LTA TRANSPORT AUTHORITY

ROAD STRUCTURE AND FACILITIES MANAGEMENT

GUIDELINES TO SUBMISSION OF DESIGN DRAWINGS FOR PUBLIC STREET LIGHTING AND ZEBRA CROSSING BEACON LIGHTING SYSTEM

CONTENTS

1 GENERAL

The Technical Specification sets out the requirements for the design, supply, installation, testing and commissioning of modification works and new works for Street Lighting. It is to be noted that the existing Street Lighting which were constructed over time do not conform in all aspects of this Technical Specification and the Contractor shall have no cause for making any assumption that they accord with the Technical Specification.

1.1 Design of Street Lighting

1.1.1 The design of lighting for public roads shall comply with but not be limited to the latest edition of BS 5489, BS EN 13201, CIE (International Commission on Illumination) and all applicable Codes, Regulations, Standards, and relevant Authorities.

1.1.2 For the purpose of design, road surface shall be taken as Class R3 road (Asphalt CIE R3).

1.2 Power Factor

When the lantern is operated on a supply voltage of 230 Volts ±6%, at a frequency of 50 hertz ±1% and with a suitable lamp, the circuit power factor shall be not less than 0.85 lagging.

1.3 Maintenance Factor (MF)

Luminaire maintenance factors vary according to the intervals between cleaning, the amount of atmospheric pollution and the quality of the sealing of the lamp housing of the luminaire. Their values may be established by field measurements. Lamp flux maintenance factors vary according to lamp type and power. Values are usually available from lamp manufacturers. However, a 0.75 maintenance factor shall be adopted for the purposes of producing the lighting simulation design.

1.4 Lantern

The lanterns shall be suitable for use on a supply voltage of 230 Volts ±6%, at 50 hertz ±1%.

1.4.1 Conformity with Standards

The lantern shall comply with and be tested to the requirements of IEC 60598-2-3 or equivalent Standard.

1.4.2 Classification

The lantern shall be classified for protection against electric shock as Class I or Class II and the Degrees of Protection for lamp compartment and gear compartment shall be at least **IP 66**.

1.4.3 Marking

The provision of IEC 60598-2-3 shall apply.

1.4.4 Construction

(a) The lantern shall be designed and constructed so that it is capable of providing the service for which it is intended. Sound engineering principles shall be adopted throughout and the lantern shall be designed to enable ease of maintenance and replacement of lamp, bowl, control gears, reflector and lamp holder, without the use of special tools.

(b) The lantern is by way of "top opening" of the lantern's canopy, this ensures an ergonomically sound posture for the service personnel. During opening, the canopy swings backwards and a stainless steel mechanism falls into position to keep the canopy open.

(c) The lantern shall be constructed from corrosion resistant materials such that no undue deterioration occurs in its safety, performance or appearance during normal life when operating under all local conditions. It shall be robustly constructed to withstand vibration in normal use.

(d) The lantern body including the control gear housing shall be made of die-cast aluminium materials. The thickness of the lantern body shall be at least 3mm and the maximum weight of the lantern shall be 24kg.

(e) The lantern shall be designed so that condensation shall not fall on any operating part, which may fail or deteriorate as a result.

(f) The lantern shall be constructed to make provisions for the installation of anti-glare louver easily at site for lantern wattages below 250W.

1.4.5 Lantern Cover

(a) Hinges and catches of the lantern cover shall be robust and simple to operate and shall not be liable to accidental detachment during installation or maintenance. It shall be made of stainless steel.

(b) The lantern cover or other component giving access to the interior of the lantern shall, in the closed position, be firmly attached to the fixed portion of the lantern. In the open position, it shall be attached in such a way that there is no likelihood of it becoming accidentally detached or damaging any part of the lantern, the bracket or the column.

(c) The bowl shall be made of tempered glass and shall form part of the lighting cover.

(d) It shall be possible to change the glass bowl to flat glass on the same lantern when the need arises. This shall be done easily at site without the need of sealing tools.

1.4.6 Optical System

(a) The design of the optical system shall incorporate a reflector in one single piece. The reflector is attached to the canopy, so that when the lantern is opened by swinging the canopy upwards, the lamp is revealed. The reflector shall not be glued to the front glass so that access to the lamp and reflector during maintenance is possible. The reflector shall not form part of the canopy of the lantern. The reflector shall be made of polished high purity aluminium.

(b) The optical compartment shall be sealed and dust-tight in normal operation, such that the reflector unit and lamp always remain dust-free. Correct tightness shall be ensured on the covers provided for ease of lamp changing, maintenance etc. when closed. The gaskets used shall be tropicalised and positively retained in its seating position and shall not work loose during and after maintenance. Materials used in the gasket shall effectively prevent the ingress of moisture and shall not deteriorate unduly due to heat, light or compression.

(c) The optical system shall be adjustable by way of shifting the reflector in different position. Adjustments shall be provided in the lantern to shift the main light distribution towards the axis of the road to suit different road widths / conditions.

(d) Such adjustments shall be simple and positive and shall be firmly retained in clearly identified positions. Photometric data shall be supplied with each of the possible adjustments.

(e) There shall be at least five (5) positions for the adjustment. The total light output ratio after adjustment shall be equal or exceeded 75%.

1.4.7 Lamp holder, Support & Bracket

(a) The lamp holder for Street Lighting shall be the relevant type according to the rating of the lamp as shown in the table:

Rating of Lamp	70W	150W	250W	400W
Type of lamp holder	E27	E40	E40	E40

(b) The lamp holder shall come with a brake system to avoid loosening of the lamp and with protective porcelain skirt to avoid an operator coming into contact with live metallic parts.

(c) The lamp holder, its supports and brackets of the lamp holder shall withstand normal usage throughout the life of the lantern. They shall accept and retain lamps, which are within the dimensional tolerances stated in the appropriate IEC or equivalent Standards and shall locate the light source in the correct relation to the optical control device of the lantern.

(d) No special tools shall be required for the insertion and withdrawal of the lamp. A lamp fully inserted shall be rigidly held with its axis substantially coincident with that of the pole under normal conditions of wind, vibration and mechanical shock.

(e) Where provision is made for alternative sizes of lamp, the means of adjustment shall be simple and positive and shall be firmly retained in clearly identified positions.

(f) The lamp holder's supports and brackets shall be made of corrosion resistant metal e.g. stainless steel, die-cast aluminium.

(g) The lamp holder shall be fixed on the gear tray, so that electrical checks can be carried out smoothly without the need for additional support.

1.4.8 Terminal Block

(a) A readily accessible barrier 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.

(b) A means of clamping the electrical supply cables shall be provided in the lantern to relieve the termination of strain. The cable clamp arrangement shall not damage the insulation of the cables.

(c) The terminal block shall be in the form of a “male” and “female” connector and shall comply with the latest edition of CP 5.

1.4.9 Earthing Terminal

(a) A separate terminal for the connection of an earth continuity conductor, clearly and indelibly marked shall be provided.

(b) All exposed metal parts and other parts accessible when the lantern 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.

1.4.10 Internal Wiring

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

(b) The wiring used shall be heat resistant type with a temperature rating of at least 105^{o}C. Cable manufacturer specification shall be submitted to LTA.

1.4.11 Lantern Control Gear

(a) The lantern shall be furnished complete with integral electrical control gear comprising of inductive ballast, capacitor and ignitor.

(b) The electrical control gear shall be mounted on a suitable module unit and shall be easily removed and replaced as a unit without the use of any special tools. The removable gear tray shall be made of plastic and a cover is needed so that no life parts are exposed. Electrical connection and disconnection of the electrical control gear unit from the lantern shall be easily done and terminals easily accessible.

(c) The ballast supplied shall be solidly filled with Polyester compound and totally enclosed in sheet steel or die-cast aluminium container or vacuum impregnated with a suitable varnish. The ballast supplied shall match the lamp for all operating conditions.

(d) The rated voltage of the ballast shall be 240 Volts. The lamp current crest factor of the ballast shall not exceed 1.8 for ±6% voltage variations. Maximum rated operating temperature of the winding (tw) shall be at least 130^{o}C and rated temperature rise of the ballast (Δt) shall not exceed 70^{o}C.

(e) The ballast shall be fixed at its nominal position inside the lantern. Three (3) testing voltage of 230 Volts, 240 Volts and 250 Volts shall be applied to the ballast at an ambient temperature of 25^{o}C. Temperature measurement shall be made for the winding, sealing compound, internal wiring and point of connection of supply wires, casing of capacitor. The temperature of the winding of the ballast shall be measured by means of change of resistance method and the others by means of thermocouples.

(f) The ignitor shall be of the electronic semi-parallel type. It shall provide one high voltage peak pulse cycle across discharge tube to achieve instant ignition and upon ignition shall automatically switched out of circuit.

(g) The ignitor shall incorporate a 5-minutes timer to switch off the ignitor circuit to prevent cycling at lamp failure. These will ensure a reliable and smooth starting behaviour. It shall be equipped with screw terminal blocks of Simple screw or click-fit mounting for rapid assembly.

(h) The ignitor shall comply with the latest edition of Safety EN 60926, Performance EN 60927, Quality standard ISO 9001 and Environmental standard ISO 14001. It shall also come with a CE marking.

(i) The capacitor shall be totally enclosed, condensation proof, internal safety leaks and fitted with an internal discharge resistor.

(j) The capacitor shall be rated at 85^{o}C. It must not contain any toxic element e.g. PCB (polychlorobiphenyls).

1.4.12 Lamp

(a) The lamp to be accommodated in the lantern shall be High Pressure Sodium Vapour SON, tubular clear type.

(b) All SON lamps shall be of high performance type, capable of maintaining a minimum survival rate of 90% after 16,000 burning hours. A full manufacturer's lamp specification shall be submitted by the for the Superintending Officer's approval. The minimum initial luminous flux (lm) of each type of lamp shall be as shown in the following table:

Rating of Lamp	70W	150W	250W	400W
Minimum Initial lm	6 600	17 500	33 200	56 500

(c) The lamp cap shall be the type as shown in the following table:

Rating of Lamp	70W	150W	250W	400W
Lamp Cap Code	E27	E40	E40	E40

(d) The colour temperature shall not be more than 2,100^{o}K.

1.4.13 Means of Attachment

(a) Attachment of the lantern to its side entry bracket arm shall be by means of clamps / other securing mechanism and designed to accommodate bracket arm tube of relevant diameters as shown in the following table.

(b) The securing mechanism of the lantern shall be applied with medium strength threadlockers and shall be secured to the pole arm in accordance to the manufacturer's recommended torque setting.

(c) Length of penetration of the side entry bracket arm shall be the relevant length as shown in the table. The mounting arrangement and wind resistant area of the fitting shall be such as to withstand a minimum wind speed of 27m/sec with a safety factor of 5.

Rating of Lamp	Diameter for side entry (mm)	Length of Penetration (mm)
70W	>42 & ≤ 60	100
150W	>50 & ≤ 60	100
250W	>50 & ≤ 60	100
400W	>50 & ≤ 60	100

(d) One (1) copy of wind speed test reports certified by accredited laboratories shall be furnished to LTA.

(e) All fixings that carry the weight of the lantern and internal accessories shall be provided with suitable locking devices to prevent the dislodgement of any part of the lantern by vibration either in service or during maintenance.

1.4.14 Test for Lantern

(a) The tests are as follows:-

(i) Type Test for Lantern

1) A full type test shall be carried out for compliance with the latest edition of IEC 60598-2-3.

2) For the humidity test, the test shall be carried out at a relative humidity around 95% and at an ambient temperature of 28°C.

(ii) Quality Control Tests

1) A quality assurance scheme shall be established during the manufacture of the lanterns to ensure the quality of the product leaving the factory.
2) The scheme shall cover the assurance of the quality of incoming materials, methods of welding, casting, moulding, forging, fabrication, assembly and final testing and inspection of the finished product.

(iii) Photometric data measurements and tests

The following tests and measurements shall be conducted to verify the lantern photometric data:

1) Isolux Diagram
2) Coefficient of Utilisation curves
3) Polar Lighting Distribution Diagrams

(b) One (1) copy of all test certificates and reports certified by accredited laboratories shall be furnished to LTA.

1.5 Specification for Hot-Dipped Galvanised Octagonal Steel Poles Complete with Base Plates and Bracket Arms

1.5.1 These shall be manufactured generally in accordance with the latest edition of BS EN ISO 1461. The base plates and bracket arms (Single, Double or Triple) shall be manufactured as separate units and suitable for mounting or fixing on to the poles Bracket Arms are not required for 3.5 metre pole.

1.5.2 Poles and Brackets

(a) Construction

(i) The poles shall be continuously tapered hot-dipped galvanised octagonal steel poles made up of two sections.

(ii) The top section fits into the bottom section to form the pole.

(iii) Upper and lower sections shall overlap each other by 1.7 (±20%) times the diameter of the immediate lower section and shall be easily assembled on site by using simple tools without welding. The supplier shall provide a mark on the finished pole indicating the overlapped position of 1.75 X diameter.

(iv) The poles shall be suitably designed for ground and flange mounting. The J-bolt size shall be of 25mm diameter and of stainless steel grade SS 316. Each individual J-bolt shall be complete with washers and nuts (the quantity of J-bolt, washers and nuts shall be recommended by the pole supplier) and they shall be of the same stainless steel grade as the J-bolt.

(v) To fill up the gaps between the foundation and the base plate of the lamppost, pressurised, flowable high strength non shrink cementitious grout shall be used.

(vi) Mounting details including all data, calculations, imposed loads and forces and dimensional drawings for the foundations required for the poles shall be endorsed by a registered Structural Professional Engineer.

(vii) The soil bearing capacity at the site shall be ascertained so that the foundations can be correctly designed.

(viii) For poles with two or more sections, the lower and upper sections shall have a minimum thickness of 3.2mm. The brackets shall have a minimum thickness of 2.5mm.

(ix) Every section of the poles shall be made in such a way that only one (1) sheet of steel plate is used to form an octagonal pole. Welding shall be carried out along one edge of the poles only.

(x) Poles seam welding shall comply with the latest edition of BS 5315 by automatic continuous welding process.

(xi) A hole of 20mm diameter shall be provided at approximately 500mm below the top edge of the top section. This hole shall come with a tight-fit rubber stopper to prevent water from entering the pole.

(xii) As bitumen coating will be applied internally and externally to the base section of the poles, extra care shall be taken during the transportation and storage to prevent the poles from being dirtied by the bitumen coating. The two sections of the pole shall not be stored inside one another. The poles shall be packed for transportation and storage in such a way that the clean galvanised surfaces are not side-by-side, below or above the bitumen coating. Wrapping of the bitumen portion with newspapers is not acceptable, as the removal of the latter will pose a problem. The protection of the bitumen from smearing the non-bitumen part of the poles shall be such that it could be easily removed during erection.

(xiii) The material used for strapping the poles together during the delivery shall be of non-rust type. This is to prevent rust from appearing at the straps due to weather if stored for a long period.

(xiv) All lighting poles shall be conspicuously numbered using two (2) sets of red colour retro-reflective type, diamond grade with size 45mm x 100mm and a round sticker bearing a black arrow against a yellow background that indicates the direction of the lighting control box.

(b) Materials

(i) The poles shall be manufactured from steel as specified in the latest edition of BS EN ISO 1461.

(ii) The base plates shall be manufactured from mild steel.

(iii) The bracket arms shall be manufactured from materials as specified in the Drawings attached.

(c) Design and Dimensions

(i) The general design and dimensions shall be as close as possible to the Drawings attached and certified by a registered Mechanical Professional Engineer.

(ii) The poles with bracket arms shall be designed to withstand a minimum wind speed of 27m/sec with a safety factor of 5.

(d) Tolerances

(i) Width or Diameter - The tolerance on the width or diameter of the section shall be ±1.5% of the width or diameter.

(ii) Thickness - The tolerance on the thickness of the material shall be ±15% of the thickness.

(iii) Straightness - The completed poles shall not deviate from straightness by more than an amount calculated at the rate of 2mm per metre. This also applies to the complete poles and bracket assembly.

(iv) Bracket Arms - The bracket arms shall be heavy duty hot-dipped galvanised steel fabricated in accordance with the design Drawings with particular attention to the following areas:

1) smoothness of curvature of bracket arms

2) tolerance of curvature - which shall be within ±2% of the radius of curvature.

3) the angle of tilt at the end of the bracket arm - which shall be within ±1% degree of the tilt. The angle of tilt other than 4m arm shall be five (5) degrees and measured with the bracket arm installed on the poles and measurements made with a calibrated spirit-level at any point within 150mm from the end of the bracket arm.

4) the shape of the bracket arm shall be octagonal throughout except the spigot which shall be tubular end as shown in the Drawings.

(e) Design of Pole Door and Locking System

(i) A door shall be provided with a locking device over the door opening of each pole as shown in the Drawings. The triangular locking device shall be made of stainless steel as specified in the Drawings. The locking device shall be properly assembled. The triangular bolt shall be jammed at one end so that it will not be dislodged when it is fully opened.

(ii) Pole doors shall be flush with the poles with no gap between pole and door to prevent ingress of water.

(iii) An aluminium name plate of size 50mm x 75mm shall be installed on the outer surface of the pole door. The following details shall be engraved on the plate:

1) Name of Manufacturer
2) Year of Manufacture
3) Batch Test Number
4) Height of Pole

(iv) The rivets used to fix the name plate must be of non-rust type.

(v) The pole door shall be hinged at the top. The hinges shall have minimum opening of the door of 180 degrees.

(f) Alternative Design of Pole Door and the Locking System

(i) This design requires the pole door to be hinged on one side (left side). The two hinges shall be welded on the inside and the minimum opening of the door is 180 degrees. Hinges welded on the outside can also be considered provided it is aesthetically acceptable. A locking system shall be provided. Pole doors shall be flush with the poles with no gap between pole and door to prevent ingress of water.

(g) Baseboard

(i) During installation, a cut-out unit will be installed inside the poles by means of three (3) 4mm diameter screws.

(ii) A fixing device, which could be a perforated plate made of hot-dipped galvanised steel shall be fixed in the pole directly facing the pole door as part of the pole. The cut-out unit shall be mounted directly onto the fixing device. The fixing device shall be able to cater for different types of cut-out units.

(iii) Alternatively, a baseboard made of hot-dipped galvanised steel shall be provided and mounted in each pole for fixing of cut-out unit.

(h) Earthing Terminal

An earthing terminal in the form of a bolt made of stainless steel material shall be provided close to the door opening of each pole and inside the pole. In addition, it shall have substantial contact surface for the attachment of an earthing lead. Two (2) suitably sized washers and two (2) nuts shall be provided for each bolt. The bolts, nuts and washers shall be made of stainless steel.

(i) Protection against Corrosion

Individual sections of the pole, base plate and bracket arm shall be protected against corrosion by hot-dipped galvanisation internally and externally in accordance with the latest edition of BS EN ISO 1461. All welding works shall be done before the galvanisation.

1) No zinc flux shall be left inside the pole or bracket arm after galvanisation. The presence of these impurities can pose a problem in the installation of lantern wire.
2) The treatment prior to galvanisation shall include degreasing, pickling and rinsing.
3) The minimum average zinc coating weight shall be 610 grams per square metre.

(j) Extra Protection against Corrosion at the Pole Base

(i) A coat of bitumen shall be applied internally and externally to the base section on top of the galvanised coating by means of dipping. It shall be applied over the length of the planting depth and for a distance of 200mm (and not more than 250mm) above the planting depth. The total length to be applied with the bitumen coating shall be shown in the following table. A circular marking shall be made on the poles during manufacturing to indicate the level of the planting depth.

Type of pole (m)	2.5	3.5	6	8	10	12	13
Recommended planting depth/ Length of bitumen (m)	0.95	0.6	1.4	1.5	1.7	1.7	1.8

(ii) The bitumen used shall conform to the latest edition of BS 4147 or ASSHTO M190-70.

(iii) The bitumen shall be heated in a tank to a temperature of approximately 220^{o}C before dipping.

(iv) The dry film thickness of the bitumen coating shall be at least 762um.

(v) A layer of lime powder shall be applied to the bituminous coating for easy handling of poles.

(k) Aesthetic Appearance of the Finished Surface

(i) The poles and bracket arms shall be of prime finish and good uniformity; i.e. free from injurious defects, such as blister, flux and non-coated spots, white rust, peeling of bituminous paint coating, etc.

(ii) The galvanising and bituminous appearance of poles and brackets supplied shall not be inferior to the sample submitted for evaluation. If in the opinion of LTA that the galvanising and bituminous finish of the poles and brackets is inferior to the sample supplied, LTA shall have the right to reject the inferior poles or the entire lot.

(l) Pole internal wiring

(i) An adequate length of XLPE/PVC sheath cable, 3-core, 2.5mm^2 rated at 600 / 1000 Volts, shall be provided for the connection between the fuse cut-out unit and the lantern. The cables shall be properly supported to prevent undue strain on the cable terminations. The cable colour identification shall comply with the latest edition of CP 5.

(ii) The cables shall be manufactured to the latest edition of IEC 60502-1.

(m) Test and Test Certificates

(i) All sample poles and bracket arms shall be submitted to a Testing Authority for the following tests

1) Dimensional and Weight Measurements of pole & bracket.
2) Temporary Deflection Test: The pole shall be mounted horizontally and rigidly supported for the distance equivalent to planting depth from the butt and loaded, as a cantilever at a point from the top of the pole as specified in the Drawings. The Temporary Deflection measured at the point of application of load shall not exceed 150mm by more than 5%.
3) The Deflection test shall be carried out with the flat faces 1 and 5 with face 1 being the pole door opening and face 5 the opposite face.
4) Galvanising Test: The poles and brackets shall be subjected to the galvanising thickness test as laid down in the latest edition of BS EN ISO 1461.
5) Bitumen Test: The bitumen coating on the pole base shall be subjected to thickness test as laid down in the latest edition of BS 4147 or ASSHTO M190-70.
6) Material Test: Steel material used for the manufacturing of poles and brackets shall be subjected to test for compliance with the latest edition of BS EN ISO 1461 (Grade 43C). The test method and the reference standards shall be subjected to the approval of LTA.

7) Welding Test: All welded portions of the pole and bracket shall be subjected to a relevant welding test. The supplier shall state the reference standard and the strength of the welded joint together with the tender. The reference standard shall be the latest relevant British Standard. The reference standard and the strength of welded joint shall also be subjected to the approval of LTA.
8) For longitudinal seam weld, the reference standard shall be the latest edition of BS 4870 Part 1; i.e. by transverse tensile test where results shall not be less than 60% of specified minimum value of parent material.
9) Mechanical Property Test: The Testing Authority for this test shall cut off a small piece of steel plate of adequate size from the base of the sample poles.
10) The tensile strength and yield strength of the sheet metal shall be measured. The test results shall comply with the limits specified in the latest edition of BS 4360 for grade 43C steel as follows:

	43C
Tensile strength	430 to 580 N/mm²
Yield strength	275 N/mm² min.

(ii) Test report for the above shall be submitted by the supplier / manufacturer together with the batch delivered. Otherwise, the batch of delivery will not be acceptable.

1.5.3 Batch Testing

(a) For each batch of delivery, the supplier shall submit samples to the Testing Authority for testing and inspection on the quality of the products. The delivery will not be accepted by LTA unless the sample passes the batch tests.

(b) For every batch delivery, the number of sample to be tested is one (1).

1.5.4 Concrete Test Cubes for pole foundation

(a) Four (4) test cubes shall be made from the concrete used in each of the preliminary test piles and working pile as directed by LTA. If a concrete footing is cast separately from a preliminary pile or a working pile, a further four (4) cubes shall be made from this concrete.

(b) The test cubes shall be sent to accredited laboratory and tested with accordance to BS 1881.

1.6 Underground Cabling

1.6.1 Armoured Cable

(a) Cable insulation resistance test shall be carried out to laying, and after every length has been laid and after every joint has been completed.

(b) Cables of this type shall be 600 / 1000 Volts grade consisting of high conductivity copper wire, insulated and sheathed with termite repellent polyvinyl chlorine. Cable of this type shall be manufactured to the latest edition of BS 6346.

(c) PVC insulated cores shall be sheathed with PVC, which shall serve as bedding for galvanised single steel wire armouring. The nominal diameter of the wire armour shall not be less than 1.6mm complying with the latest edition of IEC 60502-1 or equivalent Standard which shall be laid on PVC bedding extruded over this insulation.

(d) All armoured cable shall be terminated in a brass cable gland fitted with armour clamp. The cable glands shall have watertight seals on the cable sheath. Each cable gland shall be supplied with a brass gland locknut and a PVC shroud shall be fitted to cover the gland body.

(e) Compression type glands shall be provided for the termination of all PVC/SWA/PVC cables.

(f) Compression glands shall comply with the latest edition of BS 4121 and shall be designed for the termination and clamping of armour wires and shall be fitted with an earth bond terminal attachment. It shall be possible to erect and dismantle compression glands without the use of special tools.

(g) All cables entering or leaving any equipment shall be provided with separate terminations so that any cable can be removed without disturbing the rest.

(h) Outer sheathing shall be of extruded PVC having a radial thickness of not less than 1.2mm and shall be coloured black.

(i) All cables terminations shall be provided with cable lug and approved PVC colour sleeve.

(j) All underground cables shall be laid in Class B type heavy-duty UPVC pipes of nominal diameter 100mm comply with the latest edition of SS 141.

(k) Cables used for street lighting poles and zebra-crossing beacon lighting poles shall be of three-phase 4-cores, 16mm^2 PVC/SWA/PVC cable c/w separate 16mm^2 yellow-and-green PVC C.P.C. (earth cable). The cable colour identification shall comply with the latest edition of CP 5.

(l) Cables used for commuter facilities equipment shall be of either single-phase 3-cores, 4mm^2 or 6mm^2 PVC/SWA/PVC cable. The cable colour identification shall comply with the latest edition of CP 5.

1.6.2 Cable Trenches

(a) "Code of Practice for Traffic Control at Work Zone" published by LTA shall be observed and complied when carrying out excavation works on the cable trench.

(b) The depth of the cable trench shall be at least 1000mm from the finished ground level on turf and on roads. All trenches shall be of sufficient width to allow minimum spacing of 50mm between pipes.

(c) Trenches in side tables or grass verges shall be at least 600mm clear of the edge of the carriageway or kerb and they shall be at least 500mm away from other services but not limited to the following: high-tension cables, gas and water mains, telecommunication cables or SCV cables. The grass disturbed shall be made good to the satisfaction of LTA / relevant authorities upon backfilling the trenches.

(d) Trenches shall be kept as straight as possible unless obstructed by existing services.

(e) The bottom of the cable trench shall be level and smooth without stones or hard lumps. In rocky or hard ground, a 75mm layer of sand or granite dust shall be laid along the trench bottom.

(f) Trial holes and manual excavation to locate services in the vicinity of the proposed trenches shall be provided for.

(g) Pumps or other means of disposing water in the trenches shall be provided.

1.6.3 Cable Laying

(a) When laying of underground cable at backlane is not permissible due to lot of services at the backlane, the cables shall be run in surface GI conduit subject to LTA's approval.

(b) The minimum bending radii of the cables as specified by the manufacturers shall be strictly observed. Cables shall be bent as little as possible and always in the same plane to avoid twisting of the cables. During laying, there shall be no 'figure eight-ing' of cables and all bends shall be avoided by using the requisite number of men, rollers and tools as required and pulling from joint to joint. LTA reserves the right to stop any cable laying work if there are inadequate means or equipment to carry out the work satisfactorily.

(c) Pulling ropes shall be attached to the free ends of power cables by means of an approved "pulling eye" as supplied by the cable manufacturers for this purpose. Cable jacket and tape armouring shall be cut back clear of the pulling eye and under no circumstances shall the pull force be transmitted to the jacket or tape armouring.

1.6.4 Backfilling

(a) After the UPVC pipe is laid, the earth filling shall be selected from earth free from stones and other sharp objects. The filling shall be compacted around the heavy-duty UPVC pipe and finished off at a level of 100mm above the pipe.

(b) PVC cable warning slabs covers shall be laid in an approved manner on top of the earth filling directly over the pipe. These slabs shall be appropriately labelled and subject to approval by LTA.

(c) The earth filling shall extend to 100mm above the PVC cable warning slabs and shall not contain stones of dimension exceeding 75mm. The filling shall be compacted by means of hand hammer

(d) The trenches shall then be filled with soil in layers of not exceeding 300mm in depth, each layer being thoroughly rammed by means of mechanical rammer before the next layer is placed over. The filling shall allow for probable subsidence, after which any excess soil shall be removed.

(e) Regular inspection to be carried out on the backfilling work during the Defects Liability Period (DLP) and shall top up the backfill should subsidence occur.

1.6.5 Pipes Crossings / Pipe along carriageway

(a) All underground cables shall be laid in heavy-duty UPVC pipes of nominal diameter 100mm.

(b) Pipes shall be encased in concrete and normally go under all obstructions such as mains, sewers, drains, conduits and the like which cross the cable route in these cases, the trenches shall be carefully ramped so that the installed pipes will ramp gradually and rise up to the original level after crossing the obstructions. Where it is not practical to go underneath culverts and drains, pipes shall with the approval of LTA go over them but care shall be taken to construct concrete ramps on both sides and steel plates or channel iron to protect the pipes.

(c) The heavy-duty UPVC pipes shall be encased with at least 50mm thick cement dust all round.

(d) The composition of cement dust consists of one (1) part of cement and 10 parts of granite dust.

(e) The cement dust mixture shall be sprinkled with water and compacted in layers to achieve a hardened layer.

(f) PVC cable warning slabs shall then be laid above the heavy-duty UPVC pipes with a layer of 250mm soft earth / sand.

(g) The different kind of material, base course and asphalt shall then be laid in accordance to Code of Practice for road opening works published by LTA.

1.6.6 Cable Pipes, Conduits and Ducts

(a) All cable pipes and ducts shall be free of obstructions and sharp objects.

(b) The pipes shall be laid as straight as possible and shall be continuous and extended to the nearest existing street lighting lamppost that is not affected by the works.

(c) One (1) no. nominal diameter 100mm heavy-duty UPVC pipe complying to SS 141, Class B type with pulling ropes / cables / pilot wire shall be provided in turf area / roadways or tarmac area.

(d) Two (2) nos. nominal diameter 100mm heavy-duty UPVC pipe complying to SS 141, Class B type with pulling ropes / cables / pilot wire encased with concrete shall be provided at road crossing.

(e) Any spare UPVC pipe(s) at road crossing shall be extended to the nearest lamppost and covered with end caps at both ends.

(f) Before being pulled into these, the cables shall be coated with petroleum jelly or an approved method such as covering the entry of the opening with a piece of cloth or rag to ensure no damage to the sheath when a cable is being pulled in. A guide pulley shall be employed to prevent the cables from fouling the opening and causing damage to the coating and armour of the cable.

(g) The location of the road crossing pipes shall be indicated by a 75mm diameter aluminium disc with a red arrow and black words “Public Lighting Cable” and it shall be secured on both (side of the) road kerbs.

1.6.7 Reinstatement Work

Unless otherwise specified, all paved / tiled and unpaved surfaces, roadways and drains shall be reinstated to the satisfaction of LTA.

1.6.8 Jointing of Cables

(a) Cable joints are not permitted without the written approval from LTA.

(b) If joining of cables is inevitable, qualified jointers registered with the SP PowerGrid Ltd shall carry out cable-jointing work.

1.6.9 PVC Cable Warning Slab

(a) The PVC cable warning slab shall be made of high impact resistant hard PVC. Use of regenerated PVC is strictly forbidden. They shall be of black in colour. Each warning slab shall be 1000mm long and 172mm wide and marked indelibly with the following "DANGER ↙ LTA LT CABLES". The lettering shall be at least 30mm high and 18mm wide. Each warning slab shall be laid in accordance to the manufacturer’s recommendation to form a continuous chain.

(b) Adjacent warning slabs shall also be linked if two slabs are placed side by side to cover the width of the trench.

(c) The warning slab shall be resistant to chemical influences likely to be encountered when buried in the ground. They shall have a hardness of not less than 8KN/cm2 with dielectric strength of not less than 40KV/mm and elasticity the order of 200,000N/cm^2. They shall not soften at temperatures of up to 70^oC.

1.7 Overhead Line

For temporary diversion of lighting poles, where overhead lines are used, five (5) nos. (for three-phase) or three (3) nos. (for single-phase), single core, 10mm^2 PVC/PVC cable c/w separate 10mm^2 yellow-and-green PVC C.P.C. (earth cable) shall be used.

1.8 PVC and PVC / PVC Cable

1.8.1 PVC cables shall be 450 / 750 Volts grade respectively consisting of high conductivity copper wire.

1.8.2 The cables shall be manufactured to the latest edition of SS 358-3, BS 6004 and IEC 60227-3.

1.8.3 PVC / PVC cables shall be 600 / 1000 Volts grade respectively consisting of high conductivity copper wire.

1.8.4 The cables shall be manufactured to the latest edition of IEC 60502-1 and BS 6346.

1.9 Lighting Control Box

1.9.1 General

(a) All components of the lighting control box shall be housed in a weatherproof housing of robust construction. The lighting control box to be constructed in accordance to type tested latest edition of BS EN60439-1 and IEC 439-1. The housing shall be provided with a watershed top. The housing must have a Degree of Protection of not less than **IP 55** IEC Publication 529: 1989.

(b) Three-phase lighting control box shall be rated at 63 Amps. HRC fuses shall be used for the protection of the circuits. Each lighting control box shall contain not more than three (3) outgoing circuits serving the lighting system. 3-poles, three-phase contactors shall be used in conjunction with programmable timer unit for the control of the streetlights.

(c) The lighting control box shall be provided with a root of ample strength and suitable for mounting on a concrete foundation. A concrete plinth of minimum height of 300mm shall be provided for mounting of the lighting control box.

(d) A space shall be reserved in the lighting control box for future KWh meter installation. The control box door shall come with a transparent UV resistance window with neoprene seal for future meter reading purpose.

(e) The door lockset of the lighting control box shall use master key "A" series cam lock.

(f) The control box shall be of double leaf door type.

(g) All electrical accessories such as HRC fuses, MCBs, ELR, timer, contactors, and electrical wirings in the lighting control box need to be neatly labelled.

(h) Inside the lighting control box at the bottom where the incoming underground cables are located, it shall be filled with "washed" sand to appropriate height.

(i) The supplier of the lighting control box shall have proven track records in the last 3 years.

1.9.2 Housing

(a) All components of the housing except the housing bolts and nuts shall be made of at least **aluminium alloy AA1100**. The housing bolts and nuts shall be of stainless steel. The four (4) pillars of the housing shall be rounded with radii of not less than 25mm. This shall be extruded from 3mm thick aluminium in one homogeneous piece according to the latest edition of BS 1484 to provide a better mechanical strength. Roof and all other panels shall be 'pressed-form' from a whole sheet of 3mm thick aluminium plate. All drilling, punching, cutting, bending and welding parts shall be completed and all burrs removed before the electrostatic powder coating process is applied.

(b) The housing shall be electrostatically coated with pure polyester powder of thickness between 80 microns and 100 microns. Materials shall be chemically treated before and oven baked after the powder coating process. The powder coating shall be weather resistant.

(c) Adequate ventilation shall be provided to permit natural circulation of air. Temperature-rise Limits of maximum 600 Amp rating to the latest edition of BS EN60439-1 and IEC 439-1. The ventilation apertures shall be suitably screened to prevent the entry of rain, vermin and other foreign bodies.

(d) The housing shall be able withstand a high voltage surge of 12KV to the latest edition of BS EN60439-1 and IEC 439-1.

(e) The colour of the lighting control box shall be RAL 7039 for the pillars and roof and RAL 7032 for the others.

1.9.3 Danger Notice

A 'Danger' notice shall be provided, stuck on the inside and outside of the door of each lighting control box.

1.9.4 Data Plate

(a) A data anodized plate shall be fixed to each control box detailing the following information:
   (i) LTA Logo
   (ii) Manufacturer's name
   (iii) Contract Number
   (iv) Date of manufacture
   (v) Serial Number

(b) A sample shall be submitted to LTA for acceptance.

1.9.5 Door and Door Hinges

(a) In general, the door shall be suitably designed to provide maximum protection from heavy driving rain and inclement weather. Access to the front of the control box shall be by means of hinged doors. The hinges on the door shall not project outside of the shell and shall be secured by open flange fasteners. These fasteners shall be flushed and not be seen on the outside of the door. The hinges must enable the door to be swung open not less than 120 degrees from the closed position. Doors shall be easily detachable by lifting of pins from the hinges without having to use special tools and to be secured by medium security cam locks.

(b) Samples of the colour shall be submitted to LTA for approval before fabrication.

1.9.6 Pillar

The pillar shall be provided with a root of ample strength and suitable for mounting on a concrete / foundation at ground level. A removable apron of approximately 500mm high shall be provided at the front of the pillar to facilitate direct installation and jointing of cables to the distribution units. Sufficient number of UPVC pipes shall be provided for cable entries into the box.

1.9.7 Provision for plastic pocket to house single line drawings (endorsed by LEW of appropriate grade) fitted inside the interior of the lighting control box door.

1.9.8 Provision for Tapping Temporary Supply from the lighting control box

For the purpose of tapping temporary supply from the lighting control box, the design of the lighting control box shall also incorporate the following:

(a) A 65mm diameter opening shall be provided on both right and left hand side-panels of the housing. This opening shall allow

temporary overhead electrical wires to be brought into the box and shall be covered with aluminium plate when not in use.

(b) Two pairs of nuts shall be welded on the side-panel of the housing at a position above the opening. These nuts are intended for use with clamps to secure vertically a 65mm diameter PVC pipe for leading in the overhead temporary wires for tapping of supply from the box. The ends of nuts shall be permanently sealed to prevent rain water from getting onto the box.

(c) The lighting control box front apron shall be provided in one piece minimum height 225mm for easier pulling of the wires.

1.10 Lighting Pole Cut-Out Unit

1.10.1 General

(a) The body of the cut-out unit shall be made from material with good insulation properties having a BS 5901 Tracking Index of not less than 500. The material grade specified should also have a suitable temperature rating and be proven to resist moisture absorption from humid atmospheres. The front cover shall be transparent and provided in two portions to allow the replacement of fuses without exposing the cable terminals. The terminal cover shall carry a warning of "DANGER LIVE TERMINALS" including the symbol of a triangle with a lightning bolt. The insulating terminal cover shall provide a degree of protection of not less than **IP2LX** to BS EN60947. The base of the housing shall be opaque and shall be suitable for use in the tropics and of robust construction. It shall be drip-proof and be suitable for installation onto a steel mounting plate within an octagonal street lighting steel pole.

(b) The cut-out unit shall be designed and constructed in accordance with the latest edition of BS 7654 and IEC 947 Part 1. It shall be designed for ease of cable termination and in addition, screws for the cut-out unit cover should be self-retaining.

(c) The minimum clearance and creepage between the different phases shall be at least 6mm.

(d) The insulation thickness separating the different phases shall meet impact test and short circuit test requirements in accordance with the latest edition of BS 7654 and IEC 947 Part 1 or equivalent standard.

(e) The cover for the cut-out unit shall be made of material with similar insulation properties and temperature ratings as the

material used for the base. The cover for the fuse section shall be separated from the termination section.

(f) The cut-out unit shall be supplied complete with armour continuity clamps or similar devices to ensure electrical continuity between the armours of the two (2) main cables. The design of clamps or glands shall be such that the cables can be easily installed. The clamps or glands shall be made of brass.

(g) The fuse carrier and terminal covers shall be interlocked in such a way that the terminal cover cannot be removed without first removing the fuse carrier.

1.10.2 Cable Termination inside a Three-phase Cut-Out unit

(a) The cut-out unit shall be suitable for use in a 400 Volts, three-phase, 50 hertz, 4-wire system with system neutral solidly earthed.

(b) It shall be suitable for terminating two (2) nos. of 16mm^2 4-core PVC/SWA/PVC cable and two (2) nos. 16mm^2 PVC C.P.C. (earth cable) manufactured to the latest edition of IEC 60502-1 or equivalent standard.

(c) The cut-out unit shall be provided with at least eight (8) termination blocks and 10 nos. 16mm^2 copper lugs for the red, yellow and blue phase, neutral and earth conductors. Each termination block must be able to accommodate up to two (2) cores of the two (2) PVC/SWA/PVC cables.

(d) Where tunnel terminals are used the incoming phase and neutral terminals shall have sharply serrated bores to break through any surface oxidisation on the cables and to ensure a low resistance contact.

(e) Insulated barriers of 25mm - 30mm height (from the base of the unit) shall be provided to separate the phase terminals.

(f) The cut-out unit shall also be provided with two (2) 2.5mm^2 copper sleeves, three (3) nos. of screws (brass, M12), three (3) nos. of plastic nuts for mounting the cut-out unit onto the baseboard in the pole and one (1) 140mm cable tie (orange colour). Two (2) circular rubber glands are to be provided at entry of the two (2) main 16mm^2 cables.

1.10.3 Copper lugs and fuse Unit

(a) 16mm^2 copper lugs for three-phase system shall be fixed on the respective termination blocks with self-retaining M6 screws before delivery.

(b) A fuse unit (suitable for one (1) 10 Amps HRC fuse with offset open-ended slot, 2-hole fixing) shall be provided on the fuse cover. Provision for connection of lantern wire at the fuse, neutral and earth terminations shall also be included. The 10 Amps HRC fuse link shall be fixed and supplied together with the cut-out unit.

1.10.4 Termination Block & Link

The terminal blocks for the termination of the three-phase shall be designed to accommodate links at the cable terminals. The function of these links is to enable the cable cores to be separated during testing, thereby reducing the time taken to isolate the cables. The links shall be pivoted at the outer termination screw.

1.11 Earthing System

1.11.1 General

(a) The earthing system shall comply with the latest requirements stated in CP 5: Code of Practice for wiring of Electrical equipment of Buildings and CP 16: Code of Practice on Earthing.

(b) The earthing system shall comprise of the earth electrodes, earth continuity conductor and earth terminals and earth bar.

(c) The final arrangement and number of earth pits shall be determined by testing on site before commencement of electrode installation. Each earth bed shall consist of specified number of copper bond steel rod electrodes connected together by 16mm^2 yellow-and green PVC cables buried at a depth of at least 500mm below the ground. Each electrode shall be of 16mm diameter, 2 x 1800mm long spaced at a minimum distance of 6000mm spacing and driven with steel head and tip and connection clamps. All equipment and accessories shall be of proprietary made.

(d) A 200mm x 200mm heavy duty, high impact resistance, steel inspection chamber complete with hinged cover shall be provided for each earth pit. The cover shall be flushed to the ground level. A PVC plate engraved with the words “PUBLIC STREET LIGHTING. DO NOT REMOVE” shall be fixed to each inspection chamber cover. A sample of the chamber shall be submitted to LTA for approval.

(e) The inspection chamber shall be filled with “washed” sand to appropriate height.

(f) The electrodes shall be driven into the ground by a purpose made hammer and the earth pit shall be connected to the earth bar in the control box using 16mm^2 yellow-and-green PVC cable.

(g) The earthing system shall be connected in a ring to the earth bar in the lighting control box.

(h) Testing of earth resistance shall be carried out in dry weather conditions. The earthing resistance shall not exceed one (1) ohm.

(i) A test report endorsed by the LEW bearing the test result of the earth loop impedance test shall be kept in the lighting control box.

1.11.2 Earth Leakage Relay

Earth Leakage Relay (ELR) shall be approved type and manufactured to the latest edition of BS 4293.

1.12 Programmable Timer Unit

1.12.1 General

(a) Timer input voltage shall be powered by AC 100 - 240 Volts AC (+10% / -15%, 50 hertz), conforms to:

Noise Immunity:	IEC 61000-4-4, 2kV (Power supply line)
Ambient operating temperature:	0^{o}C to 55^{o}C
Humidity:	10% - 90%

(b) The Timer shall have the following programmable features:

(i) Programmable: With 3 inputs and 1 output conditions per line.

(ii) Basic CPU Input / Output: Minimum 6 inputs and 4 outputs.

(c) All outputs should have a relay switching capacity of 8 Amps at 250 Volts AC with independent common.

(d) The Timer Central Processing Unit (CPU) shall be provided with built-in real-time clock and calendar functions. The real time clock should have an accuracy of ±15 sec per month. The data of real time clock, calendar, holding bits, holding timers and counter present value shall be held by a non-battery system for a minimum of 48 hours for prolonged power interruptions.

(e) The timer program and system setting data shall be stored in internal EEPROM to prevent loss of setting / program during power failure.

(f) The Timer shall have the following features and functions:

(i) Front panel LCD display with backlight. Backlight can be automatically cut-off through adjustable settings to save the life span of backlight.

(ii) Input filters settings to prevent noise-related malfunctions such as false triggering of inputs.

(iii) Password protection function to prevent unauthorised modification of Timer programs and settings.

(g) Timer shall provide RS232C communication port or infrared port for downloading of program and setting.

(h) Timer shall support communications via RS232C to host devices such as computers and Personal Digital Assistant (PDA).

(i) The Timer system shall be equipped with the Windows Based software programming tools and drivers for the set-up of communication between Timer and host devices.

(j) The Timer shall be provided with an application software tool running on Windows CE powered PDAs to allow setting of programs and the download / upload of the settings.

(k) All Timer technical details and full communication protocols shall be provided.

(l) The Timer shall have self-diagnostic functions and shall be displayed on the CPU LCD. All errors shall be able to communicate back to host via the RS232C communication port or infrared port.

(m) The timer shall have 16 programmable On / Off period within a year. Weekly timings and 16 programmable calendar timings.

(n) The On / Off switching timing of the timer shall be programmed based on the local sunrise and sunset time. It shall be programmed with at least eight (8) different segments of switching timing as follows:

S/No	From	To	Time On	Time Off
1	10-Jan	31-Mar	1911	0715
2	01-Apr	17-Jun	1903	0702
3	18-Jun	28-Aug	1907	0706
4	29-Aug	15-Sep	1900	0702
5	16-Sep	07-Oct	1852	0658
6	08-Oct	06-Dec	1847	0655
7	07-Dec	23-Dec	1855	0702
8	24-Dec	09-Jan	1903	0710

(o) The timer shall have a Mean Time Between Failure (MTBF) of at least 300,000 hours and a stored programmed calendar year / month / day of equivalent length of time.

(p) The timer shall be protected with an enclosure and a surge arrestor to prevent external adverse conditions such as high humidity, pests' infestation or frequent sudden power surges from the incoming power supply.

(q) The size of the timer enclosure box shall measure 125mm(W) x 125mm(L) x 100mm(D) in dimension and rated at **IP 66**. The temperature rating is -40^{o}C to 80^{o}C of the box. The material used shall be Acrylonitrile Butadiene Styrene (ABS) for body, clear PolyCarbonate (PC) for cover.

(r) The surge arrestor shall comply fully with the Transient Immunity EMC requirements (Norms EN 61000-4-4 & EN 61000-4-5), while providing effective transient voltage protection to the timer.

(s) The surge arrestor shall design and manufactured to the safety standards: CE, UL, VDE, IEC, EN. The housing shall make of compact plastic according to UL-VO.

V nominal	440 Volts, three-phase
Frequency	50 hertz
Max Operating Voltage	500 Volts (L-L)
Max Surge Current	4.5 KA
EMI / RFI noise rejection	20 dB
Response Time	1 ns

1.13 Fuse Carriers and Fuse Bases (incorporated in lighting control box)

1.13.1 The HRC fuse carriers and bases shall be moulded from high quality electrical grade thermosetting moulding compounds with high dielectric strength to ensure excellent rigidity and dimensional stability under high temperature conditions.

1.13.2 The design of the fuse carrier and base shall be for maximum contact area between the base terminals and carriers. The terminals shall be made of robust extruded non-ferrous conductor.

1.13.3 The fuse bases shall have contacts with cable entry holes and cable clamping screws made to the latest edition of BS:88 PART 1: Section 2.1 & Section 2.2.

1.14 Electro-Magnetic Contactor

1.14.1 General

(a) The contactor shall be manufactured in accordance with the latest edition of IEC 60158-1 and BS 5424 Part I. This contactor shall be suitable for use in the tropical climate and it is intended to be mounted in an enclosure. They shall be provided with main contacts capable of at least 105 switching operations and at least two auxiliary contacts for remote control (230 Volts, AC). Contactors for lighting control shall be of Utilisation Category AC2, Class 3.

(b) The rated operating current shall be 60 Amps when used on 400 Volts, 50 hertz (rated operating voltage and frequency) and for uninterrupted duty. It shall be suitable for switching on high intensity discharge Mercury or Sodium Vapour lamps with power factor improvement capacitors connected across the incoming circuits of the lamps.

(c) The contactors shall have at least 900 Amps making capacity and 720 Amps breaking capacity to prevent contact welding during switching on and off.

(d) The rated operating magnetic coil voltage shall be 230 Volts ±6%, 50 hertz ±1%, single-phase. The coil shall be preferably encapsulated type.

1.14.2 Contactor Enclosure Box

(a) The box shall be designed to contain a 60 Amps three-phase contactor. Its size shall be:

LENGTH	WIDTH	DEPTH
190mm - 200mm	190mm - 200mm	130mm - 135mm

(b) The box shall be dust-protected and preferably be constructed of thermoplastic self-extinguishable material. The cover of the box shall be transparent.

(c) Mounting rails or similar attachments shall be provided on the base of the box for easy mounting of a contactor.

(d) The box shall be provided with eight (8) nos. holes on the top side for entry of 16mm^2 single-core and three (3) holes on the bottom side for entry of 35mm^2 single-core (box mounted in a vertical position). 11 nos. of entry seals (grommets) are to be provided for the entry holes.

2 STREET LIGHTING

2.1 Lighting Level

(a) Illuminance Level - as a guide, the designed lighting levels for the different categories of road for new Street Lighting are as follows:

Type of Roads	Average Illuminance (at floor level)
Expressway and Major Road	20 lux
Minor and Residential Road	10 lux

(b) Illuminance Uniformity - the uniformity of the light distribution on the road shall be at least 0.3 for all categories of road. The uniformity is defined as the ratio of minimum illuminance to the designed average illuminance.

(c) The lighting design proposal shall be based on latest edition of BS 5489 (British Standard), BS EN 13201 Part 2, 3 & 4 and CIE 115 (Technical Report of Commission International de L'Eclairage).

(d) The lux level calculation / simulation based on lighting supplier's lighting data shall be submitted to LTA for acceptance.

(e) All lux measurements between lighting poles shall be taken at minimum of nine (9) reference points.

(f) The average illuminance shall be at least 1.5 times the luminance of the carriageway for conflict areas, like junctions, T-junctions, intersections, cul-de-sac, etc.

2.2 Sitting of Lighting Pole

2.2.1 Sitting of lighting pole adjacent to bridges shall be at least 12 metres away so that the light from the luminaire is not obstructed and does not cause problems of nuisance or glare or danger to users on top of the bridge.

2.2.2 Sitting of lighting pole adjacent to gantry shall be at least 10 - 15 metres away so that the light from the luminaire is sufficient to brighten up the surrounding gantry area without casting shadow on the road.

2.2.3 The recommended minimum clearance (set-back) from the edge of carriageway to the face of lighting poles shall be as follow:

Type of Roads	Minimum Clearance (from the edge of carriageway)

Expressway	1800mm or 1000mm away from the VIG
Road	600mm

2.2.4 Whenever practical and appropriate, lampposts shall not be installed at the gore area (neutral area).

2.2.5 Where normal standard cannot be adopted due to site constraints like abutting properties, nature of the ground topography, its will be dealt with on case-by-case basis not compromising safety.

2.3 Lighting Pole Arrangement

2.3.1 The following arrangements of lighting poles shall be considered.

(a) Twin central: used on dual carriageways and motorways; provides clear visual guidance for the through route at T-junctions;

(b) Opposite: used on wide roads or dual carriageways where twin central are not suitable due to narrow central reserve width, ground conditions or maintenance access constraints;

(c) Staggered: generally used on traffic routes, residential and subsidiary roads;

(d) Single-sided: used on narrow roads, widely separated carriageways, curved link roads and slip roads;

(e) Combined twin central and opposite: used for wide carriageway layouts and merge and divide areas where one type of lighting alone is inadequate.

2.4 Street Lightings under Soffit of Flyover

2.4.1 For sections of roads which have wide spans of flyover traversing across it, where the height clearance is permissible, the road shall be lighted using normal pole lighting. Where the height is constrained by the flyover, such that it is not possible to install lighting poles underneath the flyover, the affected road section shall be lighted by luminaries from the soffit of the flyover.

2.4.2 The luminaries shall be rated at minimum **IP 65** and classified for protection against electric shock as class I. The luminaries shall comply with and be tested to the requirements of the latest edition of IEC 60598 or equivalent Standard.

2.4.3 The luminaries housing shall be made of extruded aluminium body with painted white die cast end plates. The reflector shall be made of

high purity anodised aluminium material with facetted shape design to give a variable optical distribution and maximum optical efficiency.

2.4.4 The glass cover shall be shock resistant and tempered proofed, installed to the housing by one continuous aluminium hinge with a full length closing device. Lamp holder shall be made from ceramic E27 - E40 type.

2.5 Cable Support System

2.5.1 General

(a) All GI conduits shall be earthed in accordance to the latest edition of CP 5.

(b) Conduit entry to lighting junction / control box shall be by means of a coupling and a hexagonal male brass bush.

(c) GI conduits shall be run truly vertical, horizontal or parallel with the features of the viaduct / flyover. Conduit shall run continuous between outlets with minimum number of bends.

2.5.2 Galvanised Iron Conduits and Accessories

(a) All conduits shall be heavy gauge, hot-dipped galvanised welded steel, manufactured in accordance to the latest edition of BS 4568, Part 1 and Class 4 type.

(b) Conduits shall be free from internal burrs, fins and the like which may cause damage to cables.

(c) Colour of conduits shall be to LTA acceptance. Appropriate surface preparation shall be carried out prior to the painting of the final coating.

(d) All circular junction boxes, pull boxes, solid elbows and inspection boxes shall be made of malleable iron type and of standard pattern with spout to the latest edition of BS 4568 Part 2.

(e) Circular junction boxes, pull boxes and inspection boxes shall be provided with heavy gauge lids.

(f) Conduit outlet (knockout) boxes shall be of hot-dipped galvanised steel complete with adjustable lug, ample knockouts and brass earth terminals fitted in the base and shall comply with the latest edition of BS 1363 and BS 4662.

3 ZEBRA CROSSING BEACON LIGHTING SYSTEM

3.1 General

The flashing beacon Technical Specification shall follows those as stated in Street Lighting Specification except those guidelines as stated below.

3.1 Light Emitting Diode (LED) Flashing Beacons

(a) General

(i) The LED flashing beacons for Zebra Crossing Lighting shall have full 360 degrees illumination.

(ii) The LED flashing beacons shall be rated at **IP 54**.

(iii) A sample of LED flashing beacon with specification shall be submitted for approval before installation.

(b) LED Module

(i) The LED module shall comprise the following:

1) Array of LEDs
2) Failure detection circuit with red indicator LED
3) Flashing system (integrated or remote type)
4) Synchronization system
5) LED power unit

(ii) The LED module shall not be operating at more than 30W. The minimum illuminance of the flashing beacon at the start of operation shall be at least 360cd/m^2 (measured with the globe installed over it). Should a number of the LEDs malfunction such that the illuminance of the flashing beacon (measured with the globe installed over it) fall below 300cd/m^2, a red indicator LED or equivalent indicating mechanism shall light up, providing a signal to maintenance staff that the LED module needs replacement.

(iii) The red indicator LED shall be located at the bottom of the LED module. When the red indicator LED is lit, the light shall be visible without having to remove the globe.

(iv) The LED module shall have a flashing system that is able to flash 40 - 50 times per minute. The flashing system shall be integrated in the LED module or remotely mounted within the zebra pole.

(v) The flashing system shall allow the beacons to flash in synchronization at each zebra crossing except where the supply is from a different source. The installation shall be restricted to the boundary between the cut-out unit and the LED beacon. There shall be no need for additional connecting cables between the zebra crossing beacon poles.

(vi) The LED power unit shall have the ability to step down AC input voltage of 220 - 240 Volts, 50 hertz to a suitable range of DC operating voltage for the LED module.

(vii) The LEDs shall be cast on aluminium with heat dissipation ability.

(viii) The LEDs used shall be of high output flux density type and with rated life of at least 100,000 burning hours.

(ix) A layer of protective lacquer or anti-oxidant shall be applied over the printed circuit board to prevent oxidation and deterioration of the copper track and solder point under local temperature and humidity conditions.

3.2 Globe

(a) The globe shall be of one piece, vandal proof, high density, UV stabilised polyethylene material.

(b) The diameter of the globe shall be 300mm.

(c) The wall thickness of the globe shall be 2mm.

(d) The colour of the globe shall be RAL1023 Traffic yellow or equivalent.

3.3 Base Connector

(a) The base connector shall be made such that it can fit into the zebra beacon pole of diameter 76mm.

(b) The base connector shall be hot-dipped galvanised and powder-coated RAL 9004 or equivalent.

3.4 Number Labels

Zebra beacon pole shall be labelled with white, reflective, diamond grade self-adhesive labels. Each number or letter shall be on a label measuring 85mm x 45mm. Each pole may require up to three (3) labels. Samples of the number labels, pole numbering and height and position of the labels shall be submitted for the Superintending Officer's approval.

3.5 Test and Test Certificates

(a) The LED flashing beacon comprising of the LED module, globe and base connector shall be submitted to a recognised accredited laboratory for the following tests:

(i) Illuminance Test: To conduct measurement of the illuminance of the LED flashing beacon after 100 burning hours.

(ii) Power Consumption Test: To conduct measurement of the power consumed by the LED module.

(b) The manufacturer shall conduct the following batch tests in the factory prior to delivery:

(i) Environmental Test: To verify that the LED flashing beacon can operate reliably under local temperature and humidity conditions.

(ii) Burning Test: To ensure all components in the LED flashing beacon can meet the requirements of the Specification after continuous operation of seven (7) days.

(c) Manufacturer's batch test reports shall be submitted together with each delivery. Otherwise, the delivery will not be accepted.

3.6 Warranty

(a) LED flashing beacon shall have a warranty of up to 12 months after the date of Completion of the Term.

(b) The warranty shall cover the following:
(i) Drop in illuminance of the flashing beacon (measured with the globe installed over it) below 300cd/m2.
(ii) Fault in the failure detection circuit
(iii) Fault in the flashing system
(iv) Error in synchronization
(v) Failure of LED power supply unit
(vi) Colour of globe fading

3.7 Crossing Floodlights

The crossing floodlight shall be of post top mounted and the lantern used shall be in accordance to Lantern Specification, clause 1.4. It shall complete with 150W High Pressure Sodium Vapour SON, tubular clear type lamps.

3.8 Poles

(a) Beacon lighting poles shall have a height of 2.5 metres above ground level. The poles shall be hot-dipped with tubular

galvanised steel. It shall be completed with a hinge base door with a door swing of 180 degrees and with a mounting board.

(b) Each pole shall be painted with one (1) base coat of red oxide. Traffic yellow (RAL 1023) and traffic black (RAL 9017) or equivalent shall be painted as specified in the Drawings.

4 Submission Requirements

4.1 Prior to the installation of streetlight or zebra crossing beacon lighting, the Qualified Person (QP) is to submit to LTA / DBC through the Developer the following:

(a) Checklist for street lighting design submission (Appendix A)
(b) Location plan showing the proposed development
(c) A copy of approved street layout plan
(d) Development Plan showing:
    (i) position of proposed poles with distance between lampposts indicated
    (ii) proposed underground cable routing
    (iii) proposed lighting control boxes (LCBs) location
(e) Lighting Simulation sheets
(f) Original / Certified true copy of the Electrical single line diagram endorsed by an Electrical Professional Engineer (PE)
(g) Original / Certified true copy of design electrical load calculation sheets endorsed by an Electrical PE
(h) Original / Certified true copy of the pole's concrete foundation design and calculation with Structural PE endorsement
(i) Catalogues of lamppost, lamp, lantern, the lantern gears, cables, cut-out unit, control box, its accessories and concrete base, HD UPVC pipe, cable warning slab, fuse, earthing accessories, j-bolts, etc including Country of Origin

4.2 The following Photometric Data relevant to each luminaire type shall also be provided:

(a) Isolux Diagram
(b) Utilization Factor Curves
(c) Polar Curves
(d) Downward Light Output Ratio
(e) Downward and Upward Flux Fractions

4.3 PE shall endorse all designs and calculations.

4.4 The QP (Electrical) shall comply with all written law, bylaws, rules, regulations and Code of Practices of any government ministries, statutory boards or other public authorities which are applicable or relevant to the execution of the services.

4.5 The QP (Electrical) shall conduct site visits to investigate and propose feasible design to suit the actual site condition for installation of new poles or relocation of poles, etc.

4.6 The QP (Electrical) shall arrange for licensed cable detection worker to carry out detection of underground services.

5 Handing Over of installations to LTA

5.1 For the handing over of installations to LTA, the Developer shall submit the following:

(a) 3 sets of As-built layout drawing
(b) 3 sets of electrical single-line diagram
(c) 3 sets of electrical test reports
(d) 3 sets of Operation and Maintenance manuals (only if it is non-standard poles)
(e) 3 sets of lamppost access door key (only if it is non-standard poles)
(f) Catalogues of lamppost, lamp, lantern, the lantern gears, cables, cut-out unit, control box, its accessories and concrete base, HD UPVC pipe, cable warning slab, fuse, earthing accessories, j-bolts, etc (only if it is non-standard items).

5.2 Until the installation is satisfactorily taken over by LTA, the QP (Electrical) shall be fully responsible to attend to any breakdown fault, complaints, malfunction and whatsoever that may arise which required rectification and restoration to normal working conditions.

5.3 The QP (Electrical) shall submit a letter of notification of the commissioning of street lighting to LTA.

5.4 The billing of electricity consumption will come under LTA only after the road is declared a public street.

5.5 LTA will take over the maintenance of street lighting at the expiry of one month from the date the road is declared a public street.

APPENDIX A

CHECKLIST FOR STREET LIGHTING DESIGN SUBMISSION

(✓) Tick the appropriate box for all items

Part A: Technical Information

S/n	Standard Requirements	Applicable	Remarks
		Complied with	
1.	Location plan in A1 size is enclosed		
2.	Approved street layout plan in A1 size is enclosed		
3.	Layout diagrams of poles locations, underground cable routing, and lighting control box, in A1 size is indicated and highlighted.		
4.	Type of lamp and lanterns, details of poles e.g. height, hot-dipped galvanised, single / double arm, arm's length, etc is enclosed.		
5.	Catalogues of pole, lamp, lantern, the lantern gears, cables, cut-out unit, control box, its accessories and concrete base, HD UPVC pipe, cable warning slab, fuse, earthing accessories, j-bolts, etc. including manufacturer and / or Country of Origin is enclosed.		
6.	Average illuminance (can comply).		
7.	Illuminance Uniformity Ratio can comply.		
8.	Original / Certified true copy of the Electrical single line diagram endorsed by an Electrical Professional Engineer (PE) is enclosed.		
9.	Electricity supply for lighting street lightings is taken from new proposed lighting control box.		
10.	Source of power supply is indicated in the layout drawings.		
11.	Lighting simulation, design calculation & isolux diagram is enclosed.		
12.	Original / Certified true copy of the pole's concrete foundation design including calculation endorsed by the Structural PE endorsement is enclosed.		

Note:

Items 1 to 12 are subject to review and approval from Dy Director, Road Infrastructure Management.

_____	_____	_____
NAME OF QUALIFIED PERSON	SIGNATURE OF QUALIFIED PERSON	DATE

Part B: Particular Information

S/n	Information to be provided
1.	Name of Organisation undertaking the project and Officer-in-charge
2.	Total quantity of existing poles to be removed (if applicable)
3.	Total quantity of new poles and lanterns to be installed under this project
4.	Estimated cost per pole, and per lantern for each type (Applicable only for non standard poles and lanterns)
5.	Quantity of spares (poles & lantern) that will be handed over to LTA after DLP for each type (Applicable only for non standard pole and lanterns. Minimum 5 % to be handed over to LTA)
6.	Expected project commencement date
7.	Expected project end date

NAME OF OWNER | SIGNATURE OF OWNER | DATE