/50µSec open circuit test and 3kA, 8/20µSec short circuit test .

The SPD shall be Full Mode (L-N, L-E, N-E) protection with a working voltage of 275Vac series connection and complete with LED indicator.

	ADDENDUM NO.1	CKE.LS.01.20.(02).2013 Date Issued: Aug 1999
SECTION: A2.0	ROAD LIGHTING LUMINAIRES - LED	Revision of addendum: 0
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		Page: SA2 - 7 of 9

A 2.3.6 Internal Wiring and Earthing Terminal

2.3.6.1 Internal Wiring

- a) The luminaire shall be completely pre-wired, requiring only the connection of the electrical power supply cables to the terminal and the earth continuity conductor to the earthing terminal.

2.3.6.2 Earthing Terminal


- a) A separate terminal for the connection of an earth continuity conductor, clearly and permanently marked shall be provided. The installation shall comply to MS 60364.
- b) 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 earthing terminal.

A2.4 Computer Simulation for Lighting Level Calculation

- 2.4.1 Computer simulation for lighting level calculation shall include Photometric Data which comprises of the following:

- i) Isolux Diagram
- ii) Utilization Factor Curves
- iii) Polar Curves of the following C-Planes : 0°/180°; 90°/270°; maximum intensity plane
- iv) Downward Light Output Ratio
- v) Downward and Upward Flux Fractions

Tender documents submitted without the appropriate Computer Simulation will be disqualified.

	ADDENDUM NO.1	CKE.LS.01.20.(02).2013 Date Issued: Aug 1999
SECTION: A2.0	ROAD LIGHTING LUMINAIRES - LED	Revision of addendum: 0
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2.4.2 Tenderers are required to furnish comprehensive information and technical particulars as stipulated in:-

- i) APPENDIX D1 – Computer Calculation Format for Road Lighting Installation
(To be submitted for Road 1 and Road 2 as given in **Attachment A**)
- ii) APPENDIX D2 – Tabulated Summary of Lighting Level Calculation / Data For Road Lighting Installation

The computer plots shall also be attached.


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

A2.5 Schedule and Technical Information on LED Luminaires

2.5.1 Tenderers are required to furnish comprehensive information and technical particulars as stipulated in **Attachment B (Product Features)**.

2.5.2 The information required in the attachment shall be completed fully and correctly. All technical data entered therein shall be substantiated with relevant pamphlets and test certificates from the manufacturers or the recognized testing authorities.

Failure to fulfill the above requirements shall result in the disqualification of the tender.

	ADDENDUM NO.1	CKE.LS.01.20.(02).2013 Date Issued: Aug 1999
SECTION: A2.0	ROAD LIGHTING LUMINAIRES - LED	Revision of addendum: 0
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A2.6 Warranty

2.6.1 System Warranty

The manufacturer / distributor shall provide a 5 year warranty certificate for the complete luminaire system to guarantee the longlife expectancy and maintenance free luminaire. **Warranty declaration** shall be filled and duly signed by distributor / manufacturer as per **Attachment C**. 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/distributor at no cost to the government.

2.6.2 Performance Warranty

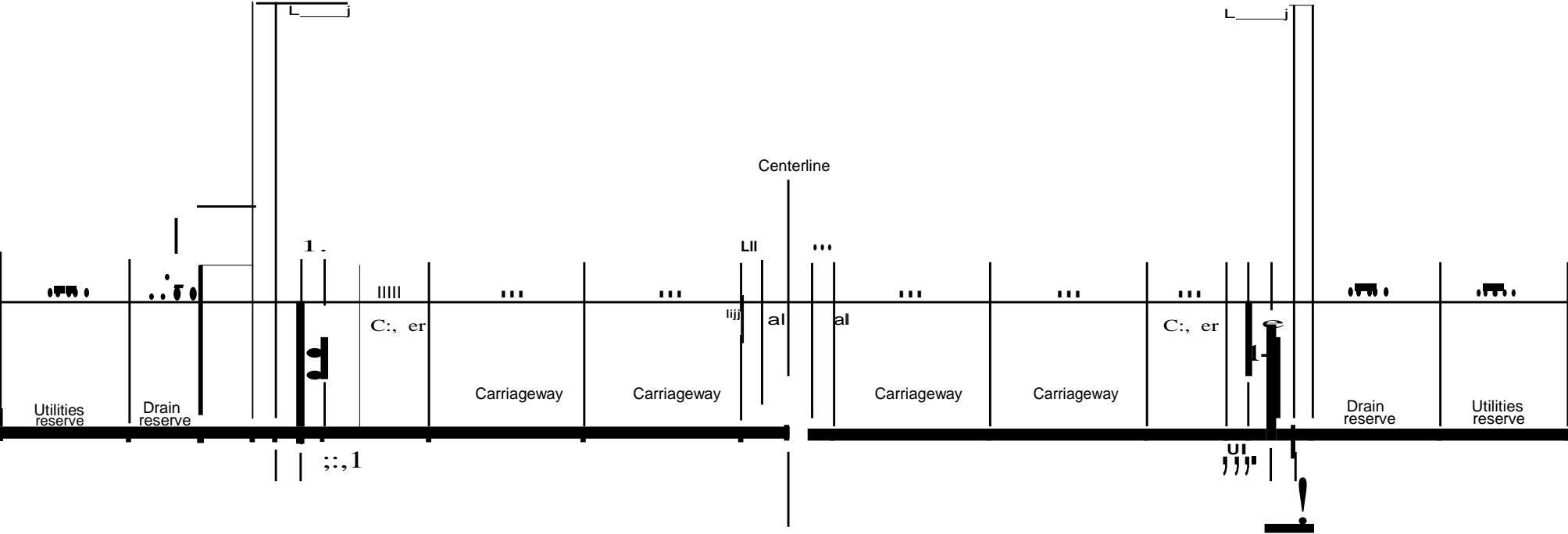
Luminance and illuminance test shall be carried out every six (6) months during defect liability period, to ensure the performance of the installed system conform to designed requirement. These tests will also confirm the lumen maintenance of the luminaire.

The contractor together with luminaire supplier shall carry out the above test and the result must meet the design criteria as submitted in the computer simulation.

Note :

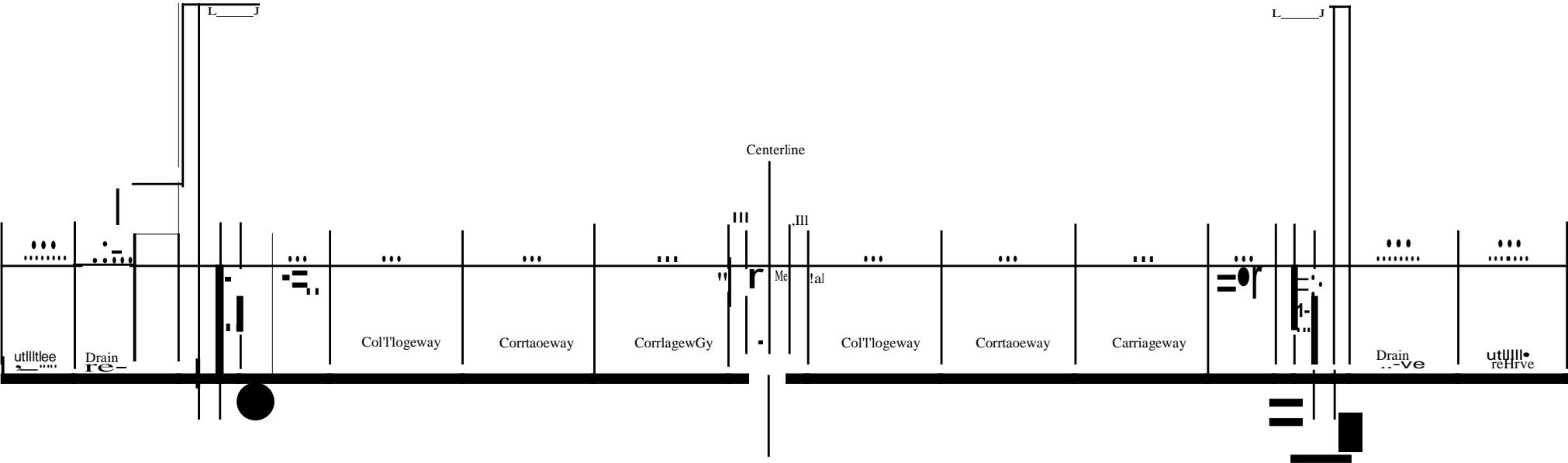
1. System Efficacy = LED Efficacy X Driver Efficiency X Optical Efficiency X Thermal Efficiency
2. System Efficiency = $\frac{\text{System Efficacy (Luminaire Lumen Output)}}{\text{LED Efficacy (Light Source Lumen Output)}}$
3. Maintenance Factor = Lamp Lumen Maintenance Factor X Luminaire Maintenance Factor

Road1



DESIGN REQUIREMENT : UGH114Ga.ASS ME1 (t.tSB25)

Permeable Layer (mm) (mm)	Overall Uniformity (mm)	Longitudinal Uniformity (mm)	Threshold (mm) (mm)	GF, Overall Ratio (mm)	Long Maintenance factor
2.0	U	0.7	10	1.5	U

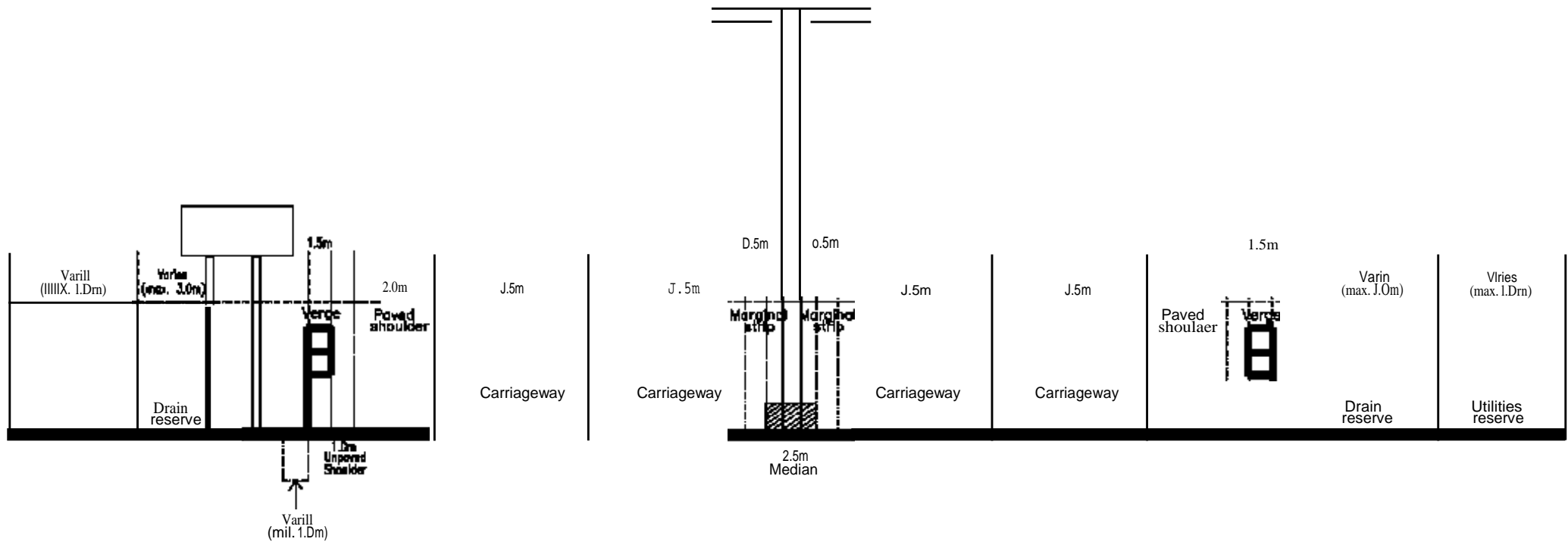


DESIGN REQUIREMENT : LIGHTING CLASS ME1 (M3825)

Average Lightsource (pole, streetlight, Lum (cd))	Overall Uniformity, Uo (cd/cd)	Longitudinal Uniformity, UL (cd/cd)	Threshold Contrast, TC (m/m) (Quality-0.05)	Glare Index, GI (cd/cd)
10	0.4	0.7	10	0.5	U

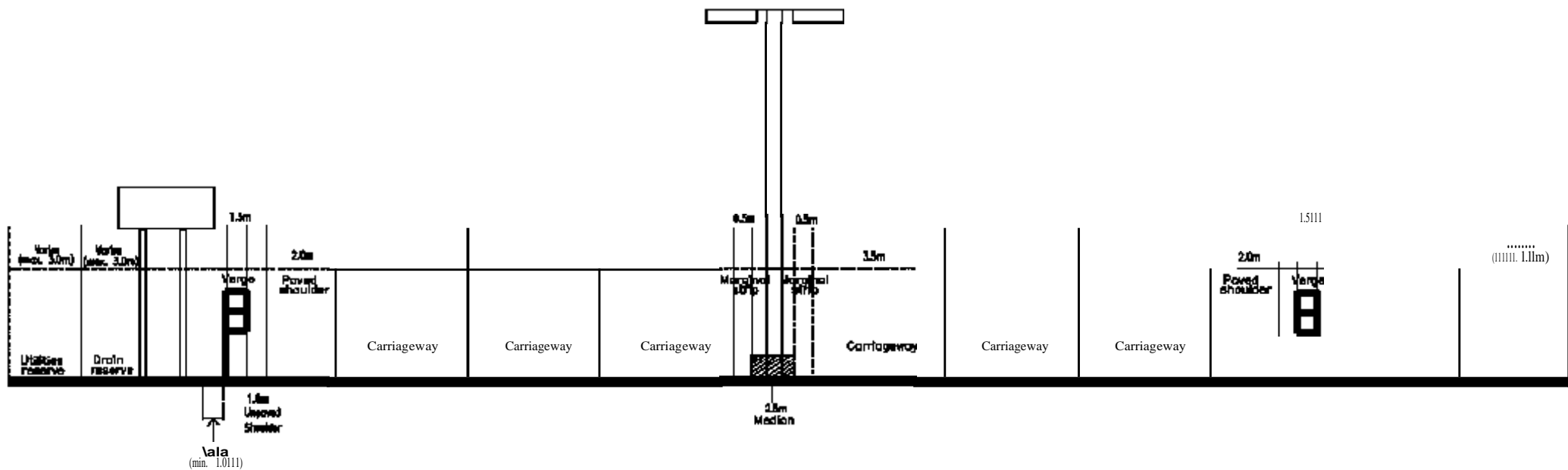
Road 1

ATTACHMENT A-3



DESIGN REQUIREMENT : UGHTING CLASS MEI (MS825}

2.0	0.4	0.7	10	0.5	D.8
-----	-----	-----	----	-----	-----



DESIGN REQUIREMENT : UGHTING CItSS ME1 (MS825)

...../11/11,Uo(olli,IL(olli,11-10 Mt
ID	u	IL7	10	u	u

ROAD LIGHTING LUMINAIRE**PRODUCT FEATURES**

NO.	ITEM	BRAND:	
		MODEL FOR ROAD 1:	MODEL FOR ROAD 2:
1	Technical Specification		
1.1	Input Requirements		
	Voltage,Hz		
	Models available		
	Power Connection Type		
1.2	Output Parameters		
	Power Consumption (@120 VAC)		
	Power Factor ≥ 0.9		
	Total Harmonic Distortion $\leq 20\%$		
	Colour Rendering Index, CRI (Ra)		
	Luminous Intensity Distribution Provided?		
	Test Temperature that photometry is produced		
	Lighting Class (results from Computer Simulation)		
	Maintenance Factor (MF= LLMF \times LMF)		
	Column Height (10m / 12m)		
	Column span / spacing		
2	Additional Information		
	Country of Manufacture		
	Product of:		
	Project reference		
3	ADDENDUM NO.1 to L-S20: Requirement on LED		
3.1	Construction And Components		
	Gross Weight		
	Materials Casing / Body		
	Ingress Protection (sealed with silicon gasket)	IP65	
	Jam bolts for clamping/securing/lock spigot to bracket arm		
	Operating Parameters		
	Operating Temperature	hot(live)/cold(lab)	
	Ambient Temperature	$T_a = 35^\circ\text{C}$	
	Working Humidity	RH> 80%	

ROAD LIGHTING LUMINAIRE**PRODUCT FEATURES**

NO.	ITEM		BRAND:	
			MODEL FOR ROAD 1:	MODEL FOR ROAD 2:
3.2	Light Source			
A.	Type of LED	High Powered LED		
	LED drive current			
B.	Brand of LED			
C.	Luminaire/System Efficacy (Lumen/w)	Min : 90 lm/W		
	LED Efficacy (lumen/W)			
D.	LED Lumen Maintenance L80@36,000 (Effective Burning Hours, Useable Lifetime)	Max.lumen depreciation = 80% at 36,000hrs		
E.	Luminaire/System Efficiency (Luminaire lumens output : light source /LED lumens output)			
	Luminaire Lumens Output	LLO = Efficacy x (a x b x c) ≥ 80%		
	a) Electronic Control Gear (DRIVER) Efficiency			
	b) Optical Efficiency			
	c) Thermal Management Efficiency, T _j			
F.	The Correlated Colour Temperature (CCT)	2500K < CCT < 3500K		
3.3	The Optical System			
A.	Component of Optical System			
B.	Optical Lens			
	Material : Poly Methyl Methacrylate / UV stabilized polycarbonate / Silicon			
C.	Reflector			
	Material : 99.85% pure aluminium with a minimum thickness of 1mm			
D.	Luminaire Cover (secondary optics)			
	a. designed as light diffuser	Tampered Glass		
	b. designed as cover only	UV Resistant Material		
E.	Silicon Gasket	one piece weather resistant type		
3.4	Thermal Management Unit			
A.	Material Type			
B.	Heat sink thermal resistance	(W/°C)		

ROAD LIGHTING LUMINAIRE**PRODUCT FEATURES**

NO.	ITEM		BRAND:	
			MODEL FOR ROAD 1:	MODEL FOR ROAD 2:
3.5	Electronic Control Gear (LED Driver) System			
A.	Component of LED Driver			
B.	Protection features	withstand short circuit current, overload, over voltage and over temperature.		
		Surge Suppressor		
		Power Factor Correction		
C.	Cooling System of LED Driver	self-cooling		
D.	Input Range	(230V, +10%, -6%, 50 Hz).		
E.	DC Output Range			
F.	Working Temperature for LED Driver	to suit local condition		
G.	Ingress Protection Index (IP)	Min : IP65		
3.6	Internal Wiring and Earthing Terminal			
	Completely Pre-wired			
3.7	Warranty			
	System Warranty:			
	Warranty Period for the complete luminaire (LED Driver, Optical System, Housing, Thermal Management)	5 year warranty certificate		
3.8	Conformity With Standards			
A	Luminaire			
	MS62722-1			
	MS IEC 60598-2-3			
	IES LM-79-08			
	IES TM 21-11			
B	Control Gear (LED Driver)			
	MS IEC 61347-2-13			
	MS IEC 60838-2-2			

ROAD LIGHTING LUMINAIRE**PRODUCT FEATURES**

NO.	ITEM	BRAND:	
		MODEL FOR ROAD 1:	MODEL FOR ROAD 2:
C	Lamp Holder		
	MS IEC 60838-2-2		
D	LED		
	MS IEC 62504		
	IEC/PAS 62707 Ed. 1		
	MS 62717		
	IEC/TR 61341		
	IES LM-80-08		
	MS IEC 62031		
	IEC 61231		
	IEC 62471 Ed. 1		
	IEC/TR 62471-2		
E	Connector		
	IEC 61984		
F	Electromagnetic Compatibility (EMC)		
	IEC 61547		
	IEC 61000-3-2		
	BS EN 55015		

WARRANTY DECLARATION

PROJECT:

Declaration by Distributor/Manufacturer:

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

Signature of distributor/manufacturer:

Name of Authorized Personnel:

Official stamp:

Date:

* Warranty certificate is attached

**ADDENDUM NO.2
TO
L-S20 : SPECIFICATION FOR ROAD
LIGHTING INSTALLATION
(August 1999)**

APPENDIX D1-1.1A : DESIGN CRITERIA


APPENDIX D1-1.2A : DESCRIPTION OF THE LAYOUT

APPENDIX D1-2A : ILLUMINANCE MEASUREMENT GRID

APPENDIX D1-3A : LUMINANCE MEASUREMENT GRID

APPENDIX D1-4A : LONGITUDINAL UNIFORMITY FOR EACH LANE

This addendum shall be read together with the complete specifications.

	ADDENDUM NO.2 TO L-S20 SPECIFICATION FOR ROAD LIGHTING INSTALLATION	CKE.LS.01.20.(02).2013 Date Issued: Aug 1999
	APPENDIX D1	Revision of addendum: 0
		Date: February 2015
		Page: 1 of 7

1. Page 3/49, item 2.3.2 – The Optical System

(iii) The luminaire shall incorporate provisions to enable adjustments to shift the main light distribution towards the axis of the road to suit different road widths. Such adjustments shall be simple and positive and shall be firmly retained in clearly identified positions. Photometric data shall be supplied for the particular distribution recommended in a given installation. These data may be supplied in computer diskettes together with software in the CIE format.

to be replaced with

(iii) The luminaire shall incorporate provisions to enable adjustments to shift the main light distribution towards the axis of the road to suit different road widths. Such adjustments shall be simple and positive and shall be firmly retained in clearly identified positions. Photometric data shall be supplied for the particular distribution recommended in a given installation. These data may be supplied in Compact Disc (CD) together with software according to the current prevailing MS/CIE format.

2. Page 37/49


to be replaced with

Page 2 of 7- Addendum No. 2 to Specification for Road Lighting Installation.

3. Appendix D1-1 (Page 39/49), Appendix D1-2 (Page 40/49), Appendix D1-3 (Page 41/49), Appendix D1-4 (Page 42/49)

to be replaced with

Appendix D1-1.1A, Appendix D1-1.2A, Appendix D1-2A, Appendix D1-3A, Appendix D1-4A

	ADDENDUM NO.2 TO L-S20 SPECIFICATION FOR ROAD LIGHTING INSTALLATION	CKE.LS.01.20.(02).2013 Date Issued: Aug 1999
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The Electrical Contractors are required to submit computer plots of road sections as stated in Appendix D2-1

The Electrical Contractors shall also filled up the Appendix below:-

- 1) APPENDIX D1-1.1A, 1.2A - Design Criteria
- 2) APPENDIX D1- (2A to 4A) - Computer Calculation Format for Road Lighting Installation (To be submitted for various layout and sections as stated in Appendix D2-1)
- 3) APPENDIX D2 - (1 to 2) - Tabulated Summary of Lighting Level Calculation/Data For Road Lighting Installation

The computer plots shall also be attached.

In addition, the photometric data of item 3.0 shall be submitted.


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

Tandatangan Kontraktor Elektrik

Cop Kontraktor Elektrik

Nama : _____

Jawatan : _____

	ADDENDUM NO.2 TO L-S20 SPECIFICATION FOR ROAD LIGHTING INSTALLATION	CKE.LS.01.20.(02).2013 Date Issued: Aug 1999
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APPENDIX D1 – 1.1A
DESIGN CRITERIA

*Road Lighting Class : ME____/ CE____

*Road Surface Type : Asphalt / Concrete

Luminance Coefficient, Q_o = _ _

Average Luminance, L_{ave} _____

Overall Uniformity, U_o _____

Longitudinal Uniformity, U_l _____

Threshold Increment, TI _____

Surround Ratio, SR _____

*Maintenance Factor , MF : _ _

*Column Height , H : _ _ m

* Column spacing (m) : _ _ m

*Lamp Type : _ _

*Lamp Wattage : _ _ W

Flux (klm) : _ _ klm

Lamp Tilting Angle : _ _

*Arm Length : _ _


*Overhang : _ _

*Setback : _ _

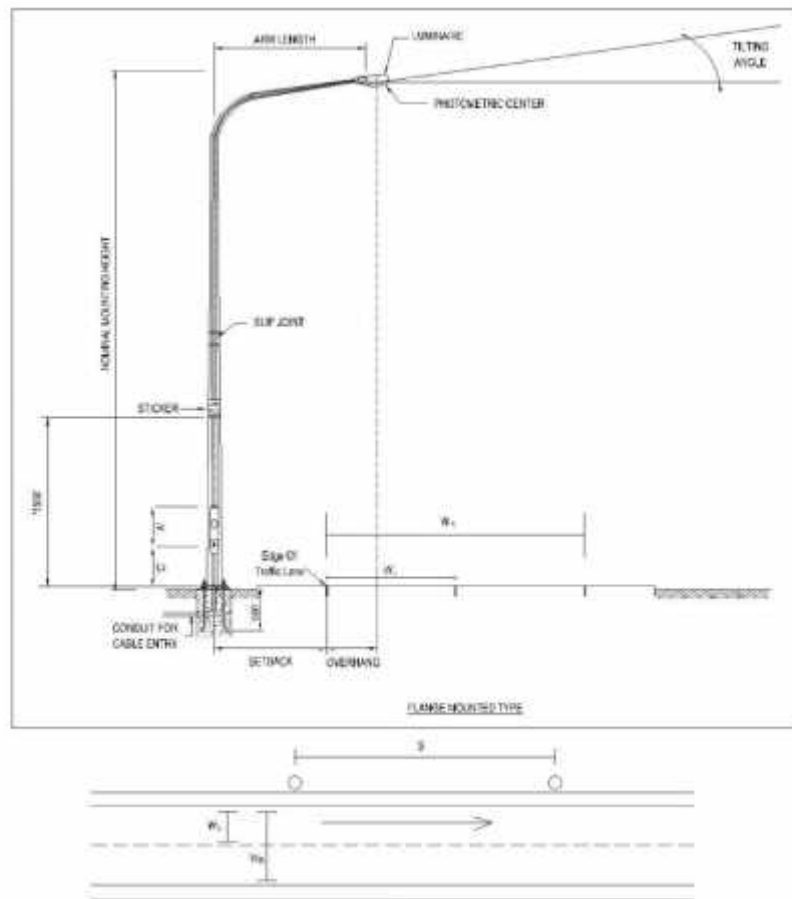
Note :

* Data to be filled by Designer

Maintenance Factor , MF = Luminaire MF X Lamp Lumen MF


	ADDENDUM NO.2 TO L-S20 SPECIFICATION FOR ROAD LIGHTING INSTALLATION	CKE.LS.01.20.(02).2013 Date Issued: Aug 1999
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APPENDIX D1 – 1.2A **DESCRIPTION OF THE LAYOUT**



LEGEND

S = Column Spacing (m)
 W_L = Lane Width (m)
 W_R = Carriageway Width (m)

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APPENDIX D1-4A
LONGITUDINAL UNIFORMITY FOR EACH LANE

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

$U_{11} = L_{\min} / L_{\max} = \underline{\hspace{2cm}} \%$

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

$U_{12} = L_{\min} / L_{\max} = \underline{\hspace{2cm}} \%$

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

$U_{13} = L_{\min} / L_{\max} = \underline{\hspace{2cm}} \%$

Tandatangan Pengilang/Pengedar

Tandatangan Kontraktor Elektrik

Cop Pengilang/Pengedar

Cop Kontraktor Elektrik

Nama : _____

Nama : _____


Jawatan : _____

Jawatan: _____


**ADDENDUM NO.3
TO
L-S20: SPECIFICATION FOR ROAD
LIGHTING INSTALLATION
(August 1999)**

INTEGRATED SOLAR LED ROAD LIGHTING SYSTEM

This addendum shall be read together with the complete specifications.

	ADDENDUM NO.3 TO L-S20 : SPECIFICATION FOR ROAD LIGHTING INSTALLATION	CKE.LS.01.20.(03).2020 Date Issued: Aug 1999
	INTEGRATED SOLAR LED ROAD LIGHTING SYSTEM	Revision Of Addendum : 1
		Date : August 2022
		Page: i of i

SECTION	CONTENT	PAGE
1.0	General	1/12
2.0	Construction	1/12
3.0	Components	2/12 - 5/12
	3.1 LED Luminaire	
	3.2 Solar Photovoltaic (PV) Module	
	3.3 Rechargeable Deep Cycle Battery	
	3.4 Solar Charge Controller	
	3.5 Lighting Column	
4.0	Schedule and Technical Information on Integrated Solar LED Road Lighting System	5/12
5.0	Warranty	6/12
6.0	Conformity with Standards	6/12
	Appendix A	8/12 - 11/12
	Appendix B	12/12


	ADDENDUM NO.3 TO L-S20 : SPECIFICATION FOR ROAD LIGHTING INSTALLATION	CKE.LS.01.20.(03).2020 Date Issued: Aug 1999
	INTEGRATED SOLAR LED ROAD LIGHTING SYSTEM	Revision Of Addendum : 1
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1.0 GENERAL

- 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 integrated solar LED road lighting system in accordance with the Conditions of Contracts, Bill of Quantities, Drawings and other related documents.
- 1.2 All standards shall conform to the latest Malaysia Standards (MS), International Electrotechnical Commission (IEC), MS IEC, British Standard Institution (BS), and /or BS EN standard.

2.0 CONSTRUCTION

- 2.1 An integrated solar LED road lighting system is an outdoor lighting luminaire system used for illuminating road or an amenity. A basic solar road lighting luminaire components are:
- 2.1.1 LED Luminaire;
 - 2.1.2 Solar Photovoltaic (PV) Module;
 - 2.1.3 Rechargeable Deep Cycle Battery;
 - 2.1.4 Solar Charge Controller and
 - 2.1.5 Lighting Column
- 2.2 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 electricity to charge the battery during daytime. The battery's charging shall be controlled by a solar charge controller. The operation of the luminaire shall be controlled by a control circuit either by using voltage or current sensor.
- 2.3 The configuration of integrated solar LED road lighting system shall be designed to be robust and shall withstand the harsh environment condition as the system will be continuously exposed to sun, rain, fog, pollution etc. The integrated solar road lighting system installed shall enhance the aesthetic of the city or road.
- 2.4 The rough service of integrated solar LED road lighting system 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.

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3.0 COMPONENTS

3.1 LED Luminaire

- 3.1.1 The luminaire shall be designed by using solid state lighting i.e. Light Emitting Diode (LED) as a light source.
- 3.1.2 The LED luminaire and its associated electrical components and technical specifications shall be designed and comply with L-S20: Specification for Road Lighting Installation (Addendum No.1: Road Lighting Luminaires – LED).
- 3.1.3 The LED luminaire shall be designed and constructed to be capable of providing the required lighting performance level as follows:
- Solar PV module shall be sized such that they can provide sufficient energy to the system for the intended service life of 25 years;
 - System losses shall be considered including dust and dirt, wiring losses, electronics losses and charging losses;
 - Batteries shall be sized for a minimum life cycle of 500 cycles at 80% Depth of Discharge (DOD);
 - The average luminous flux of luminaire shall not depreciate more than 30% from initial value at 50,000hours (L70 @ 50,000hours);
 - 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;
 - The solar lighting system shall be based on a 12 VDC or 24 VDC system voltage.

3.1 Solar Photovoltaic (PV) Module

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

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3.2.2 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.


3.2.3 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).

3.2.4 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.

3.2.5 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, 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/m^2 (2,400 Pa);
- e) Permitted operating temperature : -10°C to $+85^\circ\text{C}$;
- f) Warranties :
 - i) Linear performance warranty of 25 years.
 - ii) Degradation of power shall be as per table 1A :

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


Table 1A - Degradation of actual power versus nominal power

3.3 Rechargeable Deep Cycle Battery

- 3.3.1 Batteries are used to store the electricity generated by the solar PV module. Battery shall conform to the latest IEC 62133-2 or IEC 62619.
- 3.3.2 The battery shall be only Lithium-ion or Lithium polymer or Lithium iron phosphate battery type.
- 3.3.4 The lithium batteries shall be designed with the following features:
- System voltage : 12 VDC or 24 VDC;
 - Operating temperature : -5°C to 60°C;
 - Cycle efficiency : not less than 90%;
 - Minimum life cycle : 500 cycles at 80% Depth of Discharge (DOD);
 - Sufficient autonomy : minimum of two (2) overcast or rainy days;
 - Discharge time : minimum of 12 hours

3.4 Solar Charge Controller

- 3.4.1 Solar charge controllers shall be used to control the charging of the batteries. Since the output from solar PV module are variable and needs 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 conform to the latest IEC 62109-1.

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3.4.2 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.

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

- a) Total electronic efficiency : minimum 90% at full load;
- b) Humidity : 95% non-condensing;
- c) Terminations : Connectors;
- 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);
- o) Internet of Things (IoT) readiness (if specified)


3.5 Lighting Column

3.5.1 Lighting column shall comply with L-S20: Specification for Road Lighting Installation. It shall be designed and fabricated to withstand loading of all integrated solar LED road lighting components.

4.0 SCHEDULE AND TECHNICAL INFORMATION ON INTEGRATED SOLAR LED ROAD LIGHTING SYSTEM

4.1 Tenderers are required to furnish comprehensive information and technical particulars as stipulated in **Appendix A (Technical Schedule of Integrated Solar LED Road Lighting System)**

4.2 The information required in Appendix A shall be fully and correctly completed. All technical data entered therein shall be substantiated with relevant catalogues and test reports from the manufacturers and the accredited testing authorities respectively.

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5.0 WARRANTY

- 5.1 The manufacturer / distributor shall provide a 5 years' warranty certificate for the complete integrated solar LED luminaire to guarantee the long life expectancy and maintenance free luminaire.
- 5.2 Warranty declaration shall be filled and duly signed by manufacturer / distributor as per Appendix B. 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 / distributor at no cost to the government.
- 5.3 The warranty shall cover failure due to external factor such as phenomenal influences, etc. The cost to replace the integrated solar LED luminaire from uninstal to reinstall new replaced luminaire shall be borne by the manufacturer / distributor .


6.0 CONFORMITY WITH STANDARDS

The luminaire shall comply with and be tested to the relevant latest edition of Malaysia Standard or other relevant international standard as below:

Item	Criteria	Relevant Standards
Safety and Performance	Luminaire	IEC 60598-1 Luminaires - Part 1: General requirements and tests IEC 60598-2-3 Luminaires - Part 2-3: Particular requirements - Luminaires for road and street lighting IEC 62471 Photobiological safety of lamps and lamp systems and other relevant standards as stated in L-S20 Specifications
Photometric	Luminaire	IES LM-79 Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products

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Item	Criteria	Relevant Standards
Design	Solar Photovoltaic (PV) Module	IEC 61215-2 Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test Procedures
Safety	Rechargeable Deep Cycle Battery	IEC 62133-2 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 IEC 62619 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	Rechargeable Deep Cycle Battery	IEC 62620 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for use in industrial applications
Safety	Solar Charge Controller	IEC 62109-1 Safety of power converters for use in photovoltaic power systems - Part 1: General requirements
Safety and Performance	Lighting Column	Refer to Section 8.0 L-S20 Specification
Design	Road Lighting	PD CEN/TR 13201-1 Road Lighting - Guidelines on selection of lighting classes


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APPENDIX A


TECHNICAL SCHEDULE OF INTEGRATED SOLAR LED ROAD LIGHTING SYSTEM

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	LED LUMINAIRE			
1	Manufacturer		Please attach catalogue	
2	Brand & Model		Please attach catalogue	
3	Efficacy (lm/W)	lm/W	≥ 100	
4	Wattage (W)	W		
5	Correlated Colour Temperature (Kelvin)	K	2500 - 3500	
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	

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	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
A3	SOLAR PV MODULE			
1	Manufacturer		Please attach catalogue	
2	Brand & Model		Please attach catalogue	
3	Module Capacity	Watt	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})	Ampere	Please attach Solar PV datasheet	
8	Maximum voltage (V_{mp})	Volt	≥ 18.8 As per system voltage Please attach Solar PV datasheet	
9	Maximum power (P_{mp})	Watt	$P = I_{mp} \times V_{mp}$	
10	Lifetime	year	25	

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	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
A4	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 <i>Note : Battery capacity (Ah) varies based on the rated battery voltage</i>	
6	Operating Temperature	°C	-5°C to 60°C	
7	Charging Mode		Included	
8	Days of Autonomy	day	≥ 2	

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	DESCRIPTION	UNIT	DESIGN REQUIREMENT/ SPECIFICATION: - JKR	OFFERED SPECIFICATION (CONTRACTOR TO SPECIFY)
9	Discharge time	hour	≥ 12	
A5	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		95% Non - condensing	
6	Operating Temperature Range	°C	0°C to 50°C	
7	System voltage	V	12 VDC or 24 VDC	
8	Maximum charging current	A	Please provide detail calculation	

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APPENDIX B

WARRANTY DECLARATION

PROJECT:

Declaration by Manufacturer / Distributor:

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