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15 ROAD LIGHTING

15.1 GENERAL

15.1.1 Scope of Works

- 1 Work related to the road lighting installation provided for in this specification shall include the supply, installation, testing, commissioning and putting into satisfactory operation any or all of the following systems as required by the project drawings.
 - (a) Road lighting (L.V/M.V) cables and terminations.
 - (b) Road lighting Feeder Pillar and internal associated control equipment including photocell control & Astronomical time-switch .
 - (c) Road lighting column/lantern assemblies.
 - (d) High mast lighting mast/lantern assemblies.
 - (e) Roadway Lighting System control, adaptive, smart or remotely managed
 - (f) Lighting network earthing, including electrical grounding.
 - (g) Installation testing including lighting performance verification.
 - (h) Provision of equipment technical and maintenance data.
- 2 The Contractor shall provide the shop drawings and supporting calculations required by the specification, as well as the provision of all required supporting technical literature and samples in connection with the approval of proposed equipment.
- 3 The equipment supplied shall include all necessary items for a complete installation according to the specification requirements in order to provide for satisfactory operation, notwithstanding errors and omission. The equipment listed in the Contract documents are, therefore, indicative and not limitative.
- 4 On satisfactory completion and commissioning of the lighting installation the Contractor shall be responsible for the maintenance of the whole system for a period of 400 days. This will include for the free replacement of any component or lamp that fails during that period of time. In addition, the Contractor shall be responsible for the rectification of any fault that occurs within the cabling network. As part of this rectification work no cable joints will be permitted.
- 5 All of the works associated with the road lighting installation shall be carried out in accordance with the Qatar Highway Design Manual 2015 or most recent (QHDM 2015), Qatar Roads Maintenance Manual 2015 or most recent (QRMM 2015) and the latest specifications issued by the PWA including The Qatar General Electricity & Water Corporation "KAHRAMAA" Regulations for the Installation of Electrical Wiring, Electrical Equipment.
- 6 The Contractor is deemed to be in possession of these regulations and the latest specifications.
- 7 The luminaire shall be suitable for connection to the low voltage single phase supply of the main network grid in The State of Qatar.
- 8 For voltages and frequencies, regulations and requirements of Kahramaa and relevant authorities should be taken into account.

15.1.2 References

- 1 The following standards and other documents are referred to in this Part:
 - BS HD 60269-2 Low Voltage Fuses. Supplementary requirements for fuses by authorized persons (fuses mainly for industrial application)
 - BS 302 Specification for higher breaking load ropes
 - BS 791 Solid-stem calorimeter thermometers
 - BS 1011 Process of arc welding of carbon and carbon manganese steels
 - BS 2484 Straight concrete clayware cable covers
 - BS 4343 Plugs, socket-outlets and couplers for industrial purposes
 - BS 4360 Weldable structural steels
 - BS 4533 Luminaires
 - BS 4800 Colour chart
 - BS 5467 Cables with thermosetting insulation for electricity supply for rated voltages of up to and including 600/1000 V and up to and including 1900/3300 V
 - BS 5486 Low voltage switch gear and control gear assemblies
 - BS 5489 Road lighting
 - BS 5649 Lighting columns
 - BS 5972 Photoelectric Control Units for Road Lighting
 - BS 6121 Mechanical Cable Glands for Elastomer and Plastic Insulated Cables
 - BS 6141 PVC insulated PVC sheathed circular flexible cables
 - BS 6346 PVC-insulated Cables for electricity Supply
 - BS 6360 High conductivity stranded copper shaped conductor with XLPE insulation
 - BS 6622 Cables with extruded cross-linked polyethylene or ethylene propylene rubber insulation for rated voltages from 3800 / 6600 V up to 19 000 / 33 000 V
 - BS 6746 Extruded black PVC over sheath
 - BS 6977 Specification for insulated flexible cables for lifts and other flexible connections
 - BS 7430 Code of practice for earthing
 - BS 7671 Requirements for electrical installations

 - EN 40 Lighting Columns
 - EN 295 Vitrified clay pipes, fittings and pipe joints for drains and sewers
 - EN 1011 Welding
 - ISO 1461 Hot dip galvanized coatings on iron and steel articles
 - EN1559-1 Founding. Technical conditions of delivery. General.
 - EN1559-4 Founding. Technical conditions of delivery. Additional requirements for aluminium alloy castings.
 - EN1676 Aluminium and aluminium alloys. Alloyed ingots for remelting
 - EN 10137 Plates and wide flats made of high yield strength structural steels

- EN 10210 Hot-finished hollow sections
- EN 12767 Passive Safety of Support Structures
- EN 60529 Degrees of protection provided by enclosures
- EN 60898 Miniature and moulded case circuit breakers
- EN 60947-3 Air-break switches, air-break disconnectors, air-break switch disconnectors and fuse combination units for voltages up to and including 1000 V ac and 1200 V dc.
- EN 62305 Protection against lightning
- IEC 60598 Luminaires for roadway lighting
- CIE 126-1997 Guidelines for minimizing sky glow.
- ISO 9001 Quality Management Systems
- EN62262 IEC62262 Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts.

The Qatar General Electricity & Water Corporation “KAHRAMAA” Regulations for the Installation of Electrical Wiring, Electrical Equipment and Air Conditioning Equipment.

The Qatar Highway Design Manual 2015 (QHDM 2015)

Qatar Road Maintenance Manual 2015 (QRMM 2015) .

WEEE Directive (2002/96/EC). RoHS Directive (2002/95/EC).

Institution of Lighting Engineers (ILE), Code of Practice for Electrical Safety

Institution of Lighting Engineers (ILE), Technical Report No 7 ‘High Masts for Lighting and CCTV’

Institution of Electrical Engineers (IEE), Wiring Regulations

State of Qatar, Qatar Wiring Regulations

15.1.3 Approved Contractors

- 1 All road lighting works shall be carried out by a contractor or sub-contractor approved by the PWA. Proof of such approval shall be required in writing prior to the works commencing on site and the name of any sub-contractor to be engaged shall be entered in appropriate forms during tender submittal.

15.1.4 Supply of Materials

- 1 The Contractor shall supply all the materials required to carry out the Works as specified in the Contract Documents and Drawings. No materials will be supplied by the Owner or the PWA.

15.1.5 Programme of Work

- 1 The Contractor is responsible, with the agreement of the Engineer, for all liaisons with the respective department within PWA, in respect of programming the installation and commissioning of the complete road lighting system. In addition to the Engineer, he shall also ensure that relevant departments within the PWA are at all times kept informed of the current progress of the road lighting works on site and that his approved sub-contractor programme works are in the specified sequence in accordance with the overall approved Works programme.

15.1.6 Technical Requirements

- 1 All works carried out on the installation shall be in accordance with the requirements of these specifications so that their true meaning and intent are fulfilled. Minor deviations from the drawings may be made to accomplish this but no change shall be made without written approval of the Engineer and in consultation with the relevant departments within the PWA.
- 2 In addition to all the regulations, codes of practice and standards referred to within this specification, all the lighting and associated electrical works shall comply with the current Qatar wiring regulations and the requirements of PWA.
- 3 Where applicable, any associated work involving other authorities in the State of Qatar their relevant standards and specifications, as issued by them, shall be complied with.
- 4 All equipment and materials supplied for the project shall be manufactured in strict compliance with the latest standard of BS, IEC, EN or other standards and regulations specifically referred to in this specification. Here in after they are referred to as the "Standards".
- 5 Acceptance tests shall conform to those referred to in the above mentioned "Standards".

15.2 APPROVAL OF EQUIPMENT

15.2.1 General

- 1 All materials shall be approved by the Engineer. The Contractor shall be responsible to ensure that, where applicable, for nominated items of equipment only the type and manufacturer approved by the PWA, as detailed in their List of Approved Manufacturers are submitted for incorporation into the works. In addition, written approval must be obtained from the PWA, prior to ordering. Contractors shall note that only products with a proven record of performance, efficiency and long life will be considered for approval.
- 2 The Contractor shall not order any equipment for the incorporation into the Works before receipt of formal approval in writing. The approval procedure shall be as follows:
 - (a) The Contractor shall submit four copies of his equipment proposals to the Engineer. This submission shall be comprehensive and clearly state any manufacturer's deviations from the specification. Manufacturer's literature associated with the submission shall be originals and not photocopies. Specific reference to the compliance of certain specification requirements shall be identified.
 - (b) The Engineer shall review this submission. The Engineer's approval shall be as follows.
 - (i) With the Engineer's comments and recommendations attached, a copy of the submission shall be forwarded to the departments concerned within the PWA, to obtain their approval.
 - (ii) Where minor deviations exist from the specifications but do not affect the performance of the equipment or installation the Engineer's recommendations to accept such deviations, his approval together with a copy of the submission shall be forwarded to the departments concerned within the PWA, to obtain their approval.

- (iii) Approval shall be transmitted to the Contractor in writing once the approval of the relevant departments within the PWA, has been given.
- 3 All submissions shall give clear, unambiguous details and performance data of the equipment proposed, together with all supporting calculations where necessary. Clear catalogue identification references shall be provided. Documents shall be in English.
- 4 The Engineer reserves the right to direct the Contractor to provide equipment of a make and type that is essential to achieve the Contract design criteria.
- 5 Approval of samples by the Engineer in consultation with the relevant departments within the PWA, does not in any way relieve the Contractor of his contractual obligation in respect of the suitability of the equipment or their final performance once installed, and the co-ordination with all the elements of the lighting works into a fully operational installation.
- 6 After receipt of equipment the Contractor shall arrange for them to be examined and approved by the Engineer's Representative in consultation with the relevant department within the PWA, prior to installation.
- 7 Column and Mast Base Enclosure Requirements

In paved or walkways areas Enclosure plate is required. The Enclosure plate shall be cast Aluminium or Galvanized steel, comprising two removal halves per base with size matching the base plate. It shall be painted to match pole finish. Provided with backup plate to one halve of Enclosure Plate and with tapped holes to accept stainless steel screws countersunk into other half of Enclosure Plate.

8 Specific Requirements for Columns

The gap between base plate and top of foundation shall be grouted. Means of discharging any accumulated moisture shall be provided at the pole base and provision shall be made for adequate drainage.

9 Testing and Factory Visits

The contractor shall facilitate authorised Engineer representatives, and/or their appointed representative, to examine the test and manufacturing facilities and witness manufacturing processes and sample testing related to the luminaire and associated components submitted for evaluation, at no cost to Ashghal or their appointed representative.

10 Saving Energy Lamp's Luminaire specification data sheet arrangement or each model of luminaire the manufacturer shall produce a data sheet providing a detailed and comprehensive description of the luminaires characteristics and component parts. The data sheet will contain adequate information for the reader to select and specify a particular model from the luminaire range. This will include;

- (a) Luminaire diagram external dimensions, weight and windage
- (b) Optical arrangement (lens and reflectors types and settings)
- (c) Driver type (drive current, system power consumption)
- (d) Luminaire output (lm)

- (e) Luminaire efficiency (lm/W)
- (f) Glare rating
- (g) Control and switching options (photocell, programmed stand alone, CMS, etc.)

15.3 STORAGE OF PLANT AND EQUIPMENT

- 1 All plant and equipment shall be stored off the ground under weatherproof cover ready for incorporation in the works. All electrical apparatus shall be examined and cleaned before installation. All open conduit ends shall be fitted with plastic caps or suitable protective covering to prevent the ingress of foreign matter. All drums with cables shall be protected from direct sunlight.

15.4 SPECIAL REQUIREMENTS

- 1 All notices from the Contractor shall be in writing and delivered by hand.
- 2 The Contractor shall consult the Engineer not less than one month before it is proposed to commence work to ascertain whether any underground installations will be affected by the proposed work, in which event the Contractor shall make all necessary arrangements with the Engineer to safeguard the installation. It will be the Contractors responsibility to liaise with the utility authorities and to arrange for all road opening notices
- 3 The Contractor shall give at least one week's notice in writing to the utility authority's Engineer of the dates upon which it is intended to operate plant or equipment or carry out any work for which permission has been given in writing by the utility authority's Engineer. Such operations of work shall only be carried out in the presence of the utility authority's Engineer unless notice shall have been in writing from the utility authority's Engineer that they do not require to be present.
- 4 The utility authorities may require work to be executed on their installation during the period of the Contract. The Contractor shall afford all facilities to the utility authority's contractors or workmen until their diversion work is complete. The Contractor shall co-ordinate the work of the utility authorities and his own activities and when necessary shall amend his programme of working to suit all requirements of the utility authorities in connection with their diversion work and shall keep the Engineer informed in writing of all arrangements made.
- 5 The Contractor shall locate and mark with suitable posts all the utility authority's underground installations that are within the area of the Works and shall ensure that such markers are maintained in their correct positions at all times. The Contractor shall advise the utility authority's agent of any installation not found where shown on the Drawings, or found but not shown or found damaged or subsequently damaged.

15.5 HIGH MAST LIGHTING

15.5.1 General

- 1 This work shall consist of the supply, installation upon prepared foundations, connections, commissioning and putting into satisfactory service the high masts complete with the operating mechanisms, luminaire support ring or bracket, luminaries, control gear, wiring and distribution equipment.

- 2 The mast luminaire support ring shall be designed to provide for the appropriate distribution of lighting either in one direction or in many directions thus making it possible to concentrate the required number of luminaires on any zone and fix them rigidly in any direction desired. Prepared foundations are specified in other sections of this specification.

15.5.2 High Mast Column

- 1 The high mast column shall be of the height specified on the Drawings, hot dipped galvanized to ISO 1461 and the guide to methods for assessing the acceptability of flaws in metallic structures as per BS 791. They shall be of multi-sided cross-section with a continuous taper made of formed sheet steel in accordance with BS 4360 grade 43C and electrically welded. They shall be delivered to the site in manageable sections of not greater than 12 metres and be joined by means of pressure over-lapping or slip-joints, which shall have a minimum length of 1.5 times diameter of the joint. Site welding will not be allowed.
- 2 The walls of the masts shall have a minimum thickness of 6mm for the base section, 5mm for the central section and 4mm for the top section. The steel used shall have tensile strength between 490 and 630 MN/sqm and minimum yield strength of 355 MN/sqm.
- 3 The mast cross-sections shall be so designed that once installed and fully equipped, it shall have safety factors in accordance with Technical Report No. 7 of the Institute of Lighting Engineers – London and shall be capable of withstanding wind load resulted from the, 160Km/h wind speed for 3 sec gust and blowing in the most unfavourable direction at a height of ten meters above ground level. Appropriate reinforcement shall be provided where necessary to increase the strength. Its behaviour under wind induced oscillation shall be such that it shall not fail due to fatigue and the design should ensure that these oscillations be damped to a minimum of zero.
- 4 The maximum deflection at the top of the mast shall not exceed 2.5% of the mast height at the maximum wind speed provided in Section 1 Part 1 Clause 1.5.2.
- 5 A steel flange plate of adequate thickness and free from laminations shall be welded above and below the base of the mast developing fully the strength of the section. In addition supplementary gussets shall be provided between bolt holes if deemed necessary.
- 6 An access door shall be provided in the base of the mast of adequate dimensions to permit clear access to the back plate installed for the mounting of the circuit breaker assembly and junction box, winch, etc. The backboard shall be made of steel or other non-hydrosopic material. The door shall be completely weatherproof fitted with a hidden hinge and a heavy duty lock. The door area shall have appropriate reinforcement.
- 7 A stainless steel earthing 12mm diameter bolt shall be welded inside the mast near the access door and shall be complete with stainless steel washers and nuts.

15.5.3 High Mast Head Frame

- 1 The head frame shall be hot-dipped galvanized steel attached to the mast by means of a steel slip-fitter and secured by at least four stainless steel set screws. It shall be composed of spun aluminium or other approved weatherproof cover, housing the required number of steel cable sheaves and associated accessories for the operation and powering of the luminaire ring.

15.5.4 High Mast Luminaire Ring

- 1 The high mast luminaire support ring or carriage shall be constructed of hot dipped galvanized steel channel fitted with the appropriate number of luminaires, lamp gear mounting brackets, wiring chamber and mounting plate. It shall be in two halves joined by bolted flanges to permit removal from the erected mast. The luminaire shall be mounted on the luminaire rings by means of either a specially designed bracket allowing it to be swiveled in any desired direction or rigid bracket arm assembly. It shall be possible to lock each luminaire firmly in position, thus preventing any rotation or falling while moving the luminaire ring. The weight of luminaire ring assembly shall be transferred from wire ropes to the mast in the final locked position.
- 2 The carriage assembly shall be arranged to locate firmly against stops when in the secure position and these shall be of adequate strength to ensure that they cannot be damaged by over winding of the winch.
- 3 A shaped protective aesthetic canopy, designed to give a coordinated appearance of head frame with the luminaire ring, shall cover the head frame.
- 4 For masts fitted with a mobile luminaire ring, rollers with a centering mechanism shall be provided to ensure a perfect alignment of the luminaire ring both axially and in azimuth, while ascending or descending the mast. Rollers shall be made of water resistant non-marking composition material with oil-impregnated bronze brushings. All shafts and washers shall be stainless steel.
- 5 A weatherproof wiring chamber or terminal box shall be provided constructed from a corrosion resistant material or aluminium alloy and installed on the luminaire ring. It shall be equipped with the high temperature shrouded terminal blocks and neutral bar or block and shall include facilities on the luminaire ring to allow testing of luminaires while in the lowered position. The wiring chamber shall be fitted with an earthing stud accessible from inside and out for earthing connections. The housing shall be completely weatherproof.
- 6 The cables installed in the luminaire ring connecting each luminaire to the wiring chamber shall be factory pre-wired avoiding the need for field wiring, and shall have single core copper conductors with neoprene or cross-linked polythene or approved equivalent insulation and sheath. Cables shall be either single core or 3 core 2.5mm² with copper conductors and colour coding different phases being in conformity with relevant cabling standards.
- 7 Cables from the terminal box shall run in hot dipped galvanized metal duct fixed to or within the luminaire carriage to each luminaire from the wiring chamber.

15.5.5 Multi Core Mast Rising Cable

- 1 The cable connecting the MCCB assembly at the base of the mast to the wiring chamber on the luminaire ring, shall be a flexible multicore copper cable with conductors and neoprene or approved equivalent high temperature resistant insulation and sheath in accordance with EN 50525-2-21:2011 and IEC 60245-3:1994 and IEC 60245-4:2011.
- 2 The colour coding of the different phases of the cable shall conform to the relevant cable standards. RYB for phases, Black for neutral and Y/G for earthing. Each luminaire shall have its own neutral conductor connected to the neutral bar or block.
- 3 The mast cable shall consist of a circular multi core cable to EN 50525-2-21:2011 and

- 4 IEC 60245-3:1994 and IEC 60245-4:2011, 90⁰ C, 450/750V grade. Each conductor core shall be insulated with ethylene propylene rubber (EPR) and the complete core is sheathed with heavy duty polychloroprene (PCP).
- 5 A multicore electrical power cable shall be provided terminating in the base compartment with a special multi-pin plug and socket coupler fitted with a guard, and at mast head connected to the wiring chamber fixed to the luminaire ring. It shall be suitable for the bending, flexible and load carrying stresses involved.
- 6 The cable shall be fitted with a correctly rated multi pin weatherproof plug and socket within the base compartment of the mast which will enable the cable to be disconnected before lowering the luminaire carriage. The socket must be connected to the supply side of the circuit and may either be free cable coming from the fuse box or be fixed to the fuse box in the base compartment.
- 7 The wiring shall be such that the plug and socket can be isolated before disconnecting.
- 8 The cable shall be suitably restrained to prevent its own weight from causing strain to the terminal box and lanterns.

15.5.6 Raising and Lowering Equipment

- 1 The pulleys located within the head frame shall be of non- corrosive cast aluminium alloy material grooved to exactly suit the steel rope and cable diameters, and fitted with stainless steel shafts. The pulleys shall be housed in a chassis integral with a sleeve, which slopes over the top of the mast and is secured axially and in azimuth. The complete chassis assembly shall be hot dipped galvanized. A guard is to be provided for the separation of the wire rope and power cable before entering in the pulley and the locating of the steel wire rope and power cables in their grooves when operating either loaded or slack. An arrangement shall be provided to ensure that the electric and steel cables are separated before passing over their respective pulleys, and close fitting guides shall ensure that the cables cannot disengage the pulley during operations.
- 2 The luminaire carriage shall have the provision made on it for supporting and gripping the weight of the supply cable without damage of the cable sheath.
- 3 The luminaire ring shall be supported by 3 steel ropes coupled to 2 steel ropes and suspended from the double drum winch by means of a manufactured steel coupling unit. A divider bar shall ensure the separation of the steel ropes during raising and lowering.
- 4 Flexible stainless steel stranded wire ropes having a tensile strength of 165kgf/mm² in accordance with BS 302 suitable for the application, with factor of safety 5 times S.W.L. of the winch, shall support the luminaire ring assembly. Stops installed on the steel cable shall support the luminaire ring assembly in extreme lower position to within 900mm above the base of the mast. Provisions shall be made to prevent the power cable from winding around the steel hoisting ropes. Manufactures test certificates for each steel wire rope confirming their quality, strength and material specification.
- 5 A steady system shall keep the luminaire ring in the correct top position avoiding any rotation around its vertical axis.
- 6 The termination of the wire rope shall be by compression crimp joint. Terminations shall be certified to have been made 'strictly in accordance' with the appropriate British Standard.

- 7 An additional safety chain should also be provided between the rope shackle and supporting cleat in the mast when the luminaire carriage is in the raised position.

15.5.7 Raising and Lowering Winch System

- 1 The luminaire ring shall be raised and lowered for installation and maintenance purposes by means of a winching system specially designed to be installed in the base of the mast and removed through the access door at the base of the mast.
- 2 The winching system shall have a lifting capacity of at least double the weight of the luminaire ring assembly and the maximum winding torque during operation shall be specified. The winching system shall employ double drums as a safeguard against a single suspension steel wire rope failing.
- 3 The winch shall have a positive locking device which shall remain engaged to prevent rotation in the lower direction when the mast is in service. This device will operate automatically under gravity to the locked position whenever the driving tool or operating handle is removed.
- 4 Winches shall be capable of normal winch speed operation using a heavy duty type portable power tool, which shall be a multi speed reversible type incorporating an adjustable torque limiting device, which can be readily adjusted and locked in any adjustment. The power tool shall be equipped so that the operator can be positioned clear of the moving head frame and using push-button controls at the end of a 5m long flexible lead. A power unit mounting or support frame shall be provided for locating and securing during operations.
- 5 Termination of winch cables shall not involve distortion or twisting of the cable structure. One full layer of turns shall remain on the drum when the luminaire ring is fully lowered or alternatively the drums shall be grooved to ensure a tidy cable lay. The winch drum shall be made of cast iron, or cast aluminium alloy, LM 6M
- 6 Winches shall be provided with a handle for the use of manual operation, if required. Winches shall be completely self-sustaining without the need for brakes or clutches which require adjustment or which can be affected by moisture or lubricant shall not be used.
- 7 Winch gear shall be totally enclosed and self-lubricating by means of an oil bath. Only lubricant recommended by the supplier shall be used. The gear ratio shall take into account operational safety and speed.
- 8 An MCCB providing overload protection shall be incorporated to stop the ring when the effort required by the winch becomes superior to the nominal load.
- 9 The winch shall be fitted with suitable equipment to allow the winch to stop in a safe manner, without damage to the mast finish, in the event of a supply failure to the power tool. The winding mechanism should then be capable of being operated by hand.
- 10 Each winch supplied shall be uniquely identified. In addition it shall have its own individual test certificate recording the safe working load. Lubrication details shall also be permanently recorded on its housing for future maintenance purposes.

15.5.8 Finish

- 1 All welds shall be smooth with the splatter removed and the interior and exterior surface of the mast and ring shall be cleaned by pickling or blasting and shall be free of any grease.

- 2 All components shall be hot dipped galvanized by total immersion in a bath of molten zinc after completion of the fabrication. No further levelling up, finishing or modifications shall be carried out after completion of the galvanizing process. The minimum thickness of zinc coating shall be 450 gm/sqm on the inside and outside surfaces of the mast and ring. The galvanizing shall conform to EN ISO 1461.
- 3 Any damage to the galvanizing shall be rectified during erection by wire brushing the affected area and treating with an approved zinc restorative. Sufficient materials shall be applied to provide a zinc coating at least equal in thickness to the galvanized layer.
- 4 If required by the Engineer the underside of the flange plate and internal surface of the mast to a height of 0.5m shall be given a coat of heavy duty bitumen paint prior to erection.

15.5.9 High Mast Luminaires

- 1 The high mast luminaire shall have a 'cut off' distribution. It shall be of the side entry mounting type, with toughen a flat glass protector and integral control gear suitable for the operation of either a 400W with lamp lumens output rating of no less than 56,500, or 600W with lamp lumens output rating of no less than 90,000, 220-240V, 50Hz. High Pressure Sodium tubular lamp of E-40 base, as defined for the contract.
- 2 The luminaires to be adopted shall be high performance street lighting lanterns currently used for conventional roadway lighting routes to BS 5489 or equivalent suitable for use at a mounting height of 25 or 30 metre. It shall comply with IEC 60598 or other approved equivalent norms. The body shall be made of die-cast aluminium and shall be divided into two separate compartments.
- 3 The first compartment of the luminaire shall house the optical system with polished and anodized pressure aluminium reflector. The second compartment shall contain the electrical accessories (control gear) cable feed terminals and side entry mounting socket. This separation shall protect the electrical accessories from the direct radiant heat emitted by the lamp. The optical compartment shall be protected by a toughened flat glass protector and shall be dust and watertight to a protection rating of IP65
- 4 The access to the optical compartment shall be by tilting the protector frame around the hinge without tools. A heat resistant gasket fitted on the frame shall ensure the tightness of the optical compartment. The accessories such as ballast, ignitor, and capacitor shall be re-wired and pre-assembled by a metallic plate that is mounted and fixed into the rear compartment. Special care shall be taken to allow easy maintenance and quick replacement of the accessories and to minimise the risk of falling.
- 5 The cable feed terminal and the earth-screw shall be fixed to the metallic compartment, a cable holder shall be mounted near the terminals. The side entry mounting sockets should accept a 125 mm. long spigot and 50 mm diameter OR adjustable from 42 to 60 mm dia. Exterior side of both compartments should be with grey colour in finish.
- 6 LED Luminaires for High Masts shall have efficacy not less than 100 lm/ W at 500 C ambient temperature, 40000 K color temperature.

15.5.10 High Mast Distribution Equipment

- 1 The high mast base compartment shall be fitted with a power control and distribution assembly installed in a pre-wired weatherproof box opposite the access door inside the base of the mast.

- 2 The assembly shall consist of a surface mounted sheet steel weatherproof box with a cover enclosing:
 - (a) One 3-pole main 63Amp MCCB together with a neutral link for luminaire circuits. The ratings of the MCCB shall be in accordance with the QGEWC regulations and suitable to the connected load and cable.
 - (b) One single pole 20 Amp MCB with neutral link for each luminaire circuit of a suitable current rating.
 - (c) One-pole MCCB with neutral link connected to the incoming supply and serving a 16A-250 V DIN socket outlet complete with 3-pin plug to suit the raising and lowering mechanism.
 - (d) A multi-pin plug and socket outlet with guard fitted with cable outlet for connection to the multi-core electric power cable provided from the MCCB to the luminaire ring wiring chamber.
- 3 The MCCB's shall be de-rated and calibrated to provide over-current and short circuit protection when used in an ambient temperature of 50° C and shall have the required breaking capacity. The incoming side of the triple pole MCCB with the neutral links shall be fitted with a 4-way, line-tap type terminal block, with each terminal capable of accepting 2 x 35mm² copper conductors.
- 4 The multi-pin coupler for supply to the portable raising and lowering power tool shall be connected to the MCCB via a flexible connection to ensure accessibility.
- 5 Where an high mast assembly supplies a ground sign lighting unit or equivalent it shall be equipped with an additional 15 Amps circuit breaker to supply the sign lighting installation. The circuit breaker shall be installed inside the mast distribution box.

15.5.11 Aircraft Obstruction Light

- 1 Where required by Civil Aviation Authorities, two red luminaires within cast aluminium bodies shall be fitted at the top of each high mast attached to the movable luminaire ring with a purpose made bracket and arranged to project through the canopy.
- 2 The luminaires shall be provided with a change over relay such that, in the event of lamp failure, the second lamp is automatically connected. Lamps shall be GLS Rough Service 100 watt suitable for an E.S. (E27) lamp holder.
- 3 The obstruction lights shall be wired on a separate circuit protected by a separate SP & N circuit breaker with terminals to accept separate incoming cables.

15.5.12 Earthing and Lightning Protection

- 1 All masts shall be provided with a separate system for earthing as a protection against lightning. This shall comply with EN 62305.
- 2 High masts shall be equipped with an air terminal of the correct height to provide the required zone of protection for the mast head frames and fixtures. The air terminal shall be bonded to the mast to ensure the discharge is dissipated via the earth ground terminal without damage to the steel winch ropes or electrical cables.

- 3 Separate earthing shall be provided for each item of control equipment within the mast assembly and connected to a central earthing point.
- 4 A 12mm diameter stainless steel or brass stud with nuts and washers in the base compartment connected to the main body of the mast structure shall be provided.

15.5.13 High Mast Foundations Construction Requirements

- 1 High masts shall be installed on concrete bases as detailed on the Drawings. The foundation design and construction shall be as based on the high mast manufacturers recommendations according to the ground and climatic conditions that exist at the site location. The erection of high masts and the assembly of the luminaire, head frame with raising and lowering gear shall be carried out strictly in accordance with the manufacturers' instructions. The Contractor shall before commencement of the construction work confirm by means of structural calculations that the foundations proposed are suitable for use with the high mast installation he proposes to install. Holding down bolts and plumb adjustment nuts, washers, locknuts or nyloc nuts shall be galvanized steel or cadmium plated.
- 2 The holding down bolt/nuts complete with the anchor plate for casting into the foundation shall be provided by the high mast manufacturer together with a mild steel anchor bolt template with tube holes to ensure correct vertical and precision made horizontal bolt alignment.
- 3 The anchor bolts shall be of guaranteed performance high tensile steel.
- 4 All buried external surface of the high mast foundation shall be protected by brush painted tanking membrane and hard board protection.
- 5 The Anchor bolts shall be protected by PVC caps

15.5.14 High Mast General Requirements

- 1 Final setting and adjustment of the luminaires shall only be carried out after all the masts along a route, junction or interchange are complete and operational.
- 2 Each high mast metal work shall be bonded to a separate earth rod as indicated on the Drawings and also to the separate earthing cable connected to the distribution system earth bar
- 3 The high mast shall be of specified height carrying luminaires as indicated on the Drawings Each luminaire shall be fitted with the specific lamp or lamps arranged to be separately oriented to give the correct illumination at designated locations along the road surfaces.

15.5.15 High Mast Approval

- 1 For the approval of the Engineer before manufacturing commences the Contractor shall submit detailed calculations and supporting data to show that the mast meets the design criteria detailed and shall include the following information:
 - (a) The deflection at the top of the mast at the designed wind speed.
 - (b) The neutral frequency of the mast.
 - (c) The critical wind speed for resonance.
 - (d) The damping characteristics of the mast.

- (e) The steel stressed under resonant conditions.
- (f) The acceleration at the top of the mast under resonant conditions.
- (g) Welding procedure.
- (h) Procedure to ensuring that the flange plate is not laminated.
- (i) Details of the joints between the mast sections and between the bottom section and the flange.
- (j) Details of the base compartment with the method of reinforcement at the door area and means adopted for making the door weather and tamperproof.

15.5.16 Maintenance Requirements

- 1 The following items must be provided for the Engineer at the time of the commissioning of any high mast assembly:
 - (a) Power tools – 1 No.
 - (b) 'L' hooks – 6 No.
 - (c) Operating handles – 2 No.
 - (d) Foundation Bolt/Nut and Head frame Nut/Bolt Spanners – 2 No. Sets.

15.5.17 High Mast Lighting Performance

- 1 The Contractor must provide guaranteed lighting performance data as part of his technical submission to confirm the minimum light values that will be maintained at each location and where specifically identified by the Engineer or representatives from the relevant departments within the PWA.
- 2 The minimum light levels that must be obtained shall be: Not less than the standard mentioned in QHDM for the class of road / type of junction

15.6 LIGHTING COLUMNS

15.6.1 General

- 1 All columns and brackets shall be produced by ISO 9001 certificated lighting column manufacturers registered and certified for the manufacture, supply and certification of lighting columns under their quality assessment schedule.
- 2 All columns of the same mounting height and with the same arrangement shall be identical in construction.
- 3 Road lighting columns shall be hot dip galvanized steel, octagonal, or tubular shape, of height as detailed in the Contract specification and drawings, complete with bracket of outreach, number of arms and of shape all again as detailed in the Contract specification or on the drawings.

15.6.2 Design Criteria for Columns

- 1 For all columns and masts the stress and deflection calculations shall be based on the maximum bracket and luminaire projection, on the bracket arm, with projected area, length and weight as designated.

- 2 In still air conditions, loaded with the designated luminaire positioned in any of the variable locations, there shall be no appreciable deflection of the column.
- 3 The maximum permissible deflection in the column or mast shall be 1° in any 1m length with a maximum total of 7.5 ° over the whole shaft under maximum design wind loading
- 4 Columns must be designed to withstand the wind force at 160Km/h wind speed for 3 sec gust
- 5 The "K" factor for columns over 8 m in height shall be 2.2.
- 6 Columns shall be designed to support lanterns with the data given by the Engineer.

15.6.3 Details of Column

- 1 The column shall be made from hollow sections to EN 10210 in steel to EN 10025 or any approved equivalent norms. The hollow sections shall have a minimum tensile strength of 430 N/mm² and minimum yield strength of 255N/mm².
- 2 Columns shall be in one piece tubular (round), or multi-sided sheet steel and be of the flanged (bolted) type.
- 3 Columns should be designed in accordance with BS 5649 in steel and finished with hot dip galvanized internally and externally with no other treatment in accordance with ISO 1461 or equivalent.
- 4 Strengthening shall be provided at the door opening. Care shall be taken to ensure that rounded edges are provided at the corners of the door opening to avoid stress concentrations.
- 5 The top of the column should be designed and provided as suitable to fix the bracket arm collar with the top of the column as shown in the Contract drawings.
- 6 All dimensions for the column shall be in accordance with the latest requirements of the PWA, and, if applicable, as detailed on the drawings. Modifications to suit the particular foundation/support details proposed by the manufacturer shall be submitted to the Engineer for approval prior to incorporation.

15.6.4 Details of Bracket

- 1 Brackets shall be formed of hollow sections to EN 10210 in steel to EN 10137 Grade 43C or equivalent.
- 2 The column bracket arms and spigots shall be so designed that when assembled with the shaft the design altitude of the arm and projection shall be as detailed in the contract requirements.
- 3 Welding on bracket arm shall be carried out in accordance with EN 1011.
- 4 Brackets shall be hot dip galvanized to ISO 1461 or equivalent. The bracket arm shall be so designed that when assembled on the column shaft the altitude of the arm and spigot shall be 5° above the horizontal unless otherwise stated in the Contract documents.

- 5 Unless otherwise stated in the Contract documents, bracket arms shall not be provided with end spigot. Luminaire shall be mounted directly on arm bracket. Minimum outside diameter of the arm bracket shall be 60 mm (suitable for fixing the luminaire directly) and thickness shall be 4mm.
- 6 The securing arrangement of the bracket arm to the column shall be positive so as to ensure that the arm does not rotate and shall be such that the bracket can be fixed in any of four 90 degree positions in relation to the column door opening. 8 No. socket set screws of size M10 x 16mm or approved equivalent arrangement shall fix the bracket onto the columns using stainless steel screws.
- 7 The luminaire shall be securely fixed to the mounting post or bracket by means of a clamping system that will prevent movement in high winds. All component parts shall be manufactured from non-corrosive materials.

15.6.5 Doors and Base Compartments for Columns

- 1 Each column and mast shaft shall have a base compartment large enough to offer easy access to the equipment therein.
- 2 The weatherproof door provided for each opening which shall be interchangeable between columns of the same mounting height. To avoid accidental spillage of water from irrigation of flooding the bottom of the door shall be at least 0.5m above the top of the foundation.
- 3 A stainless steel durable non-corroding tamper-proof lock device shall be provided of the triangular/allen headed screw type, unless designated otherwise. All door cover shall also be secured to the pole by a stainless steel chain of adequate length. Where applicable, door lock recess shall incorporate adequate drainage such that they are unlikely to become blocked and so form a water trap. Heat resistant silicon rubber gasket for the door shall be provided
- 4 Door openings are to be kept to the minimum size consistent with the cable termination units and any control gear.
- 5 When installing lighting columns on a single carriageway the column doors shall be located at 90° to the kerb line and in such a location that the maintenance operative faces the oncoming traffic and to ensure that the door can be opened at all times without encroaching onto the highway. In the case of installing lighting columns within the central median the column door shall be located perpendicular to the road such that the maintenance operative will be facing across the line of the carriageway. The door openings shall be free from any irregularities and burrs.
- 6 Keys are to be provided with the first consignment of columns at the rate of 10 % of the total number of columns.
- 7 A baseboard of non-hygroscopic hardwood/ marine grade plywood, minimum thickness 15 mm, shall be securely fixed in each compartment and shall be of sufficient size to accommodate the cable termination unit.
- 8 Single purpose earth terminals shall be provided in a readily accessible position, preferably on the left hand side of the opening and on the column door.
- 9 The baseboard shall be fixed using brass or stainless steel nut and bolt arrangement.

- 10 All door lock hinges and catches shall be greased before handover.

15.6.6 Details of Base Flange Plate

- 1 The base flange plate shall be manufactured from steel plate that is free from laminations. The main shaft of the pole shall penetrate the full depth of the base plate and is to be welded above and below using a semi automatic MIG shielded arc process. Additional strength shall be provided by gusset plates located between hole positions.
- 2 4 No. slots allowing for adjustment shall be provided in the flange plate of suitable size so as to accommodate the foundation bolt specified to fix the column on the RCC foundation.

15.6.7 Details of Column Foundation

- 1 The manufacturer of the road lighting column shall submit the dimensions and specification of his proposed foundation including the steel reinforcement details to the Engineer for approval.
- 2 The foundation shall accommodate 4 No. holding down bolts of size 25mm x 800mm for columns up to 10 metres high and 33mm x 900mm for 12 and 16 metres high columns, supplied with two nuts and two washers to each bolt.
- 3 Foundations shall be constructed such that they avoid being a hazard to pedestrians and cyclists on footways and shared use paths. The top surface of concrete column foundations on pathways shall not be higher than ground level, and shall not be higher than 50 mm above ground level on all other surfaces.

15.6.8 Passively Safe Lighting Columns

1 Design Criteria

- (a) All Passively Safe lighting Columns shall comply with EN 12767 – Passive safety of support structures for road equipment – requirements, classification and test methods or all road lighting columns within the clear zone (as defined in most recent QHDM Vol 3 Part 18 & Part 23) shall be protected by an approved barrier system.
- (b) Each Passively Safe Lighting Column shall be anodized aluminium or galvanized steel as specified in the Contract Documents. Design of aluminium columns shall comply with EN 40, Part 6 and its incorporated references. Design of steel columns shall comply with EN 40, Part 5 and its incorporated references.
- (c) In addition to section 15.6.2-1 the passively safe columns in still air conditions, loaded with the designated luminaire positioned in any of the variable locations, there shall be no appreciable deflection of the column. The maximum permissible deflection for passively safe poles shall not exceed 4% of the total length of the pole when furnished with bracket arm, and 2% of the total length of pole with no bracket arm. Columns must be designed to withstand a base wind speed of 30 metres/second. Columns shall be designed to support lanterns with the data given by the Engineer.
- (d) Per EN 12767, Annex F, passively safe tubular hollow section steel or aluminium posts provided shall have a nominal diameter less than or equal to 89 mm, and a nominal wall thickness of 3.2 mm. Where steel poles are specified in the Contract Documents, steel grade S355J2H shall be provided.

- (e) Aluminium columns shall be finish coated with an anodized aluminium finish providing resistance to fading, peeling, cracking or corrosion. The guarantee provided by the manufacturer shall be a minimum of 10 years against fading, peeling, cracking or corrosion of the finish.
- (f) The maximum mass of combined luminaire support and fixtures attached to breakaway supports shall be limited to 450 kg and the maximum column height shall not exceed 18.0 metres.
- (g) Where slopes are greater than 6:1, no passively safe support shall be used without the approval of the Engineer. Passively safe supports shall not be used on any columns mounted on median barriers, concrete or otherwise. No slip base mechanisms may be used on Qatar roadways.
- (h) Columns shall be certified by the manufacturer to comply with EN 12767 and shall achieve the Passive Safety Performance Classes as indicated in Table 1.

Table 1
Passive Safety Performance Classes

Roadway Posted Speed	Location	Pole Support Requirement
		Impact Speed Class*/ Energy Absorbing Type / Occupant Safety Level**
≤ 40 kph	All	(a) 70:HE:1-3 (b) 100:HE:1-3 (c) 70:LE:1-3 (d) 100:LE:1-3
> 40 kph	CBD	100:HE:1-3
	Other	100:NE:1-3
	Where columns may fall on other carriageways below (i.e. flyovers).	100:HE:1-3
Term Descriptions	CBD – Central Business District	HE – High Energy Absorbing LE – Low Energy Absorbing NE – Non-Energy Absorbing

* Poles shall be procured in order of class per availability from the manufacturer.

** The Occupant Safety Level (OSL) provides for increasing levels of safety by reducing impact severity. The preferred level of safety is OSL 3 and shall be procured as first choice when available from the manufacturer.

- (i) Certification of breakaway support shall be collected from the manufacturer and submitted for Engineer approval prior to procurement. Certification documentation shall confirm the Impact Speed Class, Energy Absorbing Type and Occupant Safety Level of the supplied luminaires.

2 Related Equipment

- (a) The column shall be rated to support Cloth Banners up to the length, width and height as required in the Contract Documents. Each column shall be provided with a 240V earthed outlet rated for outdoor conditions in compliance with Section 21 Part 10.2.2 herein.
- (b) When required by the provisions of the Contract Documents, all poles, whether aluminium or steel in type, shall be supplied with a frangible element or breakaway base tested and certified to provide passive safety elements as to be in compliance with EN 12767, with special attention to National Annex (informative) to EN 12767

3 Lighting System Requirements

- (a) Work related to the Passively Safe Lighting Column installation provided for in this specification shall include the supply, installation, testing, commissioning and putting into satisfactory operation all systems as required by the Contract Documents and the Specification.
- (b) Electrical connections for lighting columns shall be quick disconnect type at ground level, such that they provide for electrical isolation within 0.4 seconds upon impact of the lighting pole, and be furnished as required by EN 12767.
- (c) Prior to procurement, the Contractor shall provide shop drawings and supporting calculations required by the Specification, as well as the provision of all required supporting technical literature and samples in connection with the acceptance of proposed equipment approved by Ashghal's authorized representative.
- (d) Due to the long lead times of such equipment, the Contractor shall order the poles within 1 week of shop drawing approval. The equipment supplied shall include all necessary items for a complete installation in accordance with the Specification and other Contract Documents in order to provide for specified luminaire operation.
- (e) Contractor shall provide all necessary accessories, wiring and equipment from lamp to base, feeder pillar to last luminaire, to complete a functional lighting system regardless of their inclusion in the Contract Documents.

4 Lighting Equipment

- (a) **Lighting Columns**
 - (i) The Passively Safe Lighting Columns shall be procured from an Ashghal-approved manufacturer. The manufacturer shall submit no less than three references for contact on past performance, supplying previous installed contract's contact person, title, agency or company name, phone number and e-mail address to Ashghal Design's and Ashghal Operation and Maintenance's authorized representatives as part of the approval process.
 - (ii) Columns shall be constructed with their anchor bolts at no more than 100 mm above ground level. Anchor bolts furnished with the column support shall be galvanized steel or stainless steel in type.
- (b) **Luminaire**
 - (i) Each luminaire fitted on the Passively Safe Lighting Columns shall meet all illumination requirements set forth by Ashghal and the photometric specifics as outlined in the Contract Drawings.

(c) Foundations

- (i) Contractor shall submit the dimensions and specification of proposed foundations for support of the Passively Safe Lighting Columns. Drawings and specifications shall be prepared and sealed by a licensed structural engineer. The structural engineer shall provide certification that the proposed foundation design supports the performance of the breakaway mechanism, and is designed properly to prevent movement or rotation in the surrounding soil.

15.6.9 Decorative Lighting Columns

- 1 Decorative lighting systems are non-standard, themed luminaire and pole styles. The luminaires range from ornate globes known as acorns to four-sided glass fixtures having a distinct character. The luminaires are mounted on the decorative lighting columns in a post-mounted arrangement or with a bracket arm. The Contractor shall coordinate final decorative lighting column and foundation placement with the Engineer to avoid problems related to the placement of trees, other street furniture and underground utilities.
- 2 Each Decorative Lighting Column shall be anodized aluminium or galvanized steel as specified in the Contract Documents. Design of aluminium columns shall comply with BS EN 40, Part 6 and its incorporated references. Design of steel columns shall comply with BS EN 40, Part 5 and its incorporated references. Galvanized steel columns shall be supplied with aluminium cladding sufficient to provide the decorative features when detailed as such in the Contract Documents.
- 3 Galvanized steel columns shall be supplied with aluminium cladding sufficient to provide decorative features when detailed as such in the Contract Documents.
- 4 Decorative Columns must be designed to withstand the wind force at 160Km/h wind speed for 3 sec gust

15.7 LIGHTING UNITS

15.7.1 General

- 1 Road lighting luminaires (light fitting) shall be semi cut-off or cut off and side entry mounting type complete with bowl and integral control gear of rating 70W, 100W, 150W, 250W, 400W or 600W. 220-240V, 50Hz as specified in 15.9.
- 2 All types of lamps shall be energy saving lamps (LED (light emitting diode), Induction lamps) manufactured according to International Electrotechnical Commission IEC or International Standards, and accepted or approved by Qatar Standards.
- 3 The luminaires for roadway lighting shall be to IEC 60598 and shall be capable of achieving the lighting performance specification requirements set out in the Contract specification in accordance with BS 5489, EN 13201 and ANSI/IESNA RP-008 at the mounting heights identified within the Contract.

- 4 Luminaires shall be side entry mounting and semi cut-off or cut off type with integral control gear for use with either 1x 100W, 1x 150W or 1 x 250W, 220- 240V, 50Hz, high pressure sodium tubular lamp of E-40 base. The E-40 lamp shall have a porcelain skin. The lamp supports shall ensure that the lamp position in respect of the optical system remains fixed throughout its operation. The body shall be made of die cast aluminium and shall be divided into two compartments.
- (a) The first compartment shall house the optical system with a pressed high purity one piece aluminium reflector that is anodized and polished. The positioning of the reflector shall be such that should it need to be removed it can be easily refixed in the correct optical position in respect of the light source. Provisions shall be made for easy access to the lamp for replacement. The second compartment shall include for a hinged cover and can be secured in the open position. It shall house the electrical accessories (control gear); the cable feed terminals and the side entry mounting socket. This separation shall protect the electrical accessories from the direct radiant heat emitted by the lamp.
- (b) The optical compartment shall be protected by a toughened glass or an injection moulded acrylic bowl providing a smooth exterior and be complete with a high quality neoprene or silicone sealing gasket providing a sealing quality of not less than IP66 to ensure the assembly is both dust and water tight. The sealing qualities of the control gear compartment shall be IP54. The luminaire shall be so designed to ensure that any moisture collecting in the column bracket cannot enter the luminaire. The use of drain holes within the luminaire is not accepted.
- 5 The accessories such as ballasts, starters, capacitors etc., shall be pre-wired and pre-assembled in the rear compartment on a detachable metallic gear tray fixed securely to the main body of the luminaire in such a way as to ensure effective earth continuity.
- 6 Special care shall be taken to allow easy maintenance and quick replacement of the accessories and to minimise the risk of falling.
- 7 The incoming cable feed terminal block and the earth-screw shall be fixed to either the gear tray or metallic compartment. A cable restraining device shall be mounted near the incoming terminal block. All metal parts shall be effectively earthed to the luminaire earth-screw that shall be readily visible and accessible once access is obtained to the rear compartment. The spigot entry socket of the luminaire shall be compatible with the column bracket and able to accept a 125mm long by 50mm diameter or adjustable from 42mm to 60mm diameter spigot.

15.8 CONTROL GEAR

15.8.1 General

- 1 All items of control gear shall be fitted with shrouds over all terminals to prevent accidental contact during lamp replacement or routine equipment maintenance. All control gear shall have a clearly marked circuit diagram to show its terminal connections in relation to all other components. Control gear (choke, capacitor, ignitor etc.) shall be suitable to withstand temperatures up to 86°C and shall have a purpose made earth terminal. Internal connections shall be with heat resistant non-hydroscopic insulated stranded copper conductors, cleated and with porcelain connectors.

- 2 Ballast (choke) shall be closed type polyester filled can. It shall be suitable for single phase voltage operation and silent in operation. All tappings shall be brought to suitably marked standard terminals to which the lamp and supply connections shall be made.
- 3 The capacitor shall give a minimum power factor of 0.85 lagging. They shall have a tolerance of + or - 10% of its marked value. Where non-metallic capacitors are offered these shall be supplied with a fixing band that shall not damage the capacitor when fitted. Where the capacitor has an aluminium body it shall be provided with a separate earth terminal.
- 4 Ignitors shall be mounted within the control gear compartment of the luminaire. Each ignitor shall be fitted with a device that will detect the presence of a faulty lamp and automatically limit the generation of HV pulses. The ignitors shall be suitable for use with the lamp, ballast and power factor correction capacitor included within the control gear circuit.

15.9 LAMPS

15.9.1 General

- 1 Lamps shall be energy saving lamps with clear tubular hard glass envelope with E-40 base suitable for use on 220 - 240 V, 50Hz, AC. Lamps shall be manufactured according to International Electrotechnical Commission IEC or International Standards, and accepted or approved by Qatar Standards.
- 2 Energy saving lamps (that have a minimum of 50% energy saving than the standard high pressure sodium vapour gas lamps)shall be:
 - (a) High Intensity Discharge (HID) ,
 - (b) Induction lamp types;
 - (c) Light Emitting Diodes (LED)
 - (d) and any other types of energy saving lamps accepted and approved by Qatar Standards .
- 3 These lamps shall either have a built in or an external ignitor. Initial Lumen output for High Intensity Discharge (HID) lamps shall be no less than 4,500 lamp lumens output for the 50 watt lamps, no less than 6,500 lamp lumens output for the 70 watt lamps, no less than 12,500 lamp lumens output for the 100 watt lamps, no less than 17,500 lamp lumens output for the 150 watt lamps, no less than 33,000 lamp lumens output for the 250 watt lamps or no less than 56,500 lamp lumens output for the 400 watt lamps.

15.10 LIGHTING SYSTEM FOR UNDERPASSES

15.10.1 General

- 1 The basis for the lanterns for use within both the lighting of the vehicular, pedestrian and animal underpasses pertains to lanterns designed for cornice surface mounting within each underpasses, complete with lamp, fuse and associated control gear. The lighting arrangement within each type of underpass shall be based on the use of a common lantern designed such that it can incorporate either a multi lamp or single lamp luminaire arrangement of a variable wattage.

15.10.2 Vehicular Underpass

- 1 The lanterns for vehicular underpasses shall be LED lamps or energy saving lamps with a minimum 100 Lumen/Watt efficacy and L70 life expectancy of 10 years

15.10.3 Pedestrian Underpass

- 1 The lanterns for pedestrian underpasses shall consist of either 1x 70 Watt (no less than 6,500 lumens or 100 Watt SON/T (no less than 12,500 lumens) high pressure sodium vapour luminaires, or Lumen/Watt equivalent LED lamps or energy saving lamps, complete with all materials as specified herein and in the Contract Documents and as required to provide a complete lighting installation.

15.10.4 Animal Underpass

- 1 The lanterns for animal underpasses shall consist of either 1x 70 Watt (no less than 6,500 lumens) or 100 Watt SON/T (no less than 12,500 lumens) high pressure sodium vapour luminaires, or Lumen/Watt equivalent LED lamps, or energy saving lamps complete with all materials as specified herein and in the Contract Documents and as required to provide a complete lighting installation.

15.10.5 Lantern Construction for use in Vehicular, Pedestrian and Animal Underpasses

- 1 An underpass lantern shall consist of housing, front cover, reflector, socket, lamp, fuse, control gear, wiring, latches, screws, washers, pins and other parts composing a complete unit. The lantern shall provide illumination, be mechanically strong and easy to maintain. Its optical housing shall have protection against the ingress of moisture and dust to degree IP55 of IEC529 under all operating conditions.
- 2 The optical seal which shall include the reflector mounting shall be adequate to maintain this degree of protection. With the exception of the reflector, lamp holder mounting and associated cable all other equipment shall be housed at the rear of the optical system and shall be readily accessible by access through the lantern front plate. These components shall include the lantern control equipment, associated cable and isolating fuse. The cable connections to the lampholder within the lantern shall be of the heat resistant type with silicon, glass fibre or other approved insulation.
- 3 The housing and front cover shall be made of stainless steel.
- 4 The reflector shall be made of aluminium sheet of such grade and quality that :
 - (a) The reflecting surface shall have a specular finish.
 - (b) The reflecting surface shall have a dense protective coating of oxide not less than 1.2 mg/cm², applied by the anodic oxidisation process.
- 5 The reflector shall be of such material and construction as to provide low brightness and minimize glare. The latches, nuts, screws, washers, pins and other parts shall be made of non-corrosive metals or of metals with non-corrosive finishes as approved by the Engineer. The seal of the optical system shall be accomplished with a gasket material that will not deteriorate with age. This gasketing shall be continuous and shall ensure a heat and weatherproof seal. Suitably located knockouts to suit the cable conduit shall be provided in the housing. The lamp socket shall be provided with grips or other suitable means to hold the lamp against vibration.

- 6 The fascia plate of the lantern shall be manufactured from toughened glass protected, if necessary due to a high incidence of vandalism by means of the manufacturers purpose made wire mesh guard.
- 7 Between adjacent luminaries a stainless steel 'in fill' plate shall be provided such that the whole assembly gives the appearance of a continuous cornice arrangement. The main sub circuit cables interconnecting each underbridge luminaire from the underpass isolating control box shall be routed between fittings within the luminaire or 'in fill' plate by means of a purpose made cable tray arrangement. Within the structure the cabling shall be routed via galvanized steel conduit cast within the underpass walls and soffit of size suitable to accommodate the number of single core or multicore cables required whilst maintaining the stipulated space factor according to the relevant regulations. The cabling shall be either single core or multi core 6mm² copper conductors within high temperature grade double insulated or flexible cable.

15.10.6 Underbridge or Undercrossing Lantern and Installation

- 1 The lantern for use within both the underbridge and undercrossing lighting shall be designed for directly mounting immediately above the kerb edge of the carriageway and shall be complete with lamp, fuse and associated control gear. The lighting arrangement shall be such that it can incorporate either a single lamp of a variable wattage.
- 2 The underbridge or undercrossing lantern shall consist of housing, cover, reflector, socket, lamp, fuse, control gear, wiring, latches, screws, washers, pins and other parts composing a complete unit. The lantern shall provide illumination, be mechanically strong and easy to maintain. Its optical housing shall have protection against the ingress of moisture and dust to degree IP55 of IEC529 under all operating conditions.
- 3 The optical seal which shall include the reflector mounting shall be adequate to maintain this degree of protection. With the exception of the reflector, lamp holder mounting and associated cable all other equipment shall be housed at the rear of the optical system and shall be readily accessible by access through the lantern front plate. These components shall include the lantern control equipment, associated cable and isolating fuse. The cable connections to the lampholder within the lantern shall be of the heat resistant type with silicon, glass fibre or other approved insulation.
- 4 The housing and front cover shall be made of stainless steel.
- 5 The reflector shall be made of aluminium sheet of such grade and quality that :
 - (a) The reflecting surface shall have a specular finish.
 - (b) The reflecting surface shall have a dense protective coating of oxide not less than 1.2 mg/cm², applied by the anodic oxidisation process.
- 6 The reflector shall be of such material and construction as to provide low brightness and minimize glare. The latches, nuts, screws, washers, pins and other parts shall be made of non-corrosive metals or of metals with non-corrosive finishes as approved by the Engineer. The seal of the optical system shall be accomplished with a gasket material that will not deteriorate with age. This gasketing shall be continuous and shall assure a heat and weatherproof seal. Suitably located knockouts to suit the conduit shall be provided in the housing. The lamp socket shall be provided with grips or other suitable means to hold the lamp against vibration.

- 7 The fascia plate of the lantern shall be manufactured from toughened glass protected, if necessary due to a high incidence of vandalism by means of the manufacturers purpose made wire mesh guard.
- 8 The main sub circuit cables interconnecting each underbridge or undercrossing luminaire from the underbridge or uncrossing isolating control box Within the structure the cabling shall be routed via galvanized steel conduit cast within the underbridge or structure walls and soffit of size suitable to accommodate the number of single core or multicore cables required whilst maintaining the stipulated space factor according to the relevant regulations. The cabling shall be either single core or multi core 10mm² copper conductors within high temperature grade double insulated or flexible cable.

15.10.7 Underpass, Underbridge and Undercrossing Lantern Control Gear and Lamps

- 1 The control gear shall be designed to operate the lamp of the power rating and type indicated and it shall be able to start the lamp and control it continuously for ambient temperatures up to +55°C. The choke shall be tropicalised and have terminals to accept 240 V supply voltage. Each terminal shall be brought out to a separate shrouded termination. Multi-lamp gear operating more than one lamp shall not be employed.
- 2 The capacitor shall give a minimum power factor of 0.85 lagging. They shall have a tolerance of +/- 10% of its marked value. Where non-metallic capacitors are offered these shall be supplied with a fixing band that shall not damage the capacitor when fitted and, if metallic, shall be provided with a separate earth terminal. The permitted operating temperature of the capacitor shall be marked on its case.
- 3 Each lamp shall operate using only one choke and one capacitor. Any combination of two or more capacitors having the equivalent value of capacitance will not be accepted.
- 4 Chokes and capacitors shall comply with the relevant British Standard Specification or an acceptable International equivalent and shall be fully compatible with the complete associated operation lamp circuit.
- 5 The ignitor for energy saving lamp shall be of the electronic solid state type and shall be arranged so that the ignitor circuit stops working after the lamp has started. It shall be totally enclosed. The circuit shall include a shunt capacitor to isolate the mains from high frequency start pulses; this capacitor may also be used for power factor correction. The length of wiring between the ignitor and the lamp shall not exceed that recommended by the Manufacturer for satisfactory lamp ignition and re-ignition of an extinguished lamp.
- 6 The control gear shall meet the following specifications:
 - (a) It shall be suitable for 50 Hz, 240 V AC + 10% operation. .
 - (b) It shall regulate the output power to 12% for the input voltage noted above.
 - (c) It shall have an overall power factor of at least 0.85 when operated under rated lamp load.
 - (d) It shall operate the lamp without affecting adversely the lamp life and performance as specified herein.
 - (e) It shall withstand a 2500 V dielectric test between core and windings.

- (f) The choke shall be encapsulated in an approved resin compound and totally enclosed.
- 7 The lamps for vehicular underpasses shall consist of either 1x 150 Watt SON/T (no less than 17,500 lumen output) and 1 x 250 watt SON/T (no less than 33,150 lumen output) high pressure sodium vapour luminaires, LED lamps or energy saving lamps with lumen output equivalent to the above wattages, complete with all materials as specified herein and in the Contract Documents and as required to provide a complete lighting installation.
- 8 The lamps for pedestrian or animal underpasses shall consist of either 1x 70 Watt (no less than 6,500 lumen output) or 100 Watt SON/T (no less than 12,500 lumen output) high pressure sodium vapour luminaires, LED or energy saving lamps with lamp lumen output equivalent, complete with all materials as specified herein and in the Contract Documents and as required to provide a complete lighting installation.

15.10.8 Underpass, Underbridge or Undercrossing Isolating Box

- 1 At each underpass, underbridge or undercrossing location an isolating box assembly shall be provided to control and isolate the respective lighting. This assembly shall be constructed from either galvanized steel or stainless steel with a hinged vandal resistant lockable front cover complete with sealing gasket protection against the ingress of moisture and dust to degree IP54 of IEC529 under all operating conditions providing. A three phase mcb isolator shall be located within this housing to control the power supplies to each lighting sub circuit. The galvanized steel conduit providing the cabling routing within the structure shall be secured at the isolating box assembly by means of a locknut arrangement.

15.11 LED LIGHTING UNITS

15.11.1 Lighting Units

- 1 The degree of Ingress Protection provided by the luminaire, including the facility for a switching device, shall be rated at least IP66 in accordance with EN60529 (IEC529). Specification for degrees of protection provided by enclosures (IP code). This shall be certified by an independent IP testing and examination laboratory accredited by UKAS or equivalent accreditation body.
- 2 The degree of Impact Protection provided by the luminaire against external mechanical impact shall be rated at least IK10 (metals and plastics) and IK08 (glass) in accordance with EN62262:2002 (IEC62262:2002) Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code). This shall be certified by an independent IK testing and examination laboratory accredited by UKAS or equivalent accreditation body.
- 3 The luminaire assembly shall be tested and approved by an independent ENEC (European Norms Electrical Certification) national Certification Body and awarded the ENEC mark or equivalent international standards. Contractor shall provide verifiable certificate featuring contact information of Certification Body.

- 4 The luminaire shall be designed and suitably rated to ensure correct operation and continuous trouble free service under the prevailing climatic conditions. The luminaire shall be designed to withstand the effects of direct sun exposure during the day and dusty weather conditions including the occasional sandstorm. The luminaire manufacturer shall guarantee the performance and life time claims of lumen maintenance and luminaire life of the luminaire under the stated climatic conditions.
- 5 The luminaire housing shall be constructed from corrosion resistant marine grade aluminium alloy conforming to EN 1676, 1559-1, 1559-4 and 1706 and powder coated by an Akzo Nobel approved applicator, or equivalent, conforming to EN12206-1
- 6 Paints and varnishes. Coating of aluminium and aluminium alloys for architectural purposes. Coatings prepared from coating powder.
- 7 The manufacturer shall supply a RAL colour chart depicting the range of powder coat colours available for the external finish of the luminaire. Luminaire colour shall be specified at the time of ordering.
- 8 The optical assembly and control gear components shall be integral to the luminaire body. For maintenance the luminaire shall allow tool-less access and incorporate quick disconnect features and universal fittings. All component parts shall be easily accessible and securely mounted to prevent accidental falling and manufactured from corrosion resistant materials or treated to prevent corrosion. The luminaire cover shall include an optional security feature to enable locking by means of a tool. The cover shall also incorporate a safety switch to disconnect power on opening and any upward rising hinged canopy shall be secured in an open position by means of a brace to prevent accidental closing.
- 9 The luminaire shall be procured from a prominent luminaire manufacturer that publishes product specifications measured in compliance with the IEC/PAS performance requirements or equivalent.
- 10 The complete luminaire shall be at least 98% recyclable.
- 11 The luminaire shall be vandal resistant. The ingress of insects through any system vent or aperture shall be prevented by means of a filter.
- 12 The luminaire shall be compliant with the Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC) and the Restriction of the use of certain Hazardous Substances in electrical and electronic equipment (RoHS) Directive (2002/95/EC).
- 13 Each luminaire shall have a barcode securely attached internally within the gear compartment identifying the luminaires reference/catalogue number, total wattage and LED current setting and other attributes as required by Ashghal and as required of the Enterprise Asset Management System (EAMS). The barcode type shall be compatible with the handheld device authorized for use by Ashghal.
- 14 All internal and external wiring of the luminaire shall comply with EN60598-1:2008 Luminaires, General requirements and tests and shall be flexible and suitably rated and insulated to withstand the voltages and temperatures encountered in service.
- 15 Any luminaire wiring passing through metal shall have suitable grommets or otherwise be protected to avoid abrasion of the insulation.

- 16 All luminaire terminals and supply connections shall comply with EN60598-1:2008. The conducting material of any terminal block shall be made of brass and shall have screw down plates bearing on the wires. Terminals where screws bear down directly on wires will not be acceptable.
- 17 Luminaires shall be earthed in accordance with EN60598-1:2008. An earth terminal forming part of the luminaire body shall be provided. All parts of an earth terminal shall be made of brass.
- 18 Luminaires shall be “future proofed” by allowing the LED modules to be upgraded easily in situ, as LED efficiency improves. Upgrading of luminaires, or replacement of faulty components, with manufacturer approved components shall not have any detrimental impact whatsoever on the luminaires’ manufacturer warranty. Prototypes shall not be accepted.

15.11.2 Lighting Performance

- 1 Highway luminaires shall be suitable to achieve the lighting class standards as detailed in the Qatar Highways Design Manual as applicable to Primary, Secondary and Tertiary roads in The State of Qatar, under the control of Ashghal and other areas as required.
- 2 The luminaire shall be compliant with EN60598-1:2008 Luminaires. General requirements and tests, and EN60598-2-3:2003 Luminaires. Particular requirements. Luminaires for road and street lighting.
- 3 The luminaire shall be able to restrict glare and control obtrusive light in accordance with the full “cut-off” and “semi cut-off” concepts and associated luminous intensity classes defined in ANSI/IESNA RP-008 or an equivalent, Ashghal-authorized standard. Individual project contract drawings and design specifications shall detail the luminous intensity class requirement.
- 4 The luminaire shall control light output to limit light pollution and minimise sky glow in accordance with Commission Internationale de l'Éclairage (CIE) 126-1997 Guidelines for minimizing sky glow and meet the requirements therein for maximum permissible upward light output ratio (ULOR) expressed as the percentage of luminous flux acceptable in each of four different Environmental Zones.
- 5 The efficacy of the luminaire is given by the total lumen output divided by the power into the system and shall be equal to or greater than 100 lm/w (lumens per watt) operating within the climate conditions as stated herein. The contractor shall obtain a statement from the luminaire manufacturer declaring that quoted performance figures correspond to the stated ambient air temperature and ensure that the specifics of operating in the Qatar environment are written into any applicable section of the manufacturer’s warranty agreement.

15.11.3 Thermal Management

- 1 The luminaire shall be capable of withstanding severe climate conditions, as stated in Section 21, Part 1. General Provisions for Electrical Installation, clause 1.1.14.
- 2 As a minimum, manufacturers shall use 50 °C as the night time ambient temperature with 95% humidity.

- 3 The luminaire shall be designed to provide satisfactory heat dissipation for any powered component parts and maintain safe operating temperatures at all times under the stated climatic conditions. Heat dissipation shall be by passive thermal management, active or mechanical cooling is not acceptable.
- 4 All materials used in the luminaire shall be resistant to high temperature UV (ultra violet) exposure and be 90% UV-stable.
- 5 The luminaire shall incorporate a passive thermal management system, active cooling such as fan assisted systems will not be accepted. The manufacturer shall demonstrate that the luminaire is suitable for continuous operation in the Qatar environment. Within the stated climate conditions the LED junction temperatures shall be shown to remain within the range required to limit the risk of accelerated degradation of the LEDs based on the stated life expectancy of the luminaire
- 6 Junction temperature cannot be measured directly and must be derived using calculation formulae and temperature measurements read from a thermocouple device attached to a series of defined reference points (thermal pads) on the outer casing (package) of the LED. Thermal verification testing is carried out as a laboratory based operation with ambient conditions simulated.
- 7 The luminaire manufacturer shall submit a statement declaring that quoted LED performance figures correspond to the stated ambient air temperature and ensure that the specifics of operating in the Qatar environment are written into any applicable section of the warranty agreement.
- 8 The maximum allowable ambient temperature for the LED lighting shall be stated, in which the LED lighting can operate without adversely affecting any components life, luminaire light output or colour stability. This shall take into consideration the maximum case temperature of the driver and the design LED junction temperature.
- 9 Manufacturers shall state the predefined critical temperature level at which the dim down and switch off protection events occur and relate to junction temperature and ambient temperature. The luminaire shall be constructed in such a way that this protection method shall not occur during climate conditions stated within this specification.

15.11.4 Testing

- 1 LED Luminaire lighting performance shall be measured using an independent photometric testing laboratory accredited by UKAS or equivalent accreditation body. The test procedure and measurements shall be carried out in accordance and compliance with IES_LM-79-08 and IES-LM-82-12 for elevated temperatures. Approved Method: Photometric Measurements of Solid State Lighting Products. The photometric test report shall list all significant data for each SSL product tested together with performance data and also pertinent data concerning conditions of testing, type of equipment, and reference standards. The photometric test procedure shall also be used to calculate correction factors in allowance of the stated climate conditions.

- 2 Photometric data for each luminaire optical setting shall be available in electronic file format in accordance and compliance with IES_LM-63-02 Standard File Format for Electronic Transfer of Photometric Data and Related Information and EN13032-1:2004+A1:2012 Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Measurement and file format. The photometry files shall be compatible for use with industry recognised road lighting design software packages or as requested by Ashghal and include applied correction factors specific to the declared ambient conditions.
- 3 Lighting performance of the LED luminaire in terms of design spacing's relative to a specified road lighting class should be comparable to a modern HID lamp based luminaire with similar lumen output.
- 4 The luminaire manufacturer shall submit a statement declaring that quoted photometric performance figures correspond to the stated ambient air temperature (not LED junction temperature) and ensure that the specifics of operating in the Qatar environment are written into any applicable section of the warranty agreement.
- 5 The luminaire shall be tested in accordance and compliance with EN62471:2008 (IEC62471:2006) Photobiological safety of lamps and lamp systems or an equivalent standard. Any assumptions made during testing shall be clearly stated.
- 6 The luminaire LED light source shall be tested in accordance and compliance with IES_LM-80-08 Approved Method: Measuring Lumen Maintenance of LED Light Sources. The LM-80-08 test report produced for the LED light source shall meet the eligibility criteria necessary for submission to Public Works Authority (PWA- Ashghal).

15.11.5 In Situ Temperature Measurement Test (ISTMT)

- 1 In order to relate the LM-80 test to the luminaire and stated climatic conditions, testing shall be completed that simulate this application. This shall be achieved by In Situ Temperature Measurement Test (ISTMT) which follows ANSI/UL 1598-2004 Luminaires.
- 2 The luminaire manufacturer shall provide a written undertaking to the satisfaction of
- 3 Ashghal's authorized Engineer to warranty the materials and performance as follows:
 - (a) LED arrays shall have a written warranty for a minimum of 50,000 hours at the ambient temperature specified herein and shall be replaced on a one for one basis upon failure. An LED array will be deemed to have failed when:
 - (b) equal to or greater than 10% of the individual LED chips in an array has failed or an array does not provide the required lumen maintenance (L70).
 - (c) Drivers shall have a written warranty for a minimum 50,000 hours and shall be replaced on a one for one basis.
 - (d) Luminaire housing and all external components such as; lenses, gaskets & fastenings and the fixture finish shall have a written warranty for a minimum twenty (20) years against the deterioration of, but not limited to, mechanical failure, UV degradation, corrosion, yellowing, blistering, chalking, cracking, peeling or fading.
 - (e) The Warranty shall be transferable without limitations in its entirety to Ashghal, Public Works Authority, Qatar.

15.11.6 Control Gear

- 1 The luminaire control gear (driver) shall be produced by a prominent manufacturer of semiconductor components and comply with IEC 62384 DC or AC supplied electronic control gear for LED modules - Performance requirements. The manufacturer shall confirm that the packaged driver assembly is fabricated from high quality integrated circuit components including long-life electrolytic capacitors and provide data relating to the reliability of the device, in the climatic conditions stated in this specification.
- 2 The drivers shall be encapsulated / potted and Class II double insulated (IEC61140) and have a minimum energy efficiency of 85% and power factor ≥ 0.9 (full load). The control gear shall feature Surge Protection Device (SPD) for lightning strikes (IEC62305), short-circuit protection and transient overvoltage protection (IEC61643-1 / IEC61000-4-5).
- 3 The LED drivers shall be housed on a removable gear tray accessible with the luminaire cover open and be compatible with the Qatar power supply. The supply cable shall pass through the mounting post, or bracket, directly into the luminaire through an M20 cable gland located at the base of the luminaire mounting socket.
- 4 For protection in the event of temperatures reaching predefined critical levels, both LEDs and drivers shall have thermal protection, which will initially dim down and eventually switch off the light. Manufacturers shall state the predefined critical temperature level at which the dim down and switch off protection events occur and relate to junction temperature and ambient temperature. The luminaire shall be constructed in such a way that this protection method shall not occur during climate conditions stated within this specification.
- 5 The driver system shall be compatible with Lighting Control Systems / Lighting Management Systems (LMS), using both analogue (1-10V) and Digital Addressable Lighting Interface (DALI) protocols including WiMAC or other similar Ashghal-approved driver system. The driver system shall also be capable of being configured for single, and multi-stage, stand-alone dimming configurations when not connected to a CMS.
- 6 The drivers shall be programmable and permanently configured to operate under the principle of "constant flux" output or maintenance factor harvesting or similar, Ashghal-approved configuration method. During this process light output is initially dimmed to an equivalent end of life level value and then the operating current is gradually increased throughout service life to compensate for lumen depreciation and maintain a constant lighting level. The advantage of this system is to give energy savings and improve LED life and reliability. The manufacturer shall provide details of how this facility is maintained following replacement of a faulty driver or LED array.
- 7 The driver shall be capable of operating within the climate conditions previously described and shall have documentation and certification supporting the claimed minimum life expectancy of 50,000 hours in the stated conditions within this specification.

- 8 The driver manufacturer's device data sheet will provide specification details and the maximum permissible ambient temperature range in which the driver can operate (free air convection) at the defined driver current. The luminaire manufacturer shall demonstrate that the LED driver is suitable for continuous operation in the Qatar environment. Within the stated climate conditions the driver compartment enclosure shall be shown to remain within the range required to limit the risk of driver failure during operation based on the stated life expectancy of the luminaire.
- 9 The luminaire manufacturer shall submit a statement declaring that quoted driver performance figures correspond to the stated ambient air temperature and ensure that the specifics of operating in the Qatar environment are written into any applicable section of the warranty agreement.
- 10 The luminaire shall conform to CE marking directives including the European Electromagnetic Compatibility (EMC) Directive EN 61000-3-2:2009 (IEC 61000-3- 2:2009) Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current \leq 16 A per phase)

15.11.7 LED Lamps

- 1 The LEDs shall be produced by a Ashghal Approved manufacturer of solid state lighting (SSL) components and comply with the related standards and guidelines set by the Illuminating Engineering Society of North America (IESNA) and the JEDEC Solid State Technology Association and approved by Qatar Standards.
- 2 The light source is required to control light output with the aim of optimising luminaire performance and efficiency in relation to the specific lighting application. The luminaire, or luminaire series, shall provide the facility for varying luminous flux output ranging from 5klm up to at least 40klm using an appropriate number of LEDs and a suitable control method for each different lumen package.
- 3 The luminaire LED module shall comply with International Electrical Commission Publicly Available Specification IEC/PAS62717 LED modules for general lighting – Performance requirements.
- 4 The LED arrays shall be capable of operating within the climate conditions previously described and shall have documentation and certification supporting the claimed minimum life expectancy of 50,000 hours at L70 in the stated conditions as within this specification.
- 5 Technical details shall be provided of the light source optical system and range of optics or optical settings available for each model of luminaire including performance characteristics. The optical system is required to control light output with the aim of optimising luminaire performance and efficiency in relation to the specific lighting application. The system should meet the lighting requirements of most rights of way types and configurations and maximise the "light output ratio" (LOR) of the luminaire.
- 6 The inadvertent failure of any LEDs during the life of the luminaire shall not bring about any reduction in uniformity of light output. Therefore, the multi-layer method of light distribution shall take precedence over multiple spot methods.
- 7 Diffuser systems may be required for some lighting applications to eliminate the effect of multiple-source shadows.

- 8 Chromaticity tolerance and associated colour consistency of luminaire LED modules shall be measured in terms of the CIE 1931 chromaticity diagram and the CCT quadrangles defined by the American National Standards Institute (ANSI) C78.377- 2008 Specifications for the Chromaticity of Solid State Lighting Products for Electric Lamps. The ANSI quadrangle is made up by smaller quadrangles, commonly referred to as bins. The x y chromaticity components of each LED module shall be enclosed by one bin and the bin size shall not exceed a 4-step MacAdam ellipse. The binning process shall be in compliance with National Electrical Manufacturers Association (NEMA) SSL 3:2010 High-Power White LED Binning for General Illumination.
- 9 The chromaticity shift shall be measured and reported in accordance with IES_LM-80-08 Approved Method: Measuring Lumen Maintenance of LED Light Sources.
- 10 For highway lighting the Correlated Colour Temperature (CCT) of the light emitted from the luminaire shall be in the range $\geq 4000\text{K}$ with a Colour Rendering Index (CRI) of ≥ 60 . The manufacturer shall state the CCT ranges available with a $\pm 275\text{K}$ warranted window. The CCT and CRI shall include the effects of colour shift over the life of the luminaire. Other CCT ranges may be applicable to individual projects and manufacturers shall be notified as required.
- 11 Lumen maintenance (L) is the luminous flux emitted by the light source at any specified time during its operational life and is expressed as a percentage of the luminous flux emitted at the start of life ($L\%$). The rated lumen maintenance life of the LED light source shall not exceed L70, or 30% lumen depreciation at the specified temperature conditions.
- 12 The luminaire manufacturer shall define the estimated service life of the light source in terms of operating hours and rated lumen maintenance. The minimum standard expected shall be 50,000 operating hours at L70 at the temperature conditions specified herein.
- 13 The method of deriving rated lumen maintenance life beyond the limits of lumen maintenance determined from actual measurements shall be demonstrated. The method for projecting the lumen maintenance of LED light sources from the data obtained by the procedures found in IES document LM-80-08 shall be in accordance and compliance with IES_TM-21-11 Projecting Long Term Lumen Maintenance of LED Light Sources.
- 14 In combination with rated life predictions the reliability of the LED modules shall also be expressed in terms of the percentage (fraction) of failures in accordance with IEC/PAS 62722-2-1:2011 Luminaire performance - Part 2-1: Particular requirements for LED luminaires. The failure fraction (F_f) corresponds to the percentage of LED's that fail before end of rated life. This failure fraction expresses the combined effect of all components of a module including mechanical, as far as the light output is concerned. The effect of the LED could either be less light than claimed or no light at all.
- 15 The failure fraction shall also be expressed in terms of its component parts, gradual failure fraction (B_f) and abrupt failure fraction (C_f). The reliability curve relative to operating hours is calculated using statistical formulae and data gathered under test conditions during luminaire monitoring periods.
- 16 Luminaire maintenance factors (LMF) to follow model used in BS5489-1:2003+A2:2008 Annex D Table D1 with figures extrapolated to extend cleaning cycle interval up to 6 years and also adjusted to take account of environmental conditions specified herein.

- 17 Lamp flux maintenance factor (LFMF) shall be calculated by the manufacturer in accordance with calculated lumen depreciation relative to a predefined cleaning cycle interval. Currently the perceived cleaning interval is biannually due to the intense dust laden atmosphere.

15.11.8 Quality Criteria for LED Lighting

- 1 Manufacturers shall submit data in accordance with IEC/PAS 62717 Performance requirements – LED modules for general lighting and IEC/PAS 62722 Performance requirements – LED luminaires for general lighting.

15.11.9 LED manufacturers data

- 1 Manufacturer shall provide a standardised set of quality criteria, measured in compliance with the appropriate standard. The performance claims shall be matched against traceable data. The performance data required is summarised below and shall be headed Quality Criteria:

- (a) Rated input power (in W)
- (b) Rated luminous flux of the luminaire (in lm)
- (c) luminaire efficacy (in lm/W)
- (d) Luminous intensity distribution
- (e) Photometric code
 - (i) Rated Colour Rendering Index (CRI)
 - (ii) Correlated Colour Temperature (CCT in K)
 - (iii) Rated chromaticity co-ordinate values (initial and maintained)
 - (iv) Maintained luminous flux
- (f) Rated life (in h) of the module and the associated rated lumen
- (g) maintenance (Lx)
- (h) Failure fraction (F_y), corresponding to the rated life of the module in the
- (i) luminaire
- (j) Ambient temperature (ta) for the luminaire
- (k) Power Factor
- (l) Intensity Distribution
- (m) Drive Current
- (n) Optical Risk Group

- 2 This data shall be submitted on an Ashghal-approved form. Forms shall be submitted to Ashghal for approval prior to submitting data for consideration. Further data shall be provided to evidence compliance with all aspects of this specification. Additional data shall be provided as and when requested by Ashghal.

15.12 OVERHEAD SIGN GANTRY LANTERN AND INSTALLATION

15.12.1 General

- 1 The basis for the lanterns for use on the overhead sign gantries or bridges for the illuminating of overhead guide signs mounted on the sign support structure or on the gantry sign walkway supported on the gantry sign support brackets. The lanterns shall be complete with lamp, isolating fuse and associated control gear.

15.12.2 Sign Gantry Lantern

- 1 The lanterns shall be LED type and shall be rated per lamp at 2 x 50 watt (no less than 4,500 lumens/watt), 2 x 70 watt (no less than 6,500 lumens/watt), 2 x 100 watt (no less than 12,500 lumens/watt), 2 x 150 watt (no less than 17,500 lumens/watt) and 2 x 250 watt (no less than 33,150 lumens/watt) LED lamps and shall consist of housing, cover, reflector, refractor, socket, lamp, fuse, control gear, wiring, latches, screws, washers, pins and other parts composing a complete unit. At half life, the maintained luminous flux shall be a minimum of 75% of the initial luminous flux.
- 2 The lantern shall provide efficient illumination, be optically sealed, mechanically strong and easy to maintain.
- 3 The reflector mounting, wiring terminals and control gear components shall be readily accessible. When closed for operation, the optical assembly shall be sealed to provide protection against the ingress of moisture and dust to degree IP55 of IEC529 under all operating conditions.
- 4 The seal between the refractor and the housing shall be adequate to maintain this degree of protection. The refractor shall be held in such a manner as to allow for expansion and contraction of the refractor. Cable connections to the lamp holder within the lantern shall be of the heat resistant type with silicon, glass fibre or other approved insulation.
- 5 The optical system shall consist of a hydroformed aluminium primary beam reflector which shall be precisely profiled and contoured to distribute light across the inner surface of the refractor. The prismatic refractor shall be of moulded borosilicate thermal shock-resistant glass. The inner surface shall have an intricate array of prisms to direct light across the face of the sign. The outer surface shall be smooth to facilitate self-cleaning. The reflector shall be of a retro-dispersing type designed to eliminate the halo of excessive luminance to assure more uniform sign luminance.
- 6 The terminal board shall be located beneath the reflector at the conduit entry and shall accommodate 10 mm² electric cables.
- 7 The reflector shall be fastened to the housing by means of a minimum of four stainless steel screws with keyhole slot to facilitate easy removal and replacement. Levelling pads are to be provided on the inside and bottom of the main housing to permit accurate installation.
- 8 There shall be mounting within of the stainless steel housing to permit the lantern to be mounted directly to the supporting structure.

- 9 The refractor shall be form-fitted to the stainless steel door frame and shall have a single piece gasket with a sealing pad to effectively seal the assembly and housing. The assembly shall be fastened to the housing by means of separable hinges at the front and spring tempered, stainless steel at the rear. The lamp socket shall be provided with grips or other suitable means to hold the lamp against vibration.
- 10 The terminals of all ballasts, capacitors and control gears shall be shrouded.
- 11 Each sign lighting system shall be subject to the approval of the Engineer. Particular attention shall be given to the mechanical strength of all components, and to the security of their method of the sign supports.

15.12.3 Sign Gantry Lantern Control Gear and Lamps

- 1 The control gear shall be designed to operate the lamp of the power rating and type indicated and it shall be able to start the lamp and control it continuously for ambient temperatures up to +55°C. The choke shall be tropicalised and have terminals to accept 240 V supply voltage. Each terminal shall be brought out to a separate shrouded termination. Multi-lamp gear operating more than one lamp shall not be employed.
- 2 capacitor shall give a minimum power factor of 0.85 lagging. They shall have a tolerance of + or -10% of its marked value. Where non-metallic capacitors are offered these shall be supplied with a fixing band that shall not damage the shell and be provided with a separate earth terminal. The permitted operating temperature of the capacitor shall be marked on its case.
- 3 Each lamp shall operate using only one choke and one capacitor. Any combination of two or more capacitors having the equivalent value of capacitance will not be accepted.
- 4 Chokes and capacitors shall comply with the relevant British Standard Specification or an acceptable International equivalent and shall be fully compatible with the complete associated operation lamp circuit.
- 5 The control gear shall meet the following specifications:
 - (a) It shall be suitable for 50 Hz, 240 V AC + 10% operation.
 - (b) It shall regulate the output power to 12% for the input voltage noted above.
 - (c) It shall have an overall power factor of at least 0.85 when operated under rated lamp load.
 - (d) It shall operate the lamp without affecting adversely the lamp life and performance as specified herein.
 - (e) It shall withstand a 2500 V dielectric test between core and windings.
 - (f) The choke shall be encapsulated in an approved resin compound and totally enclosed.
- 6 The lamps shall be LED type and shall be rated per lamp at 2 x 50 watt (no less than 4,500 lumens output) 2 x 70 watt (no less than 6,500 lumens output), 2 x 100 watt (no less than 12,500 lumens output), 2 x 150 watt (no less than 17,500 lumens output) and 2 x 250 watt (no less than 33,150 lumens output) LED lamps and shall consist of housing, cover, reflector, refractor, socket, lamp, fuse, control gear, wiring, latches, screws, washers, pins and other parts composing a complete unit. At half life, the maintained luminous flux shall be a minimum of 75% of the initial luminous flux.

15.12.4 Sign Gantry Isolating (Safety) Switch, Conduit and Associated Cables

- 1 At each sign gantry location an isolating (safety) shall be provided at walk way level of the structure. It shall be fabricated galvanized steel complete with a vandal resistant hinged access door. A three phase mcb isolator shall be located within this housing to control the power supplies to each lighting sub circuit. The galvanized steel conduit, secured to the gantry structure by means of purpose made saddles to suit the size of conduit, providing the cabling routing within the structure shall be secured at the isolating box assembly by means of a locknut arrangement. The size of the conduit shall be suitable to accommodate the number of single core or multicore cables required whilst maintaining the stipulated space factor according to the relevant regulations. A 3-phase mcb isolator shall be located within the isolating (safety) switch to control the lighting sub circuit upon each gantry structure. The cabling shall be either single core or multi core 10mm² copper conductors within high temperature grade double insulated or flexible cable.

15.13 PHOTO ELECTRIC CONTROL CELL

15.13.1 General

- 1 Photo electric control cells shall comply with the requirements of BS 5972 and offer a Class II protection from electric shock as defined in IEC 60598.
- 2 Unit must be completely weatherproof, hermetically sealed against the ingress of moisture. It shall be resistant to vibration or change in temperature. It shall be housed in a strong impact resistant low profile translucent housing, the surface of which shall be non- oxidizing and impervious to deterioration.
- 3 The photo electric control unit (PECU) shall be guaranteed for a period of not less than six years, failures within that period of time to be replaced free of charge.
- 4 They will be capable of working in an ambient temperature of up to + 60°C.
- 5 The operation level should be preset to ON 80/100 Lux the ratio of ON to OFF should be approximately 1:2. There shall be no means of manual adjustment to the PECU's calibration and it shall not need to be orientated to operate as required.
- 6 There should be a minimum 15 second delay to prevent the unit from functioning due to short period high illumination such as lightning etc.
- 7 The power supply to the PECU shall be 240V 50Hz. A.C with a contact output rating of 30A at 240V (resistive).
- 8 The PECU and associated relay or switching device shall have pre matched responses and housed in the same envelope. The contact rating shall be 1500-Watts (1800 V.A) and should be fitted with a snap action to prevent chatter. In the case of the load to be switched then the PECU can switch directly, a contactor shall be used.

- 9 The photocell shall be located within the road lighting feeder pillar such that it can be easily removed. It shall be housed within a small compartment with an acrylic fascia plate set into the surface of the feeder pillar for the satisfactory operation of the photocell. The control circuitry for the correct switching of the road lighting will be housed within the adjacent feeder pillar. The associated specification requirements will be dealt with within that section of the specification.
- 10 The upper LED luminaire cover shall have the facility for installation and wiring of one of the following devices: an integral miniature photocell, NEMA socket (detachable photocell), telemetry device. This facility shall be included within the IP testing.

15.14 ROAD LIGHTING COLUMN CUTOUT / ISOLATORS

15.14.1 General

- 1 Cutouts in columns shall be phenolic moulded, three phase, and suitable for looping two 4 Core 25 mm XLPE/SWA/PVC cables.
- 2 Cutouts shall :
 - (a) Incorporate miniature circuit breakers complying to EN 60898 with a minimum breaking capacity of 4kA.
 - (b) Be of the combined single phase and neutral type.
 - (c) Incorporate an earth terminal.
 - (d) Be suitable for concentric or PVC armoured cables of up to 25mm² cross-sectional area with capacity for looping in and out.
 - (e) Have all metal parts tinned.
 - (f) Be provided with a minimum of 2 fixing screws.
 - (g) Be manufactured from material which is non-hygroscopic and non-tracking.
- 3 Terminals and contacts shall have a rating of not less than 40 Amp and be suitable for the use of miniature circuit breakers 6 A, 10A or16 A ratings, selected from the Table 12.1 below:

Table 12.1
Ratings of Miniature Circuit Breakers

Wattage	50W	70W	100W	150W	250 W	400 W
For 1 Lamp	6	6	6	6	10	10
For 2 Lamps	6	6	6	10	16	16

- 4 The cutouts shall comply with the 16th Edition of the IEE Wiring Regulations.
- 5 A cutout used as a means of isolation shall have the facility for padlocking.
- 6 The service cutout shall have a moulded enclosure, offering a minimum protection of IP22, capable of withstanding severe impact.
- 7 Separate terminals shall be provided for live, neutral and earth conductors complete with terminal shields to prevent accidental contact with all live conductors.

- 8 Cutouts shall be sized to accommodate the designated cables, but with a minimum of 25mm 2 cables.
- 9 Cable armouring shall be bonded as an integral part of the cutout, and complete with cable armour clamp shrouds.
- 10 The cutout shall be suitable for mounting on a wooden backboard or DIN rails.
- 11 Where there is a requirement for the use of an isolator they shall incorporate in-built fused loop terminals for the feeds to signs, bollards etc.
- 12 All isolating devices shall be double pole for single-phase systems and four poles for three phase systems.
- 13 All isolators shall be rated to suit the local environmental conditions of Qatar where these differ from those stated in EN 60947-3

15.15 FEEDER PILLAR

15.15.1 General

- 1 Road lighting feeder pillars shall be totally enclosed weatherproof with fibreglass reinforced polyester cabinet of ground mounting type complete with accessories suitable for mounting outdoor. Feeder Pillars with metallic cabinet shall not be used in outdoor applications in general unless otherwise demanded by extreme circumstances with specific approval.

15.15.2 Cabinet

- 1 The feeder pillar cabinet, unless previously approved by the Engineer, shall be of fibreglass-reinforced polyester and ultra violet ray resistant. The cabinet surface shall be totally weather and corrosion resistant with a completely smooth exterior. The outer 0.5mm - 1.0mm should consist of pure polyester. The colour of the cabinet shall be grey. The colour shall be completely light stabilised and impregnated from the surface through the thickness of the material.
- 2 Pillars shall be ground mounting type by means of a steel frame with concrete foundation. The cabinet shall have a base frame with a minimum ground clearance of 200mm between the body and the mounting area (bottom). The base frame shall have at least four holes to bolt down the pillar to the concreted steel frame. The cabinets base frame shall be removable. The feeder pillar shell shall incorporate lifting devices for the safe movement of the feeder pillar.
- 3 The cabinet top (canopy) shall be arranged so as to prevent the ingress of rainwater and provide air circulation.
- 4 The cabinet shall be provided with a front door complete with internal hinges and fixing screws fixing at top and bottom. A tamper proof lock will be provided centrally and all locks shall operate by a standard master key. Two keys for each pillar shall be provided. The door closing will have a perfect weatherproofing arrangement. The enclosure shall have a designated IP rating of IP54 in accordance with IEC 60529.
- 5 Approximate cabinet size shall be 1000mm high by 800mm length by 300mm width..

- 6 Natural ventilation shall be provided to limit the temperature rise to the manufacturer's recommendations. Such ventilation shall not reduce the stated IP rating of the cabinet and shall be screened to prevent the entry of vermin. Where recommended by the manufacturer dust filters shall be provided.
- 7 A data plate shall be fixed to the inside of the pillar detailing information as deemed necessary by the PWA and/or the Engineer.
- 8 Detailed distribution board schedules are to be provided within the each feeder pillar these to be located on the inside of the cabinet and stored in a weather protected plastic pocket securely fixed to the shell of the housing.
- 9 Additional requirements for feeder pillars metallic cabinet.
- (a) The metallic shells of the cabinets shall be weatherproof and of robust construction provided with a watershed canopy. They shall be manufactured from sheet steel of 3 mm minimum thickness. Adequate ventilation shall be provided to permit natural circulation of air with dust filters. Arrangement for earthing shall be provided welded to the shell with stainless steel bolts. Earthing continuity to door shall be ensured.
 - (b) Painting: All ferrous surface and edges shall be cleaned of scale and rust by shot blasting and shall then be treated on the same day, without outdoor exposure, with a zinc spray. The zinc shall be applied by flame gun process of a thickness ZN4 in accordance with EN 22063. The treatment shall be followed by application of one coat of zinc chromate base priming paint, an undercoat and final coat of durable oil and weather resisting paint
 - (c) Construction: All metallic parts including bolts, nuts, washers, hinges latches shall be of stainless steel / brass material. Brass gland plate of minimum thickness of 3mm shall be provided. Where live parts are adjacent to the framework, a sheet of Bakelite or other suitable low voltage insulating material (thickness shall not be less than 2 mm) shall be fixed to the inner-side walls of the feeder pillar. The fixing of the sheet of insulating material shall not incorporate metallic parts protruding out. If adhesives are used, the quality shall be such as to ensure proper adhesion under the temperature/humidity levels described earlier. Insulating materials shall be as nearly non-hygroscopic, resistant to tracking and Self-extinguishing as present good manufacturing technique permits.
 - (d) Type tests: The following type tests shall be conducted in reputed independent laboratory.
 - (i) Verification of temperature rise limits (IEC 60439-5/8.2.1).
 - (ii) Verification of Dielectric properties (IEC 60439-5/8.2.2).
 - (iii) Verification of short circuit withstand strength (IEC 60439-5/8.2.3).
 - (iv) Verification of clearances and creep age distances (IEC 60439-5/8.2.5).
 - (v) Verification of mechanical operation (IEC 60439-5/8.2.6).
 - (vi) Verification of degree of protection (IEC 60439-5/8.2.7).
 - (vii) Verification of mechanical strength (IEC 60439-5/8.2.101),
 - (viii) Verification of corrosion and aging resistance (IEC 60439-5/8.2.103).

- (e) 9.5 Tests on Painting: The paint work shall need to pass following tests carried out during FAT.
- (i) Measurement of thickness of protective coating (ISO 2808).
 - (ii) Cross cut test (ISO 2409): classification: 0.
 - (iii) Cupping test (ISO 1520): 08mm
 - (iv) Bending test – Cylindrical mandrel test (ISO 1519): 3.0mm
 - (v) Salt spray (fog) test (ISO 7253): 1000 hrs.

15.15.3 Components of Feeder Pillars

- 1 1 No. 200Amp mains breaker (MCCB) of three phase 415V - interrupting capacity according to BS 3871:
 - 240V – 85kA
 - 415V – 35kA

A facility to lock off the assembly in the open position shall be provided.
- 2 1No. 200Amp 4 pole magnetic contactor, three phase with coil voltage of 240V within an IP 54 enclosure. The contacts of the contactor shall be fitted with a snap action to prevent chatter.
- 3 A control circuit shall be provided connected to the control coil of the contactor. The circuit shall be protected by means of a 4A HRC control fuse within a weatherproof enclosure. The control circuit shall be such that in the event of a failure of the photocell control unit an astronomical time switch identified below will override the operation. In addition a manual override switch shall be provided to operate the road lighting at times outside the periods during which the lights are normally operational.
- 4 The time switch shall be preprogrammed with Qatar sunrise & sunset timings for all 365 days of the year with a provision to adjust switching in and out up to 15 minutes before /after sun rise/sunset timings. The time switch shall have minimum clock accuracy of + or – 5minutes/year and battery backup for 3 years to maintain clock operation and output switching during power supply failure or disconnection . Time switch should be protected with a HRC fuse or MCB. Arrangement for connecting a photoelectric control switch shall also be made within the pillar. Time switch shall be rated for minimum 60⁰ C continuous operation.
- 5 A 3-phase MCB metal clad or plastic distribution board complete with single pole 240V MCB's of interrupting capacity according to EN 60898. The number and size of the outgoing circuits shall be as per the feeder pillar schedules. Terminations shall be capable of accommodating sub circuit cable of size 25mm². There shall be at least 25% spare outgoing circuit capacity.
- 6 MCB's and protective devices shall be rated to withstand a minimum short-circuit current of 9kA.

- 7 Neutral terminal bar shall be provided separately. Neutral conductors shall be insulated from earth to allow use on TN-S systems. The neutral connections shall have separate connections for each outgoing cable. Where a neutral busbar is provided it shall be mounted in parallel with the phase busbars and arranged so that each neutral connection is physically identified with the appropriate circuit. A separate earth bar shall be provided at the bottom of the feeder pillar and shall be of sufficient length to accommodate a connection for each circuit including 25% spare capacity. The neutral busbar shall be coloured black and the earth busbar coloured green and yellow.
- 8 Busbars shall be of full rating having taken into account any holes, they shall be constructed from high conductivity copper and mounted on insulators and mounted at the rear of the feeder pillar. Busbars shall be insulated with non-hydroscopic, non-tracking insulation. All live parts shall be screened.
- 9 Insulated dividing barriers shall be provided between both phase contact assemblies and between phase and neutral.
- 10 Each feeder pillar shall accommodate at least 1No. brass cable gland with locknut, earth tag and PVC shroud for the incoming supply cable together with individual brass cable glands 25mm CW gland according to BS 6121 complete with lock nuts, earth tags and PVC shrouds for all outgoing cables, including an allowance for spare capacity, for stranded copper cables up to 25mm² 4 core XLPE SWA PVC.
- 11 Colour-coded leads shall identify all wiring for phase and neutral cables. Outgoing circuits shall be labelled with the circuit reference and circuit breaker rating. Wherever possible all internal wiring shall be enclosed in trunking or conduit.

15.16 ROAD LIGHTING CABLES

15.16.1 Underground Cables

- 1 Underground road lighting cable shall be copper stranded 10/16/25/ 35mm² x 4 core XLPE TCW+SWA PVC cable of stranded copper conductor 600/1000 VAC.
- 2 Cables shall be low tension 600/1000 volt 4 core stranded copper conductors, insulated with XLPE compound, core laid-up, extruded PVC tape bedded, Steel Wire+Tinned Copper Wire Armoured and PVC sheathed overall underground cables to BS 5467: 1977. IEC 60502
- 3 The cable shall be capable of withstanding vigorous climatic conditions of ambient temperature up to 50°C (the temperature can be accompanied by a relative humidity of up to 100% at 30°C).
- 4 It should also be noted that cables can be buried in sand and laid partly in ducts at a depth of up to 600mm in footpaths and 750mm in roadways. The ground temperatures can vary from 35-40°C in summer to 8-12°C in winter. Cable drums may be stored in the open for up to 1 year and will be exposed to direct sunlight. Accordingly, cables shall be designed to withstand such conditions without deterioration of the electrical or mechanical properties.

5 Cables shall have the following construction details:

(a) Conductors:

Plain, stranded, compacted copper conductor with 100 % conductivity, clean smooth surface and free from any foreign particles generally in accordance with IEC 60228 All cables shall have a full size neutral conductor. 4 shared cores of stranded compacted copper circular in shape, comprising 3 phase conductors and a neutral conductor. The neutral conductor shall be of the same size as the phase conductors.

(b) Core Insulation:

Designation XLPE (IEC 60502) Highest rated temperature 90oC (IEC 60502). Insulation thickness appropriate to applied voltage, IEC 60502. The process of extrusion shall have the facility at the point of extrusion to monitor and control the thickness of the insulation and the concentricity of the cable. The cable core should be dry cured. The phase conductor insulation for 4 core cables shall be colored RED, YELLOW, and BLUE. In all cables, the neutral insulation shall be colored BLACK. The colors should be permanent and guaranteed for entire service life of cable.

(c) Inner Covering:

The inner covering shall be solid extruded. The material to be used shall be for the operating temperature and design temperature conditions and of a thickness in accordance with IEC 60502 and compatible with insulating material. The material should be fire retardant and comprises of anti-aging components. The cores shall be laid up with non-hygroscopic fillers and bound with a closed helix of polymer tape of material appropriate to the cable temperature. There should not be any gap between cores and maintain the perfect round shape of overall cable.

(d) Armor:

The armor shall comprise a single layer consisting of both galvanized steel and tinned copper round wires. The conductivity of the copper wires alone shall be at least 50% of that of any phase conductor, at their respective normal working temperatures. The tinned copper wire shall be of substantially the same diameter as, and not less than the diameter/thickness of the armor wires. They shall comprise not less than 25% of the total number of armor wires. The whole combination of steel and copper wires shall be laid in close contact with no discernable gaps. An open helix consisting of galvanized steel tape of minimum nominal thickness 0.3 mm may be provided over round steel wire armor. Galvanizing of the wires shall be in conformity with EN 10257. The copper wires shall be uniformly dispersed among the steel wires. Two swallow able water blocking tapes shall be provided one each, over and under the armor layer. These tapes shall be capable of absorbing water and remain dry by forming into gel. The purpose of which is to inhibit flow of water in the event of penetration of the oversheath, or inflow from a faulty joint. The material shall be chemically inactive with the components with which it is in contact, both with and without the presence of water. It shall be solid at the working temperature of the adjoining components.

(e) Oversheath:

PVC extruded directly over the armor and water inhibitor (water blocking tape). The material should be fire retardant, UV resistance and comprises of anti-aging components and high resistant to soil. It shall be type ST2 in accordance with IEC 60502 and IEC 60332-1. Thickness shall be in compliance with the above standard. The over sheath shall be colored in BLACK, and shall be embossed with the legend:

- (i) ASHGHAL St. Ltg. 600/1000V LV XLPE
- (ii) CABLE SIZE AND NUMBER OF CORES
- (iii) STANDARD NO.
- (iv) YEAR & MONTH OF MANUFACTURE
- (v) NAME OF MANUFACTURER AND COUNTRY OF ORIGIN
- (vi) RUNNING SERIAL (AT INTERVAL OF 1 METER)

15.16.2 Testing of cables

1 This relates to type tests and other tests to be carried out during or after manufacture of the specified Cables. Routine, type and special tests shall be carried out in accordance with latest version of International standards IEC 60502-2, IEC 60228 & EN 60811 Copy of type test reports issued from reputed independent laboratories need to be submitted. The following tests shall be carried out on each manufactured length of cable, or sample length as instructed by ASHGHAL. ASHGHAL has the right to witness any test with no obligation to ASHGHAL.

(a) Routine Tests:

Routine tests are to be carried out each and every drum manufactured. One set of routine test reports of each drum shall be fixed with the drum in a strong water-proof envelope. Another set to be submitted along with drums serial numbers shall be submitted along with material inspection request. The following routine tests are to be carried out.

- (i) Electrical Resistance of Conductors.
- (ii) Voltage Test.

(b) Sample Tests:

Sample tests are to be carried out on 10 % drums of each lot. Samples to be taken from both sides of the entire length of the drum. One set of sample test reports shall be submitted to KAHARAMAA for review and approval. Another set to be submitted along with drums serial numbers shall be submitted along with material inspection request. The following sample tests are to be carried out.

- (i) Conductor Examination.
- (ii) Check of Dimensions as per IEC 60811-1-1
- (iii) Hot Set Test.

(c) Type Tests:

Manufacturer shall carry out type tests to IEC 60502 on the cable and issue certificates confirming that the cable has conformed. In general, following test to be carried out at International Reputed Independent Laboratory in accordance with IEC 60502- Part -1 and IEC 60228.

Type Test – Electrical

- (i) Insulation Resistance Measurement at ambient temperature.
- (ii) Insulation resistance measurement at maximum temperature in normal operation
- (iii) Voltage Test for 4 h.

Type Test – Non-Electrical

- (iv) Measurement of thickness of insulation.
- (v) Measurement of thickness of non-metallic sheaths (including extruded separation, but excluding inner covering).
- (vi) Test for determination the mechanical properties of insulation before and after ageing.
- (vii) Test for determination the mechanical properties of non-metallic sheaths before and after ageing.
- (viii) Additional ageing test on piece of completed cable.
- (ix) Loss of mass test on PVC sheaths of type ST2.
- (x) Pressure test at high temperature on insulation and non-metallic sheaths.
- (xi) Test on PVC insulation and sheaths at low temperature.
- (xii) Test for resistance of PVC insulation and sheaths to cracking (heat shock test).
- (xiii) Hot set test for XLPE insulation.
- (xiv) Water absorption test on insulation.
- (xv) Flame spread test on single cables.
- (xvi) Shrinkage test for XLPE insulation.
- (xvii) Special bending test
- (xviii) Examination of conductor per IEC 60228

15.16.3 Packing of Cables

- 1 Underground cables shall be packed in sealed wooden cable drums each of 500 metres length with a plate stating the following details:
- (a) Manufacturer's name and country of origin
 - (b) Cable type and size
 - (c) Length of cable per drum

15.16.4 Guarantee

- 1 Supplied material shall be guaranteed against any defect for 10 (Ten) years from the date of delivery or 8 (eight) years from the date of installation whichever comes first.

15.16.5 Flexible 3C PVC Insulated PVC Sheathed Circular High Temperature (85°C)

- 1 Flexible cables for column wiring should be of conductors of high conductivity copper stranded wires, 2.5 sq. mm, insulated with high temperature PVC compound, three cores, green or - yellow, blue and brown, twisted together, filled and sheathed with high temperature PVC compound, 300/500V.A.C. according to BS 6141, Table 15 or equivalent norm.

15.17 MARKER TAPE FOR UNDERGROUND POWER CABLES

15.17.1 General

- 1 Marker tape shall be installed wherever cables are to be directly buried in the ground to warn of the presence of power cables.

15.17.2 Material & Quality

- 1 The marker tape shall be of low density polyethylene, of thickness at least 100 micron. Its width shall be 40cm and be yellow in colour, with black marking indicating the presence of road lighting cable in both English and Arabic. Its location in respect of the cable position is identified within the Contract documentation.
- 2 The material shall be colour fast, and resistant to chemical action in typical ground conditions experienced in Qatar. These may vary from extremely wet to extremely dry, and with very high salinity. The ground temperature may vary from 0 to 40°C.
- 3 The material shall be mechanically durable. The manufacturer shall demonstrate the samples complying with this specification have been tested for compliance with BS 2782, Part 3, Method 326A to 326C or an equivalent standard.

15.18 MARKER POSTS

15.18.1 General

- 1 Where instructed by the Engineer, the Contractor shall install marker posts and slabs. These shall be of reinforced concrete, steel or heavy duty plastic of an approved type suitable for use in Qatar. Unless instructed otherwise pre-cast reinforced concrete or equally approved marker posts or slabs shall be installed at intervals of not more than 50m along all underground cable routes, joint pits (if any), at all changes of direction and at both ends of road crossings.

15.19 EARTHING

15.19.1 General

- 1 The integrity of the earthing system within the road lighting network shall be maintained.

- 2 2 Each item of equipment shall be individually effectively earthed within each lighting assembly and feeder pillar by means of a dedicated earth to a central earthing point. This shall be regardless of any other terminals available. All connections shall use crimped terminations.
- 3 All removable metal doors or metal frames shall be earth bonded.
- 4 Within the feeder pillar the central earthing point shall be connected to the incoming earth provided by QGEWC.
- 5 At each feeder pillar location an earth rod shall be installed complete with an approved earth pit and cover plate. It shall have a resistance to true earth of not more than 10 ohms. The size of the earth rod shall be 16mm by 2.5m in length. It shall be driven to a depth that penetrates the summer water table by at least 1m. It shall be connected to the central earthing point of the feeder pillar via a bare stranded copper conductor of cross-sectional area 70mm².
- 6 At the end of each lighting sub circuit an additional earth electrode as detailed above shall be connected to the central earthing point within the last lighting column base compartment. The connection between the earth electrode and the column central earth terminal shall be via a bare stranded copper conductor of cross-section 16mm².
- 7 Routing of the earth cable to the ground conductor within the last column of each feeder pillar outgoing subcircuit shall be via a 100mm PVC duct within the column foundation.

15.20 INSTALLATION

15.20.1 General Requirements

- 1 The Contractor is responsible for all liaisons, through the Engineer, with the departments concerned within the PWA, in respect of programming the installation and commissioning of the complete road lighting system. He shall also ensure through the Engineer that the relevant departments within the PWA are at all times kept informed of the current progress of the work. Throughout the road lighting installation works the engineering representative from the relevant departments within the PWA, must be invited to carry out periodic inspections of the works. The Contractor shall ensure that his approved subcontractor programmes works are in the designated sequence in accordance with the approved programme. On completion of each phase of the works progress to the next phase will be subject to the approval of the Engineer's Representative and/or the relevant departments within the PWA.
- 2 A qualified person having a thorough experience in road lighting and associated equipment shall supervise the execution of all electrical work.
- 3 Only workmen who have had experience in the erection of road lighting shall be employed on the work of erection.
- 4 Before carrying out any electrical works to existing services, authorisation must be obtained in writing from all relevant authorities.
- 5 The Contractor shall carry out all electrical tests and ensure satisfactory results as set out in the ILE Code of Practice for Electrical Safety.
- 6 Where an existing installation has been extended the relevant parts of the existing system and equipment earthing shall be inspected and tested for compliance with the IEE Wiring Regulations.

- 7 A completion certificate as detailed in the IEE Wiring Regulations shall be issued following the inspection and testing of the installation and any corrective action found necessary.

15.20.2 Temporary Lighting

- 1 Where the existing installation is to be disconnected during the Contract Period, temporary lighting shall be provided. Any temporary lighting proposals must have the approval of the PWA prior to installation.
- 2 At no time shall design road lighting standards be lower than those existing prior to the start of the Contract.
- 3 The Engineer must approve any form of temporary lighting and associated lighting levels.
- 4 Temporary lighting shall not be removed or disconnected until the permanent installation has been inspected and approved by the Engineer and has been energised.

15.20.3 Removal of Existing Columns

- 1 Prior to any work being undertaken the Contractor shall obtain from the relevant departments within the PWA a copy of the latest revised record drawing of the existing lighting network within the contract limits. The Contractor is to identify from these records those columns affected by the Contract and require removal or relocating. A copy of any record obtained shall be forwarded to the Engineer for his use.
- 2 Existing columns shall be removed under supervision of the Engineer's Representative in consultation with the relevant department within the PWA. Existing cables shall be disconnected, made safe and protected to the satisfaction of the Engineer in consultation with the relevant departments within the PWA prior to removal of the columns.
- 3 No existing road lighting shall be switched off, dismantled or removed without the prior approval of the Engineer and the relevant departments within the PWA. Where the existing road lighting has been removed the Contractor, to ensure safe vehicular and pedestrian movement within the designated area, shall provide necessary temporary lighting complete at his cost. Existing signs shall also be relocated at the Contractors cost to ensure compliance with the current traffic regulations.
- 4 All lamps, luminaries and fittings shall be removed before excavating around the column prior to its removal. Tie ropes shall support the columns at all times.
- 5 The Contractor shall carefully excavate existing material from around the column base, including concrete taking care not to damage any adjacent cables or services. No assembly shall be removed until it has been fully excavated.
- 6 The columns shall be lifted from the foundation by means of a crane approved by the Engineer. The foundation shall be backfilled with suitable approved material and temporarily reinstated.
- 7 All columns, cables, lamps and luminaries to be removed under the Contract shall be taken to store as directed by the Engineer and remain the property of the PWA. Where such items are instructed to be taken to the stores of the PWA, proof of delivery should be obtained by means of a signed receipt from the relevant departments within the PWA and witnessed by the Engineer's representative.

- 8 Existing road lighting, where it is to be relocated within the Contract, shall be carried out in accordance with the relevant sections of the contract specifications, as if new. Prior to re-installing all equipment it shall be inspected and any damage reported to the relevant departments within the PWA, via the Engineer.

15.20.4 Detailed Drawing for RCC foundation

- 1 The foundation for the 3 metre to 12 metre lighting columns shall be in accordance with the details provided within the Contract Documents. The reinforcement detail shall be detailed by the Contractor based on the recommendations of the column manufacturer to meet the column assembly design criteria detailed in paragraph 15.6.7 of this specification. Contractor shall consider the use of augured foundations in areas where soil and lighting utility reservation necessitate it, as per the Contract Documents.
- 2 The foundation detail for the lighting columns or masts between 16 metres to 30 metres will be as recommended by the column manufacturer for the climatic conditions applicable to the State of Qatar taking due consideration of the equipment to be supported. Contractor shall consider the use of augured foundations in areas where soil and lighting utility reservation necessitate it, as per the Contract Documents.
- 3 Final configuration of the proposed foundation will be subject to the approval of the Engineer and the PWA.

15.20.5 Road lighting Column/Lantern Installation

- 1 Road lighting columns shall be erected on pre-constructed bases offset from the carriageway, as defined in the contract Specification, via anchor bolt arrangement.
- 2 Prior to erection of the lighting pole no bracket arm or lighting fixtures shall be mounted on the column shaft.
- 3 Only purpose made cranes with nylon slings will be accepted for the purpose of lifting the columns onto the anchor bolts. Metal chains are not acceptable.
- 4 The bottom securing nut/washer arrangement or shims shall be used to align the lighting column vertical. The location of the base compartment door shall be agreed prior to the installing of the column shaft, but unless notified otherwise the door opening shall be located such that any operative working within the column shall face the on-coming traffic.
- 5 Once installed, the final alignment and verticality of the column shall be checked in two directions at 90 degrees to each other by theodolite or other approved method. The final verticality is to be approved by the Engineer's Representative prior to the column bracket and luminaire as specified being installed and commissioned.
- 6 The underground cables shall be terminated into the cut-out/isolator assembly mounted within the lighting pole base compartment. An additional length of 500mm shall be allowed at each incoming cable termination and shall remain underground for future reconnections.
- 7 Wiring between the terminal block in the luminaire and the components in the base of the column or each unit shall be using high temperature 3 core, green or yellow, blue and brown, 2.5mm² copper flexible cables to BS 6141.
- 8 All installation requirements described in the ILE Code of Practice Clause 11 shall apply.

- 9 A double insulated 6.0mm² stranded copper earth wire with clamped tag bonded to earth lug on column and the column door earth terminal shall be provided.
- 10 All cable routes shall be clear of control gear and limited to horizontal and vertical runs. Cables entering terminals shall show no bare wire nor shall the insulation be taken into the electrical conducting part of the terminal. All cable shall be neatly bunched together and securely taped.
- 11 Terminal blocks shall be clearly marked and the wiring shall be so arranged that the luminaire can be dismantled, for purposes of routine cleaning and lamp replacement, without any electrical wiring disconnections.
- 12 After installation each lighting column shall be identified by a reference number in accordance with the requirements of the PWA.

15.20.6 Road lighting Feeder Pillar Installation

- 1 The road lighting feeder pillar shall be erected on pre-constructed base off set to the carriageway, as defined in the Contract specification, via anchor bolt arrangement.
- 2 Prior to erection no internal equipment shall be installed which could be damaged either in transit to site or during the erection phase.
- 3 The bottom securing nut/washer arrangement or shims shall be used to align the feeder pillar vertical.
- 4 The electrical installation within the feeder pillar shall be undertaken as detailed elsewhere in the specification.
- 5 All underground cables when terminated shall allow for a minimum length of 500mm to be left underground to allow for future reconnections

15.20.7 Road lighting Cable Installation

- 1 The installation of all cables shall be in accordance with the requirements of QCS Section 21.
- 2 Excavation of Road lighting Cable trenches for cable size from 10mm² to 35mm² x 4 core are to be of the following dimension:

Depth: 600mm
Width: 500mm
- 3 Cable trenches shall be cleared of all stone and sharp projections and shall be drained. All cables shall be laid on a bed of 150mm approved fine aggregate sand or quarry scalping. Cabling to and between columns will be by means of copper stranded 4core XLPE.SWA.PVC cable. (Size as indicated and based on the connected electrical load and length of cable from power source) and shall be at the depth of 450mm. A layer of 150mm dune sand or quarry scalping is to cover the cable. No joints in Cable shall be permitted.

- 4 LV cables laid shall be laid straight between lighting columns with an allowance for 500mm spare underground cable adjacent to each column. Cables can be placed in the same trench with a lateral spacing between cables of 50mm. In the event of HV cables being placed in the same trench then there shall be a separation of at least 300mm. All cables shall have a clearance of at least 300mm from all other services including telephone or communication cables.
- 5 The Contractor shall arrange for inspection of the cable, trenches and cable installations by the Engineer's Representative, in conjunction with the relevant departments within the PWA prior to backfilling.
- 6 All cables shall be handled, installed and terminated in accordance with the manufacturer's recommendations. The manufacturer's recommended ambient temperature limitations for the handling of cables shall be strictly adhered to.
- 7 All cables, once removed from the cable drum, shall be immediately laid in position. No cable shall remain laying on the surface for more than is practicably possible.
- 8 Cabling is to be looped into each column and terminated by means of an approved lighting column cut out.

15.20.8 Road Crossing Ducts

- 1 Underground ducts shall be provided where cables
 - (a) Cross roads or other paved areas with vehicular access.
 - (b) Cross unpaved areas regularly used by vehicles.
 - (c) Enter buildings.
 - (d) Vehicular entrances to properties.
 - (e) Pass through corrosive soils or elsewhere as designated, they shall be drawn into underground pipe ducts.
- 2 A steel draw wire or nylon or polypropylene cord shall be inserted in each duct run immediately after its installation. A 2m surplus shall be left at each end of each run, neatly coiled and attached to a crossbar preventing the wire or cord from being drawn into the duct.
- 3 Underground pipe ducts shall be heavy gauge unplasticised PVC (high impact resistant PVC, 3.6mm wall thickness) conduits with tapered sleeve or spigot and socket joints encased in concrete as detailed in the Contract drawings and in accordance with the requirements of the PWA.
- 4 All ducts shall have a nominal internal diameter of 150 mm unless designated otherwise.
- 5 The internal diameter of ducts used to provide cable entries into structures shall have a space factor less than 25 %, unless otherwise designated.
- 6 All dual systems shall be installed so that no undue strain is placed on cables when pulled in. Cable manufacturer's recommendations shall be followed.
- 7 All underground cable ducts shall, so far as possible, be run in straight lines.

- 8 Duct runs crossing roads shall be straight and, wherever possible, perpendicular to the axis of the road. They shall be laid at a depth of 800mm backfilled and reinstated in accordance with QCS.
- 9 Except in the case of short isolated duct runs such as road crossings, underground cable duct runs shall terminate in suitable drawpits.
- 10 Cable ducts passing under roads carrying heavy vehicles shall be completely surrounded with concrete of grade SRC 30 as per the standard detail.
- 11 Ducts shall be laid so as to drain naturally towards one or both ends, where adequate provision for drainage shall be made. Adequate precautions shall be taken to prevent the cable duct system acting as a stormwater or groundwater drainage system. A minimum fall of 1 in 200 shall be provided for drainage purposes.
- 12 Any work carried out requiring the use of split ducts shall be carried out in such a manner as to preserve the withdrawability of the cables concerned.
- 13 Notwithstanding the type of duct to be used generally, cable ducts laid in ground which is liable to subsidence shall be of heavy gauge PVC with spigot and socket joints, and shall be installed on a concrete bed as designated above, but without concrete surround.
- 14 If two or more cables are to be installed in the same duct, the aggregate of their cross-sectional areas shall not exceed 30 % of the cross-sectional area of the duct.
- 15 All trenches excavated for the laying of cable ducts shall be completely backfilled and rammed before cable installation work begins.
- 16 Immediately following the installation of any duct run, the interior of the duct shall be thoroughly cleaned by twice drawing through the ducts a mandrel, once in each direction. Following this, the ends of each run shall be sealed with a suitable hardwood or plastic sealing plug which shall be left in position until cable laying is about to begin.
- 17 The polished hardwood mandrel shall be 300mm long having spherical ends and a diameter 6mm less than the nominal duct diameter.
- 18 Duct markers shall be provided in all duct crossings to indicate the location and end of ducts.
- 19 The ducts shall be extended beyond the curb stone by 500mm.

15.20.9 Backfilling and Re-instatement

- 1 All trenches and pole pit/foundations shall be backfilled, compacted and re-instated in accordance with the QCS requirements.

15.20.10 Road lighting Cable Terminations and Testing

- 1 Unless otherwise designated, cable glands shall be of brass and comply with BS 6121 where applicable, and shall be of a design appropriate to the type of cable being terminated.
- 2 Glands for cables with metallic inner sheaths shall incorporate a bonding connection.

- 3 Except where it is impracticable to do so, the cable cores shall be taken through the terminating box directly to the terminals of the equipment, without crosses, and shall be made off with sweated cast brass cable sockets, or an approved type of hydraulically crimped socket.
- 4 Terminations for armoured cable shall incorporate a method of rating off the armour which ensures a permanent earth bond between the cables terminated to the satisfaction of the Engineer. The cable armour shall be bonded to the earth terminal block in each column.
- 5 All cable sealing boxes shall be marked on the outside with 15 mm diameter painted discs, in the appropriate colours, to indicate the disposition of the phase and neutral conductors within them.
- 6 Compression glands installed externally shall be classified IP66 and be provided with close-fitting PVC shrouds.

15.20.11 Electrical Power Supply

- 1 Upon the completion of the associated work, arrangements will be made via the Engineer to provide the electrical power to each road lighting feeder pillar based on a 415V 50Hz supply. Once available, and after inspection, the lighting system shall be tested prior to connection. The Engineer shall arrange for full consultation with the relevant departments within the PWA during this phase of the lighting works.

15.21 TESTING AND COMMISSIONING ON SITE

15.21.1 General

- 1 In addition to the requirements of the Contract Specific Specification all testing and commissioning shall be carried out according to the requirements of the relevant BS , CP, IEE regulations, or other standards and regulations as may be stated or implied in this Specification.
- 2 Each completed system with the installation shall be tested as a whole under operating conditions to ensure that each component functions correctly in conjunction with the rest of the installation.
- 3 The Contractor shall afford access at all times to the relevant departments within the PWA to enable them to inspect work during and after erection and to be present at all tests.

15.21.2 Electrical Tests

- 1 As soon as is practicable after the completion of installation the tests described below, together with such other tests and measurements to prove compliance with the contract requirements shall be made.
- 2 An insulation tester shall be used to measure the insulation resistance between each conductor and the remaining conductors and between each conductor and the metallic sheath (if any) and armouring. The test voltage to be applied shall be at least 1000 V.
- 3 The above tests shall be carried out both before and after any pressure tests and the insulation resistance shall not be less than the figures in the appropriate BS.

- 4 A voltage test of 15 minutes duration shall be applied in accordance with BS 5467 Appendix 88, BS 6622 Appendix C8 or BS 6346 Table 5, as applicable.
- 5 Proposals for the appropriate test in respect of other types of cable shall be submitted for approval.
- 6 An earth continuity test shall be carried out to verify that the cable armouring and metal sheath, if any, have been properly bonded to earth.
- 7 Phase rotation and phase correspondence shall be tested to prove that the cables have been correctly connected.
- 8 Where a new cable has been jointed to an existing cable with the express permission of the Engineer, the voltage test designated above may be carried out at a reduced voltage if the existing cable has been in service for more than five years. In such a case the test voltage shall be determined by applying a factor K to the value given in the appropriate British Standard as referred to above.
- 9 The Contractor shall afford access at all times to the representatives of QGEWC and the relevant departments within the PWA to enable them to inspect work during and after erection and to be present at all tests.
- 10 Upon completion of laying and terminating underground cable runs, the Contractor, in the presence of the Engineer or his duly authorised representative, shall carry out pressure tests in accordance with relevant British Standards. The Contractor shall provide all apparatus and labour required for such tests and within a reasonable time thereafter shall present the Engineer with certificates of the tests.

15.21.3 Photometric Performance Testing

- 1 A certificate of Initial Lighting Performance of Installation shall be issued when tests have been passed as follows:
 - (a) The initial photometric tests shall be made after the installation has been in lighting operation for between 100 and 150 hours
 - (b) The location of test positions shall be distributed along the length of the installation and shall be as directed by the Engineer. All service tests throughout the testing period shall be made at these positions.
- 2 Readings shall be taken with a portable calibrated luminance meter holding a current valid calibration certificate. The measurements in accordance with the procedures laid down by the CIE and shall be taken by a qualified lighting engineer who shall confirm that the lighting performance data as identified in the contract specification has been satisfactorily obtained.
- 3 Measurement of the supply voltage at adjacent lighting columns and posts shall be taken at the time of each test and the illumination measurement shall be adjusted for any variation from the supply voltage value declared in the contract specification. Allowance shall be made for the use of control gear taps if necessary immediately before the initial tests are made. The lamps and all components of the luminaire that may affect the optical performance shall be cleaned and correctly adjusted.

- 4 The Engineer shall witness all photometric testing, unless otherwise notified in writing. A minimum of 7-days' notice shall be given to the Engineer before testing begins. After testing the certificates shall be submitted to the Engineer for approval. Representatives from the relevant departments within the PWA shall be invited to witness the lighting performance testing.

15.22 RECORD DRAWINGS

15.22.1 General

- 1 Within thirty days from the date of completion of the whole or any section of the lighting works the Contractor shall provide fully detailed "as built" drawings and schedules in respect of all sections of work completed together with all relevant operating and maintenance instructions. The drawings shall: -
- (a) Fully indicate with accurate dimensions the sizes, types and position of equipment, cables, ducts, joints, feeder pillars etc., with particular regard for the need to accurately locate buried cables after completion.
 - (b) Show the circuit arrangements for the relevant section of the road lighting installation.
 - (c) Show full details, ratings and function of each item of equipment.
 - (d) Include any other relevant information to ensure the safe and satisfactory operation of the particular section of the road lighting works.
- 2 The Contractor shall submit, within the time stated above, two copies of the Record Drawings for the approval of the Engineer. Upon and after receipt of such approval the Contractor shall provide records in both digitised and hard copy format of reproducible transparent negative drawings, and two sets of prints on paper to the Engineer for his retention.
- 3 In addition to the foregoing, the Contractor shall provide in each feeder pillar and distribution unit a good quality print on paper showing the road lighting distribution line diagram of that particular section. These prints shall be mounted on the inside of the door of each feeder pillar and distribution unit and shall be laminated to prevent undue deterioration.
- 4 In order to achieve accurate Record Drawings all relevant information relating to the lighting works shall be entered on to the stated drawings and kept for immediate use once the work has been carried out. The marked prints shall be available for inspection at the Contractor's site office at any reasonable time during the progress of the lighting works.
- 5 The contractor shall upload and update all the asset data in Enterprise Asset Management System (EAMS) to the satisfaction of the Engineer on approval of the As-built.

END OF PART