SECTION 265100

LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Procurement, installation, testing and commissioning of the lighting systems, all as indicated on the drawings and as specified herein and/or in accordance with the Contract documents' requirements. Work includes but is not limited to the following:
   1. Indoor Lighting
   2. Emergency Lighting
   3. Addressable Lighting Management & Control System.
   4. Exterior Lighting.
   5. Luminaires, Lamps, Drivers, etc.

B. Related Sections
   1. Section 260500 - Common Work Results for Electrical
   2. Section 260510 - Basic Electrical Requirements
   3. Section 260519 - Low Voltage Electrical Power Conductors and Cables
   4. Section 260526 - Grounding and Bonding for Electrical Systems
   5. Section 260533 - Raceways and Boxes for Electrical Systems
   6. Section 260553 - Identification for Electrical Systems
   7. Section 262300 - Low Voltage Switchgear
   8. Section 262726 - Wiring Devices

1.2 SYSTEM DESCRIPTION

A. Lighting fittings complete with controls, control gear, support, and accessories, including all lamps of the type and wattage specified, and operational installation.

B. The lighting installation scope of works under the electrical contract includes but is not limited to the following:
   1. Supply, store, install, test, and commission all luminaires, lamps, and their related supports, as described in this Specification, schedule, and drawings, in accordance with BS 7671 - I.E.E. Wiring regulations latest Edition.
   2. Store and handle luminaires, lamps, and associated components in accordance with the manufacturers' recommendations. All luminaries are to be stored in their protective packaging before on-site installation.
   3. Inspect all equipment and components before fixing and after installation. Reject and replace any defective in a timescale sufficient to meet the project works programme and equipment manufacturers' returns policy.
   4. The Contractor is responsible for all communication, co-ordination, and liaison with all suppliers, manufacturers, and consultants to ensure that the completed installation meets the specifications.
   5. Work is to be carried out to the standards indicated and identified in this document and to the Engineer's approval.
   6. The Contractor is to ensure that all luminaires, lamps, and related components are ordered with consideration given to suppliers and manufacturers' lead times in order to meet the building works programme.
   7. Co-ordination duties as outlined in this Specification must be carried out, and reporting to the Engineer must be within a timescale as to allow site attendance and/or information provision without causing delay to this or other contracts.

1.3 SUBMITTALS

A. Shop Drawings: Submit to the Engineer in accordance with the Contract documents' requirements for lighting fittings. Include the Manufacturer's literature, dimensions, data, photometric curves, and operation and maintenance instruction manuals.

B. Shop drawings for light fittings shall include recommended installation method for each type and on-field mounting arrangements as a typical or location-based for each type.

C. Shop drawings for wall switches, push button stations, photo-cells shall include Manufacturer's literature, ratings, data and dimensions.

D. Shop drawings for timers, contactors, lighting control panels and dimmers shall include Manufacturer's literature, ratings, data, dimensions, and schematic diagrams.

E. Shop drawing or control wiring diagram of charger/inverter, ignitor, and other control gears as recommended by Manufacturer to establish and provide wiring on field accordingly.

F. The position of all external lighting units and other equipment shown on the drawing are to be taken as approximate only. The exact location of lighting units and Feeder Pillars will be indicated and marked at the site for approval by the Engineer. After the site has been marked, the Contractor shall prepare a detailed working drawing showing the exact route of cabling and the number of lighting units connected to each circuit. Any adjustments required by the Engineer shall be incorporated at no extra cost.

G. For external lighting, the Contractor shall refer to all relevant Civil, Sewerage, Drainage, Cable Routes, Landscape, and all other services and drawings and obtain for himself the exact locations and position of various services so that in the execution of his work, he will not disturb or damage any other services and additionally shall maintain adequate and specified clearance between external lighting and all other services.

H. Should any portion of the external lighting works, which can reasonably and obviously be inferred as necessary for the satisfactory operation of the external lighting works as a whole, be not expressly described in the drawings or specified in those documents, then the Contractor shall provide and execute such works as a part of his contract without any entitlement for an extra payment.

I. Submit fitting samples for all types and models at least six (6) months prior to fitting shipment. Samples of catalog items and customized fittings shall be complete, including mounting details.

J. Visual Mock-ups: Following approval of samples, construct visual mock-ups as follows:
   1. Provide as required, located on the job site where directed, assembled to simulate final conditions, sample light fittings, suspended ceiling, supports and other fittings and features.
   2. Adjust or modify visual mock-ups to the satisfaction of the Engineer's Representative. All permanent work shall comply with the final approved mock-ups that themselves may be used in the permanent work.

K. All external light fixtures shall be certified by VDE/ASTA. VDE/ASTA certificate shall be submitted for the specified I.P. Protection Class by the Manufacturer.

1.4 CO-ORDINATION WITH MAIN CONTRACTOR

A. Contractor to liaise with Main Contractor to arrange for correct size openings in the ceiling (particularly plasterboard), determining suitability of edge/butt up details of luminaries and correct location of luminaries.

B. Supply plaster rings for recessed luminaries and installs them in conjunction with ceiling tile or plaster ceiling section in their correct location.
C. Ensure no light spill around the abutting edge detail occurs unless the luminaire/lighting design is intentional.

1.5 QUALITY ASSURANCE

A. To ensure the finished lighting installation fulfills the designed quality of lit effect and aesthetic nature of the building, the Contractor is obliged to:
   1. Where luminaires have been installed into unfinished areas, provide appropriate protection to prevent damage or soiling.
   2. All installed luminaires and related equipment shall be free from indentation or marks. Particular attention is drawn to the absence of:
      a. Extrusion die marks
      b. Casting deformities and dowel marks
      c. Metalwork ripples
      d. Spinning lines
      e. Spot weld marks

B. A sample of each of the luminaires included within the luminaires/lamp schedule shall be supplied by the Contractor to the Engineer. It will subsequently be used as a control sample to ensure consistent quality of installation. These luminaires may form part of the completed installation.

C. Luminaires, lamps and associated components are to be installed per manufacturers' recommendations and installation instructions so that manufacturers' guarantees and warranties are maintained. If this Specification requires deviation in the manufacturers' installation instructions, it must be agreed upon in writing by the Manufacturer with written notification and approval by the Engineer before installation.

D. The Contractor must gain approval for all installation details of luminaires, lamps and associated components from the Engineer before installation on site.

E. The Contractor is responsible for the design of all mounting details.

F. The luminaire schedule, for each luminaire type, proposes one primary Specification and alternatives / or approved equal. Where alternative luminaires are used, the Contractor must review / revise the proposed architectural details to suit. Alternative luminaires may vary significantly in overall dimensions and fixing details.

G. Installed lamps and luminaires are not intended for use as site lights during building works. Suppose luminaires/lamps are utilised during building works. In that case, the Contractor is responsible for re-lamping before snagging and commissioning and allowing sufficient 'burn-in' time for new lamps to expose initial lamp failures. Luminaire, lamp, and gear must be undamaged and fully functioning.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Light fixtures shall be obtained from the manufacturers and country of origin listed in the Schedule of Light Fixtures. The invoice to be stamped from the consulate of the corresponding country of origin.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FITTINGS AND COMPONENTS

A. All luminaries shall be of the manufacture, size, and type specified in particular Specification and shall comply in all respects to EN 60598 Electric Luminaires, C.I.E.

24/C.I.E. 27, EN 10598-1, EN 10598-2 & EN 60598-2-22.

1. All luminaries shall be manufactured in accordance with the appropriate sections of BS.4533.

B. All fittings and associated equipment and controls shall be shall be obtained from a recognized manufacturer approved by the Engineer of the proven best quality and current models, for which replacement parts and lamps are and will be available for the normal expected useful life of the fittings and associated equipment.

C. All luminaries shall incorporate simple means of dismantling diffusers for cleaning.

D. All internal wiring shall be carried out in 16/0.2mm high-temperature heat resistant P.V.C.wires.

E. Where the diffusers for luminaries are of a thermoplastic material, the Contractor shall include for supplying the appropriate diffusers. The diffuser panels shall be fire retardant to Class 1 BS.476: Part 7.

F. Glass used for lenses, reflectors, and diffusers in luminaries shall be tempered for high impact and heat resistance.

G. All parabolic cones and plastic for lenses and diffusers shall be guaranteed against discoloration for a minimum of ten years, and in the event of premature discoloration, embrittlement, or loss of light transmittance they shall be replaced by the Manufacturer, including both materials and the cost of labour.

H. Lamp wattages and sizes shall be as described on the fitting types.

I. Each fitting shall be provided with an earth terminal.

J. Exposed fittings and associated equipment parts shall be finished as specified or as directed by the Engineer.

K. All light fittings should be independently supported as per MEW General Specification.CONTROL GEAR

A. SOLID-STATE LIGHTING (L.E.D.) REMOTE POWER CONDITIONING EQUIPMENT (Drivers)

All L.E.D. fixtures and remote power conditioning equipment (drivers) shall be furnished by one Manufacturer to ensure compatibility and a single responsible party.

1. Electric Characteristics (at 55 C ambient temperature)
2. Efficiency Minimum – 80%
3. Output Current Regulation Range (+/-) 5%A
4. Total Harmonic Distortion (T.H.D.) – 5% maximum
5. Power Factor – 0.9 minimum
6. Crest Factor (L.E.D. Current) – 1.5 maximum
7. F.C.C. Class B for Conducted E.M.I.
8. F.C.C. Class A for Radiated E.M.I.
9. Operating Ambient Temperature as stated in Section 260510

2.4 EMERGENCY LUMINAIRES

The system shall be provided as per KFD requirements and approved shop drawings. Obtain approval from KFD for Exit and Emergency lights. Comply with KFD comments whether it is shown in the drawing or not without any additional cost to the Client.

Emergency Luminaires powered by Central Battery System shall be provided as per approved shop drawings.

. Emergency Luminaires with battery back-up shall have a separate charger power supply taken from the D.B. for charging the batteries, and shall be incorporated in the shop drawing by the Contractor. Battery shall be suitable for 3 hours operation in case of normal power failure, built-in charger shall be provided with the unit.

2.5 GENERAL REQUIREMENTS

A. Luminaires shall not be delivered to the project or stored therein until dry and protected space is available for proper storage of luminaries.

B. Luminaires shall be completely assembled in factory and shall be delivered to the project in cartons or in pallestised form, as directed.

C. Luminaires to be supplied complete with proprietary plug and socket arrangement to allow quick installation/interface with lighting control wherever feasible.

D. Where luminaries are designated as emergency they are to be factory fitted with the necessary control gear, interface units and hold-off relays as recommended by the specialist supplier.

E. Equivalent Luminaires: Should equivalent luminaires outside of the proposed in the luminaire schedules be offered, the Contractor is to submit to the Engineer for evaluation and for approval the following information and luminaire details in order to demonstrate fully that the proposed Luminaire meets the performance objectives and design parameters outlined within this Specification, accompanying drawings and Schedule of Luminaires and Lamps: The Contractor is allowed to make only one submittal for alternate material, if rejected, the Contractor to submit the specified Manufacturer. Further submission for alternate Manufacturer is not acceptable without prior agreement by the Engineer.

1. Samples of equivalent luminaires (fully operational, lamped, and wired)
2. Full technical luminaire specifications, including:
    a. Calculations for sample areas (including details of the assumed maintenance factors, interior surface reflectances and lamp lumen outputs) Luminaire photometric performance including Light Output Ratios and Polar curves. IES/LDT files. Technical Specification including materials and construction information, Lamp types, Luminaire weights and required mounting detail for operation and installation (including remote gear or battery pack information where applicable). Luminaire dimensions including recess space requirements (including remote gear or battery pack information where applicable), luminaires shall be suitable for the architectural details and ceiling designs. Demonstration of full co-ordination and compatibility with architect's installation details, available supporting and/or fixing elements, recess spaces and ceiling designers. Availability of spare parts in Kuwait. Compatibility with control system.
    b. Equivalent luminaires should represent a faithful attempt to match, in detail, the aesthetic attributes of the original product.
    c. Written authorisation by the Engineer is required before proceeding with the use of alternative luminaires.
    d. The cost of any additional works undertaken by the Engineer at the site, required as a result of Contractor proposed alternative fittings and related components, including but not exclusive of calculations, comments upon technical submissions, and sample luminaire viewings should be included as an additional

item. This cost should be subtracted from the cost savings offered due to using alternative luminaires and related equipment.

e. Standards:
   1. Supply luminaires with photometric data in accordance with BS EN 13032-1.
   2. Supply luminaires in accordance with BS 4533 (BS EN 60598).
   3. Classification - To BS EN 60598-1.
   4. Fixed general purpose luminaires to BS 4533-102.1 (EN 60598-2-1)
   5. Supply luminaires with type N protection in accordance with BS EN 60079-15
   6. Recessed luminaires to BS EN 60598-2-2
   7. Luminaires for road and street lighting to BS EN 60598-2-3 and BS 5489-1.
   8. Floodlights to BS EN 60598-2-5.
   9. Luminaires with built-in transformers for filament lamps to BS EN 60598-2-6.
   10. Luminaires for swimming pools and similar applications to BS EN 60598-2-18.
   11. Extra low voltage lighting systems for filament lamps to BS EN 60598-2-23.
   12. Electrical supply track systems for luminaires to BS EN 60570.
   13. Classification - to BS EN 60598-1
   14. Physical protection:
       I. BS EN 62262 (I.K.),
       II. BS EN 60529 (I.P.)
   15. Safety Support for Components
       I. Provide secondary support for translucent covers, diffusers and gear trays so they are prevented from falling when their primary fixing is released.
   16. Electromagnetic compatibility
       I. Ensure luminaires comply with BS EN 61547 for E.M.C. immunity.
   17. Photometric performance:
       I. Ensure luminaires of similar type have same photometric performance as published data within the tolerances defined by BS EN 13032-1.
   18. Performance and life of L.E.D. fixtures as per LM80.

f. Emergency Lighting Luminaires:
   1. Comply with BS EN 60598-2-22.
   2. Comply with ICEL:1001. Ensure emergency lighting luminaires are marked with ICEL certification label.
   3. Standards:

i. Supply luminaires with photometric data in accordance with BS EN 13032-1.
ii. Supply luminaires in accordance with BS 4533 (BS EN 60598).
iii. Classification - To BS EN 60598-1.
iv. Electromagnetic compatibility
v. Ensure luminaires comply with BS EN 61547 for E.M.C. immunity.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Luminaires that do not incorporate insulated shrouding material to the lamp holder shall be earthed. Under no circumstances shall the suspension chain, wire, or non-rigid tube be used as the earth continuity conductor. Flexible earth wires shall be provided across all ball/socket joints.

B. Where recessed luminaries are used in conjunction with a suspended ceiling, the luminaries shall be suitable for being supported from the ceiling grid system via adjustable mounting brackets. For tender purposes however, the Contract shall include for the cost of independent conduit tube suspensions.

D. The ceiling details shall be checked for suitability of taking the support of the luminaries prior to ordering the luminaries or commencing the lighting installation and if suitable, an instruction will be issued accordingly. Under no circumstances shall any independent conduit suspension for luminaries be used to support the ceiling system.

C. Continuous rows of luminaries shall be rigidly aligned for proper in-line appearance.

D. Luminaires suspended by means of conduit drops shall be fitted to ball joints allowing a swing of at least 20° all around. Reliable earthing between the fixed and moving parts shall be provided by means of a flexible braided copper tape. The ball joints shall have a stop to prevent rotation by more than 360°. Any deviation from this suspension form must be agreed upon with the Engineer.

G. Where conduit suspension is used, final circuit wiring shall be contained within the conduit and terminated directly within the Luminaire.

H. Luminaires incorporating tube suspensions shall be complete with non-rigid connections to the general conduit system, the conduits being of the hook plate type. Ball socket joints shall be provided if the suspension tubes exceed 600mm in length or are suspended from sloping surfaces.

I. Luminaire heights and locations in mechanical and electrical plant rooms shall be coordinated to clear plant and equipment and adequately illuminate meters, gauges, panels, and equipment.

J. Unless otherwise stated, each Luminaire in this Specification shall be mechanically connected to a metal conduit box by means of suitable brass R.H. screws finished to match the metalwork of the Luminaire. The terminal block shall be enclosed in the conduit

K. All batten lamp holders not fitted with shades shall be complete with insulated skirt. Shade carrier rings shall be provided with all lamp holders not incorporated in fittings.

L. After testing the installation, lamps and tubes shall be removed from the luminaries and replaced prior to handover to ensure that all lamps are new at handover.

3.2 REFLECTORS, LENSES & CLEANING

A. All glassware, diffusers, reflectors, etc. shall be left in a clean condition. The allowance shall be made for all plastic surfaces which reflect or transmit light or are visible to view to be treated with an anti-static solution to prevent static electricity.

B. Reflectors, reflector cones, and visible trim of all luminaries shall not be installed (or otherwise protected in an approved manner) until completion of plastering, ceiling tile work, painting, and general clean-up. They shall be carefully handled to avoid scratching or fingerprinting and shall be completely clean at the time of handover by methods as recommended by the manufacturers.

C. All broken parts shall have been replaced, and all lamps shall be operative.

D. Ensure that all luminaries and lamps provided are in perfect condition at handover

3.3 AIMING AND ADJUSTMENT

A. All adjustable luminaries shall be aimed, focused, locked etc., by the Contractor to the consultant's requirements. This shall be carried out once the installation is complete. The Contractor shall provide all necessary ladders, scaffolds etc..

B. Where possible units shall be focused during the normal working day. However, aiming shall be accomplished at night when daylight interferes with viewing or proper

3.4 LIGHTING FITTINGS INSTALLATION

A. The Contractor shall furnish and install all inserts, anchors, studs, and hangers to support lighting fittings and associated equipment and make all necessary adjustments required to obtain an accurate and level installation.

B. Plaster rings shall be securely fastened to the ceiling support channels, such that the bottom of the plaster ring is flush with the finished ceiling (unless specifically directed otherwise on accepted shop drawings), and such that there will be no forces on the actual plaster during re-lamping. The plaster or other finish shall be screened flush with the bottom of the plaster ring. All plaster shall be cleaned from inside the plaster ring to allow proper fitting seating.

C. Pendant fittings shall hang plumb with approved stem hangers.

D. All external lighting installation works shall comply with best modern practice and comply with this Specification.

E. Provide concrete foundations and other accessories for all external pole lights, bollards, etc., per the drawings of landscape lighting and following manufacturers' recommendations.

F. The Contractor shall commission all equipment included in the external lighting services after the electrical supply has been connected to the Feeder Pillars. The Contractor shall check the voltages at different lighting column locations.

G. Current, voltage and insulation resistance readings for each circuit shall be taken and tabulated by the Contractor. Any indication of ground fault resulting from work performed by the Contractor shall be thoroughly investigated and remedied before final acceptance of the installation.

H. All the external lighting installations and details shall, in general, comply with the MEW Standard Specifications for external lighting as applicable unless mentioned otherwise in this specifications.

I. All fittings installed shall be compatible with the appropriate ceiling system. The fixing methods of mounting shall conform to the following:
   1. Each surface fitting shall be mounted at two points on each side.
   2. Each linear f itting and signage fitting shall be suspended by means of two number heavy gauges hot dip galvanised steel conduits. The conduit shall be fixed to the ceiling boxes by swivel or ball socket connecting plates. The lead-in wiring to the fitting shall be enclosed within one of the conduit drops, and provision shall be made to ensure the continuity of the earth by providing an earth wire from the ceiling box to the fitting.
   3. Light fittings recessed in false ceiling shall be independently supported from either the soffit of the slab and/or from an independent angle supported on the wall from the ceiling by
      6mm dia. (min.) threaded rod as required below:
      i. Square fittings - 4 nos. rods.
      ii. Linear t fittings - 2 nos. rods.

J. All fittings shall be installed true and level and shall be free of light leaks, warps, dents, and all other irregularities.

K. All internal wiring of lighting fittings shall be carried out with silicon rubber or heat resistant insulated tinned copper conductor of adequate size and shall be clipped neatly in position.

L. All light fittings in a suspended ceiling shall be provided with a plug and socket arrangement for easy removal.

M. SUPPORT SYSTEM

a. Conduit Installation
   1. Support from Conduit: Where Luminaire is supported from the conduit, provide a conduit box forming an integral part of the conduit system at each point of suspension. Ensure suspensions are vertical. Where conduit enters Luminaire, use back-nuts and washers to secure luminaire body to conduit support. Provide tube with corrosion resistance equal to conduit system. Do not support luminaires directly from conduit boxes made from non-metal or heat sensitive materials, where the temperature of the material may exceed 60^{O}C or the mass suspended exceeds 3kg.

   2. Suspension: Suspend luminaires at height indicated. Ensure suspensions hang vertically unless otherwise indicated.
   3. Connections to Luminaires: Cable Protection
      Use appropriate size of grommet where cables enter through a hole in luminaire body.
   4. Earthing: Ensure that the earthing terminal of Class 1 luminaires is connected to the conduit protective conductor of the supply circuit.
   5. Loose Wiring: Clip or tie back with suitable proprietary devices loose wiring within Luminaire, at 300mm intervals.
   6. Direct to conduit:
      a. Connections to Luminaires - Direct to Conduit - Terminal Box: Terminate circuit wiring in a terminal block within the supporting conduit box. Use flexible cord from terminal block to Luminaire.
      b. Connections to Luminaires - Direct to Conduit - at Luminaire: Terminate circuit wiring at supply terminals of Luminaire. Take all conductors through the same cable entry into Luminaire.
      c. Connections to Luminaires - Conduit Suspension: Terminate circuit wiring in a terminal block within the supporting conduit box. Use a flexible cable installed within the tube from the terminal block to Luminaire.

7. Rod
   a. Support System - Rod: Use continuously threaded rods with matching washers and nuts.
   b. Installation:
      i) Suspension: Suspend luminaires at height indicated. Ensure suspensions hang vertically unless otherwise indicated.
      ii) Suspension by Rod: Use washers, nuts, and lock-nut at the top and bottom of the rod. Paint cut ends with calcium plumbate primer or zinc- rich paint.
   c. Connections to Luminaires: Cable Protection
      Use appropriate size of grommet where cables enter through a hole in luminaire body.
   d. Earthing: Ensure that the earthing terminal of Class 1 luminaires is connected to the conduit protective conductor of the supply circuit.
   e. Loose Wiring: Clip or tie back with suitable proprietary devices loose wiring within Luminaire, at 300mm intervals.
   f. Connections to Luminaires - Rod or Chain Suspension: Terminate circuit wiring in a terminal block within the supporting conduit box. Use flexible cord from terminal block to luminaire and clip cable to one of the rods or chains do not weave cable through links of the chain.
8. Flexible cord
   a. Support System - Flexible Cord: Use size and type as indicated. Confirm that the temperature rating is suitable for the operating temperature of the Luminaire or lamp holder. Confirm that cord is adequate for mass to be supported.
   b. Installaton
      i) Suspension: Suspend luminaires at the height indicated. Ensure suspensions hang vertically unless otherwise indicated. All suspended luminaires must be installed with sufficient spare cord or wire to adjust the on-site height.
      ii) Suspension by Flexible Cord: Suspend cord from the ceiling rose.
9. Wall brackets
   a. Support System - Wall Brackets:
      i) Provide wall brackets. Confirm that wall brackets are suitable for supporting Luminaire.

      ii) Installation:
      Installation of Wall Mounted Fittings: Install luminaires at height indicated.
   b. Support System - Ball and Socket:
      i) Installation:
         - Suspension: Suspend luminaires at height indicated. Ensure suspensions hang vertically unless otherwise indicated.
         - Suspension by Ball and Socket: Install cable through ball and socket connected to conduit box.
         - Provide ball and socket as top support, complete with cover fixed to circular conduit box.

10. Support System - Wire Rope:
    a. Installation
       i) Suspension: Suspend luminaires at height indicated. Ensure suspensions hang vertically unless otherwise indicated.
       ii) Provide wire rope support system. Confirm wire rope is suitable for supporting luminaires.

11. Surface Mounting to Ceiling System: Where a luminaire is a surface mounted to a suspended ceiling system, it must be securely fixed to the building structure above

(concrete or steel) such that the ceiling system is not carrying the weight of the Luminaire. In addition, the Luminaire must sit flat against the ceiling with no gaps between the back of the Luminaire and the ceiling. Unless otherwise indicated, luminaires shall be installed centrally on the ceiling tile. For setting out, refer to the architect's drawings.

b. SURFACE MOUNTED LUMINAIRES – SYMMETRICAL

1. For luminaires with a symmetrical photometric distribution: Luminaires are installed such that their designed elevation and azimuth adjustment, detailed in their product literature, are maintained.

2. Luminaires are mounted such that their downward aperture is level in the horizontal plane and plumb in the vertical plane.

c. RECESSED LUMINAIRES

1. Orientation: Install luminaires in positions indicated and horizontal unless otherwise indicated.

2. Cleanliness: Ensure luminaires are clean and grease-free on handover.

3. Material of Supporting Surface: Ensure classification of luminaires is appropriate. Do not mount luminaires on readily flammable surfaces.

4. Luminaires in Areas with Infra-Red Control System: Install luminaires in areas with infra-red control systems or data bearers to cause minimum disturbance to the infra-red transmission system following BS 7693.

5. Support: Ensure support is adequate for the weight of luminaires.

7. Support from Trunking:
   i. Where Luminaire is supported from trunking, use proprietary clamps or brackets appropriate to the Luminaire and trunking.
   ii. Do not support luminaires directly from trunking made from non-metal or heat-sensitive materials, where the temperature of the material may exceed 60^{O}C or the mass suspended exceeds 3kg.
   iii. Support by direct fixing: Refer to fixing methods, use Luminaire supporting coupler to BS 7001 or follow the Manufacturer's recommendations.
   iv. Support in the suspended ceiling: Support luminaires directly from building fabric.

8. Connections to Luminaires
   i. Connections to Luminaires - MICC Cable: Fix cable gland to Luminaire and continue conductors to supply terminals of Luminaire.
   ii. Cable Protection: Use appropriate grommet size where cables enter through luminaire holes.
   iii. Earthing: Ensure that the earthing terminal of Class 1 luminaires is connected to the conduit protective conductor of the supply circuit.
   iv. Loose Wiring: Clip or tie back with suitable proprietary devices loose wiring within Luminaire, at 300mm intervals.

6. Standards
   i. Comply with BS 3974-1 for fixings. Ensure that fixings such as expanding anchors are tested for tensile loading following BS 5080-1.

7. Shot Fired Fixings
   i. Obtain approval prior to using shot-fired type fixings.

8. Self-Adhesive Fixings
    i. Obtain approval prior to using self-adhesive type fixings.

9. Proprietary Channel Inserts
    i. Provide proprietary channel inserts for casting where indicated.

3.5 TESTING AND COMMISSIONING OF LIGHTING SYSTEM

A. General Testing and Commissioning

1. Incorporated equipment characteristics: Obtain and use information from manufacturers of equipment provided. Use information provided, for equipment supplied by others and incorporated into the installation.
2. Test equipment and consumables: Provide test equipment and consumables to complete tests satisfactorily and to retest any failed installations following corrective measures. Test equipment quality assurance requirements to BS EN ISO 10012.
3. Testing: Carry out in the same order as published the tests required by BS 7671, Section 713 for New Installation or Altered or Added Installation as appropriate.
4. Calibration: Provide current calibration certificates for all instruments used during test procedures—Record particular instrument identity on record sheets.
5. Records: Record all results and instrument readings on approved Record Sheets and hand two copies to the Client for each inspection and test

END OF SECTION