

SECTION 16475**FUSES - 600 VOLT & BELOW****PART 1 - GENERAL****1.01 SUMMARY**

This section specifies the furnishing and installation of low voltage fuses rated 600 volts and below, 6000 amperes and below.

1.02 REFERENCE STANDARDS

- A. ANSI/NEMA FU A - Low Voltage Cartridge Fuses.
- B. ANSI/UL 198C - High-Interrupting-Capacity Fuses, Current-Limiting Type.
- C. ANSI/UL 198D - Class K Fuses.
- D. ANSI/UL 198E - Class R Fuses.

1.03 APPLICABLE PROVISIONS

- A. Refer to Section 16010, Electrical General Provisions.

1.04 SUBMITTALS

- A. Provide product data on fuses.

PART 2 - PRODUCTS**2.01 VOLTAGE**

- A. Provide fuses with a voltage rating suitable for the nominal voltage of the system in which they are to be applied.

2.02 TYPES

- A. Time Delay Fuses. Unless otherwise indicated, provide UL Class RK-5 time delay, current limiting fuses having 200,000 rms symmetrical amperes interrupting rating. Use on all 600-ampere or smaller circuits supplying individual motors, and where otherwise indicated.
- B. Non-Time Delay Fuses. Fuses indicated by "K-1" on the drawings are UL Class RK-1 non-time delay having 200,000 rms symmetrical amperes interrupting rating. Use on all 600-ampere or smaller circuits supplying branch circuit panelboards, resistance heating and where otherwise indicated.
- C. Class L fuses. Fuses rated 601-6000 amperes are UL Class L with 200,000 rms symmetrical amperes interrupting rating.

2.03 MANUFACTURER

- A. Low voltage fuses must be products of a single manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Instructions. Follow the manufacturer's installation instructions.
- B. Fuse Clips. Check fasteners on fuse clips for tightness when installing fuses.
- C. Labels. Install fuses so label is in an upright, readable position. Fuses without labels are not acceptable.

3.02 SPARE FUSES

- A. As spares, provide the greater amount of either three fuses or 10 percent of each size and type installed. Deliver the spare fuses to the Employer at the time of final acceptance of the project. Neatly encase the spare fuses in suitable containers or cabinets.

END OF SECTION

SECTION 16490**ENCLOSED SAFETY SWITCHES****PART 1 - GENERAL****1.01 SUMMARY**

This section specifies the furnishing and installation of enclosed safety switches.

1.02 REFERENCE STANDARDS

- A. ANSI/UL 98 - Enclosed and Dead-Front Switches.
- B. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches.

1.03 APPLICABLE PROVISIONS

- A. Refer to Section 16010, Electrical General Provisions.

1.04 SUBMITTALS

- A. Provide product data on each type and rating of switch.

PART 2 - PRODUCTS**2.01 CHARACTERISTICS**

- A. **Voltage.** Provide switches with a voltage rating of 250 volts d-c, 600 volts a-c, as required for the installed system voltage.
- B. **Type.** Provide switches conforming to NEMA KS 1 standard for Type HD (heavy duty).
- C. **Contacts.** Provide switches with quick-make, quick-break contacts.
- D. **Poles.** Unless otherwise shown, provide 3-pole, visible blade switches.

2.02 CONSTRUCTION

- A. **Enclosure.** Provide NEMA 1 switch enclosures for indoor dry locations and NEMA 12X for outdoor locations unless otherwise indicated.
- B. **Operating Handle.** Provide a handle suitable for padlocking in the OFF position with as many as three padlocks of 80 mm diameter shank. Use a defeatable, front accessible, coin-proof door interlock to prevent opening the door when the switch is in the ON position and to prevent turning the switch ON when the door is open.
- C. **Terminal Shield.** Provide incoming line terminals with an insulated shield so that no live parts are exposed when the door is open.

- D. **Neutral.** Provide each switch with an isolated, fully rated neutral block. Make provisions for bonding the block to the enclosure.
- E. **Ground.** Provide each switch with a ground lug.
- F. **Fuse Holders.** here fusible switches are shown, provide switches with rejection-type fuse holders which are suitable for use with fuses.
- G. **Nameplates.** Provide metal nameplates, front cover mounted, that indicates the switch type, catalog number and horsepower rating (with both standard and time delay fuses).

2.03 LISTING

- A. UL 98 - Safety Standard for Enclosed Switches.

PART 3 - EXECUTION

- A. Install switches where indicated on drawings. In general, mount so that operating handle is approximately 1.5 meters above finished floor. Where grouped, align tops of switches.

END OF SECTION

SECTION 16510**LIGHTING FIXTURES & LAMPS****PART 1 - GENERAL****1.01 SUMMARY**

This section specifies the furnishing and installation of lighting fixtures complete with lamps and other accessories.

1.02 REFERENCE STANDARDS

- A. ANSI C78 Series - Lamps.
- B. ANSI C82 Series - Ballasts.
- C. ANSI/UL 935 - Fluorescent-Lamp Ballasts.
- D. ANSI/UL 1029 - High-Intensity-Discharge Lamp Ballasts.
- E. ANSI/UL 1570 - Fluorescent Lighting Fixtures.
- F. ANSI/UL 1571 - Incandescent Lighting Fixtures.
- G. ANSI/UL 1572 - High-Intensity-Discharge Lighting Fixtures.
- H. British Code (BS)

1.03 APPLICABLE PROVISIONS

Refer to Section 16010, Electrical General Provisions.

1.04 SUBMITTALS

- A. Provide product data on each lighting fixture, type of lamp and poles.
- B. Acceptable Manufacturers
 - 1- The Contractor shall submit to the Engineer the names of three manufacturers and their products which will be acceptable under this Section. Approval of the manufacturer or product must be obtained before ordering the material.

1.05 GENERAL REQUIREMENTS

- A. Pendant fixtures within the same room of area shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation.
- B. Flush mounted recessed fixtures shall be installed so as to completely eliminate light leakage within the fixture and between the fixture and adjacent finished surface.

- C. Fixtures located on the exterior shall be installed with non-ferrous metal screws finished to match the fixtures.
- D. Luminaries fitted with high frequency or electronic control gear shall be disconnected before the circuit is tested for insulation resistance.
- E. Unless otherwise stated all luminaries designed for internal use shall be constructed to IP 20 and be Class 1. For IP-Rating refer to lighting fixture schedule in contract drawings.

PART 2 PRODUCTS

2.01 FIXTURES CONSTRUCTION

- A. Metal
 - 1- Metal used in lighting fixtures shall be Grande GR 3/4 to BS 1030/1031/10051 cold rolled mild steel and not less than 0.7 mm or heavier when required to comply with the specification or standards.
 - 2- Sheet steel reflector shall have a thickness of not less than 0.75 mm.
 - 3- Aluminum reflectors shall have a thickness of not less than 1.6 mm, and coating of minimum thickness 2.5 mm.
 - 4- The grade of the aluminum used shall be similar to
 - a. BS 1470 Cat. A Type 1200
 - b. BS 1490 (Alloys) LM6, LM24 or LM25
 - 5- The metal parts of the fixture shall be completely free from burrs and tool marks. Solder shall not be used as a mechanical fastening device on any part of the fixture.
- B. Finish
 - 1- Ferrous metal shall be bonderised, given a corrosion-resistant phosphate treatment or other approved rust-inhibiting prime coat to provide a rustproof base before application of finish.
 - 2- Light reflecting surfaces shall be either in aluminum sheet with a purity of 99.9% and the aluminum shall be of grade 1080A to BS 1470, or finished in a baked white enamel having a reflection factor of not less than 80% all to the drawings and approval of the Engineer.
 - 3- All parts of reflector shall be completely covered by finish and free from irregularities.
 - 4- Non-reflecting surfaces such as fixtures frames and trims shall be finished in a baked enamel paint. The color of the paint shall be in accordance with manufacturer's standard finish unless otherwise directed by the Engineer.
- C. Lenses and Diffusers
 - 1- The diffuser shall be manufactured from Plexiglas/polycarbonate/acrylic as required.

- 2- Diffusers shall not be manufactured from polystyrene or other styrene based materials.
- 3- Diffusers shall be formed by injection moulding, with a finish as specified.

OR by extrusion moulding, with a finish as specified.
- 4- Fixtures with hinged diffuser doors shall be provided with spring clips or other retaining devices to prevent the diffuser from moving.
- 5- All fixtures shall be provided with the required accessories and hardware for complete installation.

2.02 INCANDESCENT LAMP LUMINAIRES

A. General

- 1- Luminaries for incandescent light sources shall be designed to accommodate the specified lamp.
- 2- Lamp holders for tungsten halogen lamps shall be of the best quality with ceramic bases suitable for the currents and temperatures achieved during constant use.

B. Elv Luminaries

- 1- Unless otherwise stated luminaries using low voltage tungsten halogen lamps shall be supplied complete with their own transformer.
- 2- Wire wound transformers shall be rated as shown in the luminaries specification sheets and comply with IEC 742, Class I/Class II and be insulated to Class H of BS 2757.
- 3- Electronic transformers shall be designed to IEC 742 and 34C/Comex (PK) 8 and 14 with RFI suppression to a minimum standard of BS 800 and VDE: 0875.
- 4- Transformers shall be located away from high temperature parts of the lamp and luminaries or any other heat radiating surface.
- 5- When installed in ceiling voids, transformers shall be separately supported, mounted to avoid noise transmission and be capable of subsequent removal, either through the fitting aperture or through an access panel.
- 6- Transformers not containing primary fuse protection shall be provided with accessible local protection.
- 7- The size of wiring between the transformer and the luminaries shall be such that the voltage drop is not more than 6%.
- 8- Final connections to luminaries shall be carried out using silicon rubber sheathed cables.
- 9- Transformers including electronic types shall incorporate internal protection against overload and short-circuit.

- 10- Where multipoint transformers are specified voltage regulation shall be a maximum of 6% and each luminaries shall be separately connected to the transformer.
- 11- Electronic transformers shall contain a soft start circuit and be self-regulating.
- 12- Where low voltage tungsten halogen lamps are to be dimmed, the dimmer shall be of the hard fired type suitable specifically for this type of lamp.
- 13- Electronic transformers used in dimmable circuits shall be suitable for dimming. The dimmer shall be compatible with the transformer and be recommended by the transformer manufacturer.
- 14- Transformers used in dimmable circuits shall be down rated as recommended by the manufacturer.
- 15- Where dimmers are specified they shall be of the hard firing type suitable specifically for operating low voltage tungsten halogen lamps.
- 16- Lamp holders in capsule luminaries shall be easily accessible for relamping.

C. Dichroic And Sealed Elv Tungsten Halogen Lamps

- 1- Where sealed extra low voltage lamps are used the luminaries shall be designed for the heat dissipation requirements.
- 2- Where dichroic lamps are used the internal wiring and luminaries shall cope with the temperature.
- 3- All dichroic and sealed lamps shall be of the captive type and supplied with a GU 5.3 base or similar.

D. Capsule Elv Lamps

- 1- The envelope of capsule lamps shall be made of quartz glass.
- 2- Where capsule lamps are used a protective glass shall be incorporated into the luminaries design.

E. Mains Voltage Tungsten Halogen Lamps

Luminaries designed to accommodate double-ended mains voltage halogen lamps shall be designed to ensure that a minimum bulb wall temperature of 250°C and a maximum pinch point temperature of 350°C are achieved.

2.03 FLUORESCENT LUMINAIRES (LOW PRESSURE)

A. General

- 1- Fluorescent lamps shall comply with the requirements of BS 1853.
- 2- All cables shall be secured within the luminaries body to prevent loose lengths from touching hot surfaces or becoming trapped beneath cover plates. Cable clips or cleats shall be captive and if secured by adhesive, shall not loosen with age.
- 3- Unless otherwise specified all fluorescent luminaries shall be supplied with low loss gear and single pulse electronic starters.

- 4- Unless otherwise specified control gear shall have power factor correction to achieve a minimum p.f. of 0.9 lagging.
- 5- The control gear enclosure shall be so designed to limit the maximum temperature of ballast to its stated rated temperature (TW) and in all cases to less than 65°C.
- 6- Where high frequency control gear is specified, the lamp supplied shall be compatible.
- 7- All high frequency gear shall be "burnt-in" for a minimum period of 24 hours before being installed in a luminaries.
- 8- Aluminium reflectors and louvers shall be made from high purity aluminium(99.9% minimum) with low or very low iridescence. The anoxic film shall have a minimum thickness of 2.5 microns.
- 9- Diffusers shall be made from UV stabilized polycarbonate, injection moulded.
- 10- The diffusers shall not support combustion and shall be self-extinguishing.

B. Compact Fluorescent Lamps

- 1- All compact fluorescent lamp luminaries shall be supplied with low loss control gear, single pulse electronic starters and H.F. Ballasts.
- 2- Compact fluorescent lamps shall be 4-pin type to meet the BS 6982 requirements.
- 3- Compact fluorescent lamps used for emergency lighting use shall be of the 4-pin type (2G7, G24q or G11 bases), or 2-pin type with integral starters (G24d-1, 2 or 3, or G23).
- 4- Where the lamps are used horizontally, they shall be adequately supported along their length.

C. Lamp Caps And Holders

- 1- All lamp caps and holders shall be to BS 5101 and BS 5042. Lamp holders shall be suitable for the lamp cap or base used.

a. Fluorescent Lamps

38 mm T12 and 26 mm T8 fluorescent lamps shall be supplied with bi-pin G13 end caps.

Bi-pin fluorescent tube lamp holders shall be to BS 1875. Lamp holders shall be moulded polycarbonate, urea, GRP or equivalent, with integral cable terminals capable of clamping conductors of maximum size 1.5 mm². The lampholders shall be provided with means of accommodating lamp length tolerances. The lamp holders shall be either grip-pin/spring grip/center twist rotary contact type.

2- Compact Fluorescent Lamps

Compact fluorescent lamp(s) type TC-12D shall be supplied with bases incorporating an integral starter-switch.

Lamp holders shall be moulded polycarbonate, urea, GRP or equivalent, with integral cable terminals capable of clamping conductors of maximum size 1.5 mm². The lampholders shall be provided with means for positive fixing to luminaries and be of the 2G11 type.

2.04 EMERGENCY LIGHTING

A. General

- 1- The emergency lighting installation shall fully comply with BS 5266 and emergency luminaries shall comply with BS 4533 : Part 101 and Part 102.22.
- 2- All equipment used shall be ICEL or U.L. approved and certified. Copies of certificates for all or any equipment supplied shall be obtained, as appropriate.
- 3- Where lamps are to be used for emergency lighting, emergency battery packs shall be supplied by the manufacturer of the luminaries,
- 4- On satisfactory completion of the installation the emergency lighting system shall be operated for its rated duration. The system shall then be allowed to recharge for 24 hours and` tested again.
- 5- Luminance checks at sufficient points to prove compliance with BS 5266 shall be carried out at the start and finish of the first discharge and after the full recharge period. These tests shall be witnessed.
- 6- Illuminances, and battery voltage of central systems, at the start and end and after recharge shall be noted and included with the final test certificates.
- 7- Where the system is designed for 3 hour duration, the measurements shall be taken during the last hour of this period unless the installation is large when the time taken for the measurements should determine the starting time.
- 8- On acceptance of the installation a completion certificate of the type suggested in BS 5266 (Appendix B) shall be issued.
- 9- Where remote batteries, chargers or invertors are mounted at distance greater than 0.5 m away from the luminaries, the interconnecting wiring shall comply with BS 5226, Category 1.

B. Self-Contained Luminaries

- 1- Each luminaries shall contain the charger/sensor unit, battery pack and invertor. Where these units are supplied separately they shall not be mounted more than 0.5 m away unless the connecting wiring complies with BS 5266.
- 2- All luminaries shall be clearly marked giving rated voltage, method of operation, lamp type, wattage, and battery type and voltage.
- 3- Lampholders for combined units shall be clearly identified.

- 4- Each luminaries shall have a clearly visible coloured LED (minimum life expectancy of 20,000 hours) indicating battery under charge.
 - 5- Luminaries installed in defined escape routes shall have an outer casing which shall comply with the 850oC glow wire test of IEC 695-2-1.
 - 6- Each luminaries shall contain a protective fuse in the main circuit.
 - 7- Batteries shall be protected against polarity reversal and complete discharge. Batteries shall be prevented from discharging when the cell voltage 1.5V (lead acid) or 0.9 V (nickel cadmium)
 - 8- The batteries shall have a minimum life of 4 years and the date of manufacture (month and year) shall be stamped on the casing.
- C. Slave Luminaries
- 1- All luminaries shall be clearly marked, giving rated voltage method of operation and lamp wattage.
 - 2- Where one lamp way in a multiway luminaries is used for both normal and emergency use the lampholders shall be separately identified.
 - 3- Where fluorescent tubes are fed from a DC or AC/DC emergency source the luminaries shall contain appropriate invertors.
- D. Illuminated Emergency Exit Signs
- 1- Exit signs shall be manufactured to meet the appropriate requirements of BS 4533, BS 2560 and BS 5266.
 - 2- Each sign shall be internally illuminated by two separate systems of lighting.
 - 3- The housing shall be designed to maintain an internal ambient temperature below that of the lowest temperature rating of any piece of equipment installed therein.
- E. General Battery Systems
- 1- Batteries used shall consist of a number of cells of the:
 - * Lead acid planate type to BS 6290: Part 4.
 - 2- The charger shall be capable of restoring 100% of capacity within 24 hours and 80% of capacity within 18 hours.
 - 3- The changeover contactor shall be manufactured to BS 5424 and BS 764.
 - 4- Changeover relays shall be mounted in a purpose-built enclosure adjacent to the appropriate sub-distribution board.
- F. Emergency Lighting Modification Unit (Conversion Kit)
- 1- The addition of conversion kits to luminaries if specified shall only be carried out in the factory of either the original luminaries manufacturer or the suppliers of the conversion kit. In either case the supplier of the conversion kit shall inspect and approve the modification work.

- 2- The luminaries incorporating conversion kits shall comply with all tests in BS 4533 and carry the "F" mark when used in or on surfaces consisting of flammable material.
- 3- Where only one lamp in a multilamp luminaries is used for emergency lighting or additional lamp is included in the luminaries, the luminaries shall be photometered under emergency conditions.
- 4- Where high frequency electronic ballasts are used for the normal lighting, the conversion unit shall incorporate additional devices to ensure that the ballast resets itself after testing and turns on the lamp.
- 5- Self-contained conversion kit shall contain an emergency lighting module and battery pack.
- 6- The module shall contain a battery charger with charge indicator, inverter, low battery voltage disconnect circuit and changeover relay.
- 7- An LED charge indicator shall be visible from below. Allowance shall be made to extend the LED circuit and incorporate it into the luminaries body or into the ceiling adjacent to the luminaries using a purpose made ceiling plate.
- 8- The internal temperature of the luminaries shall not exceed the battery manufacturers recommended ambient temperature for their batteries.
- 9- Where the ambient temperature of the luminaries exceeds that recommended for the batteries, then the batteries shall be mounted externally in a ventilated sheet steel enclosure with a minimum rating of IP 20.
- 10- Where remote conversion kits and/or batteries are mounted more than 0.5 m from the luminaries, they shall be interconnected using wiring complying with BS 5266.
- 11- Conversion kits deriving their emergency supply from a central battery shall contain an inverter ballast and changeover relay.

G. Testing

- 1- A central means of testing shall be provided in the cubicle for all central battery systems. Operation of the test switch shall simulate a mains failure extinguishing the normal lighting and energizing the emergency lighting.
- 2- Where the system is maintained up to the local distribution board and non-maintained thereafter using zonal or sub-circuit monitoring then local test points shall be provided.
- 3- The inclusion of test modules into emergency luminaries shall be approved by manufacturer of these modules.

2.05 LAMP CONTROL GEAR

A. General

- 1- The lamp control gear shall be of the correct type and rating for the lamp specified.

- 2- Electromagnetic interference generated by the lamp control gear propagating through the mains supply wiring shall be suppressed at the source to within the requirements of EN 55015, BS 800, BS 5394. Electromagnetic interference components shall be to BS 613.
- 3- Harmonic currents generated by the lamp control gear in the mains supply wiring shall be limited to the requirements of IEC 82.
- 4- The acoustic noise level from the lamp control gear shall not exceed NC 25.
- 5- The lamp control gear shall be ventilated to ensure that under normal operating conditions the maximum continuous rated operated temperature of any control gear component is not exceeded.
- 6- The control gear shall be power factor corrected through Power Factor corrector.
- 7- Electronic equipment shall be subjected to a test "burn-in" phase of a minimum 24 hours to ensure the supplied equipment has a minimal failure during operational life.

B. Electrical Performance Electronic Starter-Switch Circuits

- 1- Each lamp control gear circuit shall comprise the following:
 - a. Electronic starter
 - b. Current limiting ballast
- 2- The electronic starter shall be to BS 3772 : Section1.
- 3- The electronic starter shall operate 38 mm (T12) Argon filled lamps, 26 mm (T8) Krypton filled lamps and compact fluorescent lamps. The electronic starter shall incorporate means for identifying the lamp type connected and applying the correct starting conditions.
- 4- When starting the lamp, the electronic starter shall pre-heat the lamp electrodes to the full emission temperature described in BS 5717, before applying a single starting voltage pulse. The electrode pre-heat period shall conserve lamp life. The electronic starter shall be certified to provide 10,000 starts on a switching cycle as defined in BS 3772.
- 5- The period between initiation of starting and lamp ignition, shall not exceed 2.5 seconds for non-defective lamps.
- 6- The electronic starter shall incorporate a means for detecting a failed lamp and for preventing starting attempts on failed lamps.
- 7- The electronic starter shall be contained in a 2-pin polycarbonate canister to BS 3772. The electronic starter shall be mounted in a starter-switch socket complying with BS 6702.

C. Ballasts

Current limiting inductive ballasts shall be to BS 2818. The ballast core shall be of sufficiently large cross-section to avoid high flux densities and overheating. The ballasts shall be of the "low loss"/"super low loss" type.

The maximum permitted losses are as follows:

| Krypton 26 mm | Standard (watts) | Low Loss (watts) | Super Low Loss (watt) | H.F. (watt) |
|------------------|---------------------|---------------------|--------------------------|----------------|
| 18 W | 9-10.5 | 6.5 | 4.0-4.5 | 2-3 |
| 36 W | 9-10.5 | 6.0-6.5 | 4.0-4.5 | 3-4 |
| 58 W | 11-13 | 8.0-8.5 | 5.2-5.5 | 4.5 |
| 70 W | 13 | 8.5 | 5.5-6.0 | |

The manufacturer shall state ballast losses for the proposed control gear in the appropriate schedule.

D. Capacitors

High Power factor corrector shall be supplied within the fixture.

Radio interference suppression capacitors shall be dry type ceramic or equivalent, complying with BS 4017. They shall be rated at 800 V, 50/60 Hz.

E. Electronic High Frequency Ballasts (Where Required and Specified In The Lighting Fixture Schedules)

- 1- Lamp control shall be effected by electronic control gear operating the controlled lamp at frequencies higher than 20kHz, and including means for the limitations of lamp current.
- 2- The electronic control gear shall be capable of operating both 26 mm (T8) Krypton filled lamps and 26 mm Argon filled lamps.
- 3- The control gear shall incorporate means for automatically identifying the lamp type connected and applying the appropriate starting and running conditions.
- 4- The control gear shall be supplied complete, with all components in a fully enclosed housing. The control gear shall comply with BS 5717. The control gear housing shall be provided with means for fixing to the mounting, and allowing easy removal for replacement. The control gear housing shall incorporate all the cable terminals.
- 5- The manufacturer shall state, for continues normal operation, the values of:
 - a. Power consumption
 - b. Current
 - c. Earth leakage current
 - d. Power factor.
- 6- The manufacturer shall state the maximum current demand during lamp start-up.
- 7- The control gear shall pre-heat the lamp electrodes under conditions complying with BS 5717, before applying a voltage across the lamp sufficient to cause ignition. The electrode pre-heat period shall be sufficiently long to conserve electrode life. The period between initiation of

starting and lamp ignition shall not exceed 2 seconds. The control gear shall be certified to provide 10,000 starts on a switching cycle as defined in BS 3772.

- 8- The control gear shall incorporate means for detecting and automatically isolating a failed or defective lamp. After lamp replacement the control shall automatically start the non-defective lamp.
- 9- The control gear shall be designed and manufactured to ensure mains frequency, or multiples of mains frequency, is not perceptibly modulated onto the lamp output.
- 10- The control gear shall be capable of operation from a suitable standby d.c. electrical power supply and shall be provided with all the necessary cable terminals. The manufacturer shall define the requirements of a suitable d.c. source of their luminaries.
- 11- The control gear shall have a "burn-in" period of at least 24 hours and then retested before being used in the luminaries.
- 12- The final circuit shall have a power factor of no less than 0.95 lagging.
- 13- Where dimming is called for, the control gear shall be of the type suitable for dimming smoothly from 100% - 10% light output.

2.06 DIFFUSERS

- A. Diffusers shall be manufactured from one piece virgin acrylic, clear acrylic, or polycarbonate plastic having the following requirements:
 - 1- Interior diffusing type with smooth exterior surface.
 - 2- Self-extinguishing type.
 - 3- No material colour change when used with 4500 degrees K fluorescent lamp.
 - 4- No apparent yellowing after 500 hours exposure to fluorescent lamp source under conditions similar to those existing in the lighting fixture.
 - 5- No altering of the optical properties of the fixture when finished diffuser treated with anti-static wax.
- B. Diffusers shall be formed by carefully controlled processes so that the finished piece retains it's design contours and dimensions without any change at normal operating temperature.
- C. Diffusers shall be resistant to shrinking, warping, crazing, cracking, or discoloring, either in service or when stored in normal conditions in the manufacturer's standard shipping containers.

2.07 GLOBES

Globes shall be manufactured from clear seamless butyrate polycarbonate, or high impact heat resistant glass, with the following additional requirements.

- A. Minimum thickness 3.20mm surface free from visible mold seam.

- B. Reduction in strength: Not more than 10 percent after five years.
- C. Maximum haze: Two percent.
- D. Minimum light transmittance: 88 percent.

2.08 LENSES

- A. Plastic lenses:
 - Clear butyrate or polycarbonate, minimum thickness 1.52mm.
- B. Glass lenses:
 - Tempered glass, laminated glass, or double strength clear glass.
- C. Refractory lenses:
 - Spherical in shape not exceeding 152mm min. diameter, heat resistant annealed clear borosilicate glass.

2.09 LIGHTING FIXTURES

- A. Lighting fixtures are described in the "Lighting Fixture Schedule". The fixtures shall be furnished and installed complete with all necessary parts and lamps as specified herein and as shown on the drawings.
- B. Voltage rating of fixtures shall be as shown on the drawings and schedules.

2.10 RECESSED LUMINAIRES

- A. Recessed incandescent luminaires: Prewired type with junction box forming an integral part of the assembly.
- B. Supply recessed luminaires complete with trim type required for ceiling system installed. Before ordering confirm ceiling construction details and architectural finish for each area.
- C. Maximum depth of recessed fluorescent luminaires shall be 150mm including mounting yokes or bridges. Minimum distance from backface of luminaires or lens to center of lamp shall be 60mm.
- D. Select reflector and lamp positions to provide high efficiency and even brightness to eliminate lamp lines.
- E. Provide integral encapsulated ballasts for recessed high intensity discharge luminaires.

2.11 OPTICAL FIBRE LIGHT SYSTEM

The method of optical fiber light system simply is to transfer cold light (white or colored) from light source (illuminator) through fiber optic cable (F.O.C.) to its destination having either line light effect or end light effect. This system could be used for unlimited applications such as decorative, landscaping and etc..

2.12 SYSTEM COMPONENTS & GENERAL SPECIFICATION

2.12.1 Light source (Illuminator, Light Generator, Light Projector).

2.12.1.1 Light Source requirement.

The light source should meet the required international standards regarding its housing material, protection against wet conditions, type & lamp wattage, lamp color temperature, rated lamp life, power consumptions, output lumens & any required options such as : cooling fan, color wheel, control & synchronize equipment.

2.12.1.2 Light Source Installation & Location.

The illuminator should be installed (mounted) vertically or horizontally according to factory recommendation.

The illuminator should be located in any ventilated locations at the nearest point to light fixture to avoid transmission losses through F.O.C.

2.12.1.3 Environment

Avoid any possible flooded locations.

2.12.2 Fiber Optic Cables & Accessories

2.12.2.1 Cable Requirements

Two type of fiber optic cables, the strand fiber optic cable & solid core cables, having different diameter sizes & different applications. The F.O.C. should meet the required international specifications regarding its indoor or out door applications also its end or line effect functions, cables shall meet allowable limits of the transmission losses, bend radius, temperature stability, spectral transmission range, acceptance angle, refractive index for core & cladding, etc..

2.12.2.2 Cable Installation

2.12.2.2.1 End light cable installation: a bondable and flexible black jacket F.O.C. should be used for end lights, suitable conduits are recommended to simplify wiring works.

2.12.2.2.2 Perimeter or Line Cable Installation

A bondable and flexible clear jacket F.O.C. should be used for linear light applications, suitable tracks for mounting are recommended to adjust levels & curves.

2.12.2.2.3 Harness (Adapter)

The harness is a grouping of optical fibers and should be custom built in order to have maximum output lumens from light source also should be used to combine various optical fiber cable sizes.

Note : number & size of optical fiber cables should be within the recommended limits of manufacturer specification.

2.12.2.2.4 Cutting

Any type of solid core strand F.O.C. should be cut with special tool in order to have a clean 90 deg. angle.

2.12.2.2.5 Splicing

Only the solid core F.O.C. could be spliced by splicing kits & factory Recommended adhesives.

2.12.2.2.6 Environments

- avoid letting liquids get between the core & cladding. Use end seals.
- Avoid dirt & abrasions on the core & cladding.
- Unspliced lengths are brighter than spliced lengths.
- It is not possible to splice strand F.O.C. cables.
- F.O.C. cables should be UV inhibitors for out door application.
- F.O.C. cables should be al gicides & fungicides resisted for under water application.
- Avoid hard bending.

2.12.3 Light Fixtures

Light fixtures used to be end light fixtures for decorative, landscaping applications. Lenses should be crystal clear glass or clear acrylic material, suitable ferrules & special glue are recommended according to manufacturer recommendation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Furnish, assemble, install and wire up complete, all lighting fixtures. Fixtures shall be complete with lamps, lamp holders and all necessary accessories. All fixtures shall be wired in accordance with temperature limitations.
- B. Fixtures shall be rigidly mounted by approved means. Pendant-hung fixtures shall be equipped with approved ball type aligners.
- C. Provide adequate protection for fixtures during construction. At completion of work all fixtures shall be clean and free from foreign material.
- D. Support fluorescent luminaries directly from building structure by rod hangers and inserts or metal angle headers supported from framing structure of ceiling suspension system.
- E. Support luminaries more than 600mm wide by a minimum of four hangers per luminaries, independent of ceiling structure or tee bars.
- F. Install recessed luminaries to permit removal from below, to gain access to outlet or prewired fixture box.
- G. Connect recessed luminaries to boxes with flexible conduit and fixture wire.
- H. Support recessed luminaries mounted in suspended ceilings with exposed tee bar grid system from the ceiling tee bar grid structure and secure thereto.
- I. Cables shall loop in and out of bases of columns and bollards without joints. Cables shall terminate in a crimped cable socket.
- J. Provide foundations for all requiring such poles shall be set plumb.
- K. Verify that the lighting fixtures are compatible with the specified ceiling systems as indicated on the architectural drawings. Advise the Engineer of any discrepancies before placing the lighting fixture order.

3.02 TESTS

- A. Test all circuits in accordance with the codes.
- B. Test proper operation of lighting fixtures and controls.
- C. Lighting levels in rooms shall be tested using a cosine and color corrected light meter to the requirements of IES.
- D. Submit test results.

END OF SECTION