

PART THREE

WORKMANSHIP AND MATERIALS

AMENDMENT RECORD

Rev	Date	Description	Engineer	Approved
01	18/11/12	Issue	AS	MS

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3.1 GENERAL

The Sub-Contractor shall not install any, goods, materials, substances or products not in accordance with relevant British Standards and Codes of Practice, CoSHH Regulations or otherwise generally known within the industry at the time of this specification. No materials shall be deleterious to health and safety or to the durability of the Development or not in accordance with good building practices current at the time of specification.

3.2 HIGH VOLTAGE SWITCHGEAR

3.2.1 GENERAL REQUIREMENTS

High voltage switchgear shall be designed, manufactured, tested and installed in accordance with BS EN 60298.

3.2.2 SITE BUILT ASSEMBLIES

All components of site assemblies shall be of a proprietary system and type tested. Site assemblies shall be installed strictly in accordance with the manufacturers' drawings and instructions.

3.2.3 CUBICAL TYPE ASSEMBLIES

Cubical type assemblies shall be floor standing metal clad, separately compartmented structure comprising switchgear, control gear and components as detailed.

3.2.4 AUXILLARY WIRING

Auxiliary wiring shall be to BS 6231 and shall be terminated in a rail mounted moulded terminal block with fully shrouded connectors.

Each terminal and associated cable shall be fitted with an identification tag.

3.2.5 TYPE TESTING

ASTA certificates of verification of type test for short circuit strength of components for each assembly shall be provided.

3.2.6 BUSBARS

Busbars shall be rated as detailed in Section Four, manufactured from high conductivity solid copper in accordance with BS 159 and BS 1433 with either epoxy resin bonded or moulded non-hydroscopic insulation.

Busbars shall be installed in a separate compartment of the switchboard with removable access covers along the length.

3.2.7 SWITCH DISCONNECTORS

Shall comply with BS 5463 and be of the fault make load break type having the rating shown in the Technical Specification and an electrical impulse level of 75 kV and fault rating of 16 kA for three seconds.

The switch operating mechanism shall be an independent manual device operating such that the

energy, stored in the first part of the operating stroke, shall be released to complete the making, breaking, earthing or opening from earth operation, independent of the skill or physical strength of the operator. The maximum effort required shall not exceed 32 kgf at any point in the operating stroke, which must be between 300mm. minimum and 1850mm. maximum above floor level. No energy stored in the spring during the initial part of an uncompleted operation must remain in the spring when the switch is moved into the 'ON', 'OFF' or 'EARTH' positions.

Padlocking facilities shall be provided to lock the operating mechanism in any operating position and to lock off the 'EARTH ON' and 'ON' positions to prevent unauthorised operation.

A padlockable captive device labelled 'MOVE BEFORE EARTHING' shall be fitted to prevent easy operation of the mechanism, from the 'OFF' to 'EARTH ON' positions.

Positively driven (in both directions) mechanical indication of the switch positions, operated from the switch operating mechanism, shall be provided to show whether the switch is in the 'OFF', 'ON', or 'EARTH ON' positions.

3.2.8 CIRCUIT BREAKERS

Shall comply with BS 5311, have an electrical impulse level of 75 kV and fault rating of 16 kV for three seconds.

The circuit breaker operating mechanism shall be of the trip free type.

The closing and tripping devices shall operate satisfactorily between the voltage limits specified in accordance with the appropriate British Standard for the particular type of switchgear stipulated in Section Four.

A visual mechanical indicating device shall be provided on each item of switchgear equipment. It shall be positively driven in both directions to show either the circuit breaker is open or closed and shall be operative whilst the circuit breaker is in the service, isolated and earthed positions.

On spring charged mechanisms a mechanical indicating device shall be fitted indicating the state of the spring and inscribed 'SPRING CHARGED' and 'SPRING FREE'.

All circuit breakers must have a mechanically operated direct-acting trip push-button; shrouded to prevent inadvertent operation.

Padlocking facilities shall be provided so that in any position the circuit breaker can be prevented from being closed when it is open and from being manually tripped when it is closed. Each requirement shall be met by the fitting of a single padlock and shall not entail the fitting of any loose components prior to the insertion of the padlock.

Operating handles on any mechanisms shall be designed to be operated without undue effort by any operator of average physique. The operating handles must not cause an obstruction in any working position if not removable.

Earthing of the circuit shall be possible only after relocating the circuit breaker. The location shall be pre-selected only from the front of the equipment. The 'EARTH ON', 'ON' and 'OFF' positions shall be clearly identified and labelled.

Whenever a circuit breaker is in the earthing position any remote or automatic control of closing and tripping shall be rendered inoperative by means other than padlocking.

Padlocking facilities shall be provided to allow the circuit and busbar earthing arrangements to be independently locked off to prevent incorrect earthing.

The automatic features of the safety shutters shall be retained during earthing operations.

3.2.9 PROTECTION RELAYS

Protection relays shall comply with BS 142 and BS 5992.

The relays shall form part of the circuit breakers and be located in a separate dust-proof flush mounted housing.

All relay contacts, except where otherwise approved, shall be capable of breaking or making the maximum current which can occur in the control circuit in which they are connected and they shall not be affected by vibration or by external magnetic fields. The contacts shall be of silver, platinum or other approved material and shall be capable of repeated operation without deterioration.

3.2.10 CURRENT TRANSFORMERS

These shall comply with BS 7626. Separate current transformers shall be provided and matched for each protective device. The CT's shall be capable of withstanding the maximum short time withstand current of 21 kA for three seconds.

Test links shall be provided in the secondary connections.

3.2.11 VOLTAGE TRANSFORMERS

Voltage transformers shall be to BS 7625. Secondary windings shall be protected by cartridge fuses located outside the transformer enclosure in an accessible position. Where more than one circuit is connected to the secondary winding, fuse each circuit separately.

The star point of 3 phase and one side of single phase secondary windings of the transformer shall be

connected to the switchgear earth bar through removable bolted links.

Voltage transformers shall be mounted in separate dust proof enclosures provided with mechanical interlocks to prevent access at all times that the transformer is in service.

Provide danger notices and instructions detailing the switching procedure to be adopted for safe isolation and earthing of the equipment before gaining access to the fuse/transformer enclosure.

3.2.12 TOOLS

Supply one set of any special tools required for maintenance or operation. Tools shall be supplied in a wall mounted enclosure or rack clearly labelled giving the purpose for which it is supplied.

3.3 TRANSFORMER

3.3.1 GENERAL

Transformers shall be 3 phase 11,000/433 V Dyn 11 type complying with BS 171 and the following service conditions:-

Maximum daily temperature	40 °C	
Average daily temperature	30 °C	
Average yearly temperature	20 °C	
Minimum temperature	- 25 °C	(outdoor)
	- 5 °C	(indoor)

The enclosure shall be provided with the manufacturer's standard colour paint finish. All supporting metal work shall be de-greased, any localised rust removed and be provided with a high standard of corrosion resistant paint finish to the same colour as the transformer enclosure. The paint application shall comply with the paint manufacturer's recommendations.

3.3.2 WINDINGS

The insulation standard shall be in accordance with BS 2757 to the following classes:-

Dry:

HV Winding	Class B
LV Winding	Class F
Liquid Cooled	Class A

3.3.3 TAPPINGS

Shall be provided on the higher voltage winding for a variation of the no load primary voltage of $\pm 2.5\%$ and $\pm 5\%$. The tapping switch shall be controlled by an externally operated handwheel which can be locked in any position and fitted with a tap position indicator.

3.3.4 NEUTRAL TERMINAL

The neutral point of the star winding (433V) shall be brought out to a terminal in the LV cable box and the conductor and terminal shall be the same size as the phase terminals.

3.3.5 CABLE TERMINATION

Provide suitable cable terminations for high and low voltage cables as detailed in Section Four.

3.3.6 ACCESSORIES

The transformer shall be provided with the following accessories:-

Electronic converter with 2 x 240V signal supplies for alarm and tripping.

6 No. thermistor sensors (2 per phase)

Rating and connection plate

Lifting lugs

Earthing lugs

Channel base

4 plain by directional rollers

Ventilation fans

3.3.7 INSTALLATION

The transformer shall be installed in accordance with the manufacturer's recommendations.

All connections and joints shall be tightened with a torque spanner in accordance with the manufacturer's recommendations.

All terminals, cables and component parts shall be numbered in accordance with the Engineer's requirements.

3.3.8 TESTING

Transformers are to be tested in accordance with BS 1717. Provide type test certificates for each transformer supplied.

3.4 LOW VOLTAGE SWITCHGEAR

3.4.1 GENERAL REQUIREMENTS

Low voltage switch panels shall be designed manufactured, tested and installed in accordance with BS EN 60439-1 : 1999 and as detailed in the particular requirements section of this specification.

3.4.2 INTERNAL SEPARATION

The form of internal separation shall be as defined in the "BS EN 60439-1 National "Annex NA.

3.4.3 SITE BUILT ASSEMBLIES

Site built assemblies shall be of a proprietary system by one manufacturer and installed in accordance with the manufacturers' instructions.

3.4.4 CUBICAL TYPE ASSEMBLIES

Cubical-type assemblies shall be of the multiple cubical-types and shall be either wall or floor mounting.

3.4.5 AUXILIARY WIRING

Auxiliary wiring shall be to BS 6231: 1998 and shall terminate in rail mounted moulded terminal blocks with fully shrouded connectors.

Each terminal shall be fitted with an identification tag fitted into moulded tag slots.

3.4.6 MOULDED CASE CIRCUIT BREAKERS

Moulded case circuit breakers (MCCB) shall comply with BS EN 60947-2 : 1996 Category B.

MCCB shall be provided with thermal and magnetic trip devices which shall be fixed up to a rating of 125A and adjustable above 125A.

MCCB's shall have an adequately rated, service and ultimate breaking capacity.

3.4.7 AIR BREAK SWITCHES

Air break switches shall comply with BS EN 60947-2 : 1996.

Fuse switches and fuse switch combination units shall be fitted with BS 88 HRC fuses.

Isolator switches shall be of the rotary type.

Motor isolators shall be adequately rated to AC23. Direct on line started motors isolators shall have

three poles and star-delta started motor isolators shall have six poles.

Where the starter is located in a remote panel the isolator shall be fitted with an ancillary pole connected to the starter circuit.

All air break switches shall be lockable in the off position.

3.4.8 AIR CIRCUIT BREAKERS

Air circuit breakers ACB's shall comply with BS EN 60947-2 : 1996 and shall be with drawable type Category B.

Operation shall be via a stored energy mechanism for instantaneous opening and closing. The mechanism can be charged either manually or electrically and can initiated either from the local pushbuttons on the circuit breaker front face, or by remote control.

Each ACB shall be provided with interlocks to prevent movement of the circuit breaker within the housing when in "closed" or "service" position.

Automatic shutters shall be provided to cover all live contacts when the circuit breaker is isolated, withdrawn or removed from the housing.

A padlock shall be provided to lock the circuit breaker in the isolated/withdrawn position and to lock the automatic shutters covering live contacts when removed from its housing.

3.4.9 CURRENT TRANSFORMERS

Current transformers (CT's) shall comply with BS EN 60044 – 1: 1999.

C.T.'s shall be dedicated to and be fully compatible with the protection device, instrument or meter.

Test links shall be provided in the secondary connections of all C.T.'s to facilitate testing of instruments, meters and protective devices.

3.4.10 METERS

Electrical measurement meters shall be to BS EN 60051 : 1999 panel mounted and complete with selector switches as appropriate.

All meters shall be of an appropriate scale to enable the maximum accuracy under normal operating conditions.

3.4.11 ENCLOSURES

Unless otherwise detailed, enclosures shall provide a minimum degree of protection of IP21 when

located in buildings and IP54 when located outside buildings, or in 'wet' areas.

Fixing holes for equipment inside buildings shall be inside the enclosure. Equipment to be located outside buildings or in 'wet' areas shall have fixing lugs external to the enclosures.

Enclosures shall be structurally stable and rigid under all operating conditions and shall be manufactured from material suitable for the environmental conditions.

3.4.12 DISTRIBUTION BOARDS

MCB distribution boards shall be to BS 5486 : Part 12 and BS EN 60439-3: 1994 and shall be complete with all MCB's of the type and rating as detailed in the schedule of distribution boards. MCB's shall be manufactured to BS EN 60898 of the appropriate type with an adequate rated short circuit capacity.

Consumer units shall be of the MCB type to and BS EN 60439-3: 1994.

HRC fuse type distribution boards shall be to BS 5486 : Part 11 and shall be completed with HRC fuse links to BS88 as detailed in the schedule of distribution boards.

Distribution boards shall be fully shrouded and provided with blanks to cover all spare ways.

Each distribution board shall be provided with a lockable overall cover.

Distribution boards located remote from the main switchgear shall be fitted with a main isolator of the rating indicated on the drawings.

Where circuits are indicated as being protected by a residual current device (RCD) these shall be:-

Integral with the distribution board, comprising a single module width 'RCBO' unit or

Mounted adjacent the distribution board in purpose made enclosures for three phase devices.

Each distribution board shall be fitted with a typed circuit chart which shall be incorporated in a non-flammable transparent envelope securely fixed to the internal side of the distribution board door.

The chart shall indicate:

- Distribution board reference
- The measured earth loop impedance and prospective short circuit current of the distribution board
- Out-going protective device type and rating
- Circuit details
- Cable size and type.

The circuit chart shall also indicate a warning to check circuits for sensitive electronic equipment which may be damaged by insulation tests before testing.

Where the physical size of the distribution board precludes the installation of the chart within the distribution board door, the chart shall be provided in a permanised form securely fixed to the wall adjacent the distribution board.

3.5 WIRING SYSTEMS

3.5.1 STEEL TRUNKING

Materials

Steel cable trunking and fittings shall be manufactured from heavy gauge sheet steel to BS 4678, Part 1 having a return edge.

Steel underfloor trunking shall be to BS 4678 Part 2.

Cable trunking shall have a finish to:-

Class 3, i.e. Hot-dip zinc coated steel to BS EN 10143 : 1993 with a minimum coating designation of G275.

The trunking system shall be mechanically and electrically continuous throughout the fully complete with overlapping lid, couplings, end caps etc. Only factory made fittings shall be used, site manufactured tees, bends etc. will not be allowed. All accessories shall be of the same gauge and finish as the trunking body.

Each section of trunking and accessories shall be connected by a tinned copper earth continuity link, clearly visible.

Purpose made 'pin racks' shall be installed in vertical rising trunking at intervals of 3000 mm to support the weight of the cable. The 'pin racks' shall be PVC coated.

Installation

Trunking shall be installed neatly running truly vertical, horizontal and parallel with the features of the building and shall not be run closer than 150 mm to any other non- electrical service.

Cable trunking shall only be installed in areas which allow it to be fully accessible.

All cable trunking shall be properly supported at the maximum distances recommended by the trunking manufacturer.

Where trunking is fixed to parts of the structure which is liable to movement the trunking shall incorporate a flexible coupling. A protective conductor shall be firmly connected to each end of the flexible coupling to maintain the earth continuity of the trunking system.

All fixing screws within the trunking shall have round heads, to prevent abrasion or cutting of cables, and shall be of adequate size. The trunking shall be free of any sharp edges.

Where a trunking passes through a wall or floor, a short section of lid shall be fitted to the trunking which shall protrude a maximum of 50 mm either side of the wall or floor. Prior to trunking being installed through a load bearing wall or floor the approval of the Structural Engineer will be required.

Fire barriers shall be installed in the trunking as required by IEE Regulation 527-02.

Care shall be taken to ensure that all bends are of sufficient radius to ensure the minimum recommended bending radius of the cables to be installed within the trunking is complied with. Gusset type bends shall be used where possible.

Flanged connectors shall be used to terminate trunking into equipment or enclosures. The opening into the equipment or enclosure shall be the same as the internal size of the flanged connector and the edge of the opening shall be bushed to avoid cable abrasion.

3.5.2 INSULATED CABLE TRUNKING

Materials

Insulated cable trunking and fittings shall be manufactured from heavy gauge UPVC to BS 4678, Part 4 having non flame propagating properties.

Insulated cable trunking for use with PVC insulated unsheathed cables shall be suitable for use as supplementary insulation.

The trunking system shall be mechanically continuous throughout and fully complete with overlapping lid, couplings, end caps etc. Only factory made fittings shall be used, site manufactured tees, bends etc., will not be allowed. All accessories shall be of the same gauge and finish as the trunking body.

Purpose made 'pin racks' shall be installed in vertical rising trunking at intervals of 3000 mm to support the weight of the cable. The 'pin racks' shall be PVC coated.

Installation

Trunking shall be installed neatly running truly vertical, horizontal and parallel with the features of the building and shall not be run closer than 150 mm to any other non-electrical services.

Where trunking is run with 'lid down' purpose made preparatory cable retaining clips shall be installed at 1000 mm centres.

Cable trunking shall only be installed in areas which allow it to be fully accessible.

All cable trunking shall be properly supported at the maximum distances recommended by the

trunking manufacturer.

Where trunking is fixed to parts of the structure which is liable to movement the trunking shall incorporate a flexible coupling.

All fixing screws within the trunking shall have round heads, to prevent abrasion or cutting of cables, and shall be of adequate size. Each fixing screw shall be provided with a brass washer.

Where a trunking passes through a wall or floor, a short section of lid shall be fitted to the trunking which shall protrude a maximum of 50 mm either side of the wall or floor. Prior to trunking being installed through a load bearing wall or floor the approval of the Structural Engineer will be required.

Fire barriers shall be installed in the trunking as required by IEE Regulation 527-02.

Care shall be taken to ensure that all bends are of sufficient radius to ensure the maximum recommended bending radius of the cables to be installed within the trunking is not exceeded. Gusset type bends shall be used where possible.

Flanged connectors shall be used to terminate trunking into equipment or enclosures. The opening into the equipment or enclosure shall be the same as the internal size of the flanged connector and the edge of the opening shall be bushed to avoid cable abrasion.

Insulated trunking shall be installed strictly in accordance with the manufacturers' recommendations.

Fittings shall be provided with internal couplers. All joints shall be made using a solvent adhesive. Expansion joints in accordance with the manufacturers' recommendations shall be made at 6000 mm centres. Fixing holes shall be elongated to allow for linear expansion.

3.5.3 STEEL CONDUIT

Materials

Conduits and conduit fittings and accessories shall comply with BS 4568, BS EN 60423 and BS EN 50086 and be of the heavy gauge, seam welded, steel tube screwed, having a Class 4 hot dip galvanised finish.

Fittings shall be malleable iron and shall be of the same class of finish as the associated conduit system. Manufactured type elbows and bends shall not be used. All conduit boxes shall be fitted with lids secured by dome or cheese headed screws steel for class 2 finish and brass for class 4 finish.

All conduits shall be properly supported with spacings between supports not exceeding 1.75m, or as recommended by the manufacturer.

A draw-in box shall be provided in all conduit runs exceeding 10 m in length or containing more than two right angle bends.

All open ends left during the construction of the works shall be temporarily plugged to prevent the ingress of foreign matter, moisture or water.

Bends and sets shall be formed in conduits using a pipe bending machine fitted with the correct size former. The minimum bending radii of every conduit shall comply with IEE Regulation 522-08-03.

Conduits shall be threaded using correct size dies. Prior to final assembly of the joint/termination the threaded section shall be wiped clean of all cutting oil, reamer, burrs removed and graphite paste applied to all threads.

Where the conduit is to be used as a protective conductor, special care shall be taken to ensure all joints and terminations create an effective bond.

The length of thread on conduit shall suit the length of internal thread in the end of the fitting or accessory. Exposed thread shall be kept to a minimum.

Any exposed threads along with any superficial damage to the finish of any conduit shall be made good by painting with a coat of rust inhibitor metal primer and two coats of final paint (colour to match finish of conduit). Any damaged conduits will not be accepted and shall be replaced.

Surface mounted conduit and conduits in accessible locations, e.g. above suspended ceilings, shall be fixed using spacer bar saddles conduit runs shall be planned and installed to be as neat and unobtrusive as possible.

Conduits concealed within the building fabric shall be fixed using galvanised steel crampets. All chases shall be vertical, no horizontal chases shall be allowed. Chases shall be of sufficient depth to ensure a 12 mm minimum cover of the wall finish.

Extension collars shall be fitted as necessary to ensure boxes are flush with finished surface.

Conduits run at high level in portal frame or similar buildings shall be fixed using proprietary fixing system as 'caddy clip' or equal and approved.

3.5.4 INSULATED CONDUIT

Materials

Conduits and conduit fittings/accessories shall comply with BS EN 50086-2-1 and be of a super high impact heavy gauge type of one colour only throughout the system.

Conduits less than 20 mm diameter shall not be used.

Manufactured type elbows and bends shall not be used.

All conduit boxes used to support equipment shall be provided with steel screw thread inserts which shall take the weight of the equipment. Where the weight of the equipment exceeds 3 kg or the temperature at the equipment exceeds 60°C a metal box shall be provided.

All conduit accessory boxes shall be provided with an earth terminal.

Installation

Conduits shall be installed neatly running truly vertical, horizontal or parallel with the features of the building and shall not be installed closer than 150 mm to any other non-electrical service.

Special care must be exercised to ensure conduits are kept away from hot water services and pipes.

Conduits shall be properly supported spacing between supports and shall not exceed 1000 mm for horizontal runs and 1.25 m for vertical runs. Supports shall be provided within 150 mm of boxes or bends.

A draw-in box shall be provided for all conduit runs exceeding 10 m in length containing more than two right angle bends.

All open ends left during the construction of the works shall be temporarily plugged to prevent the ingress of foreign matter, moisture or water.

Bends shall be formed in conduits using a method approved by the conduit manufacturer using an appropriate bending spring.

Fractured or 'kinked' conduit will not be accepted.

Conduits shall be cut using a proprietary tool to ensure a clean finish with no swarf being left within the conduit.

Joints into couplers and conduit boxes shall be made using a solvent adhesive. Any excessive solvent shall be removed.

Expansion couplers shall be provided at 6000 mm centres on long straight runs of exposed conduit.

Termination at accessories shall be made into steel boxes via an adapter/flange coupler and male screwed bush.

Surface mounted conduit and conduits in accessible locations, e.g. above suspended ceilings, shall be fixed using spacer bar saddles. Conduit runs shall be planned and installed to be as neat and

unobtrusive as possible.

Conduits concealed within the building fabric shall be fixed using galvanised steel crampets. All chases shall be vertical, no horizontal chases shall be allowed. Chases shall be of sufficient depth to ensure a 12 mm minimum cover of the wall finish.

Extension collars shall be fitted as necessary to ensure boxes are flush with finished surface.

Conduits run at high level in portal frame or similar buildings shall be fixed using proprietary fixing system as 'caddy clip' or equal and approved.

3.5.5 CABLE TRAY

Materials

Cable trays shall be a minimum of 20% perforated type and shall be formed from bending and profiling quality hot dipped galvanised steel to BS EN 10143 : 1993.

The tray shall be a minimum of medium duty type having a return flange.

Only factory made accessories of the same type, gauge and finish as the tray system shall be used.

Installation

Cable trays shall be supported at adequate centres using galvanised steel channel to prevent deflection.

All cable trays shall be properly supported at the maximum distances recommended by the trunking manufacturer.

The tray work shall be arranged to minimise the number of cuts necessary. All cuts shall be made through unperforated metal and shall be painted with a zinc rich paint.

Any holes cut for the passage of cables shall be provided with brass bushes.

All bolted connections between tray lengths and accessories shall be made using round galvanised steel bolts to prevent damage to the cables.

3.5.6 WIRING OF CONDUIT AND TRUNKING

Materials

Cable types shall be as specified in the distribution board schedules and on the drawings.

LSF insulated cables where used shall be as specified in BS 7211 having copper conductors and insulation rated at 450/750 volt grade. No conductor size less than 1.5 sq mm shall be used and all

cables shall have stranded conductors only i.e.

For 1.5 sq. mm Conductor stranding is 7/0.53.

For 2.5 sq. mm Conductor stranding is 7/0.67.

Single solid conductors will not be allowed.

Installation

Wiring of conduits installed within the carcass of the building shall not be installed until the plaster and/or screed has dried and set and the interior of the conduit is dry.

The number of cables which are to be drawn into any conduit must be such that it allows easy drawing-in and in no circumstances shall it be in excess of the maximum given in IEE Guidance Note No. 1 Appendix A. To assist drawing-in the cables shall be liberally smeared with french chalk. All cables shall be drawn-in simultaneously within crossovers. The cable reels shall be arranged on a stand or support so as to allow them to revolve freely as cables are drawn-in to the conduit. On no account shall cables be allowed to spiral off the reel.

Connections on all conductors shall only be made at accessories/switchgear positions. No other joints shall be allowed.

The Engineer will inspect the wiring prior to the trunking lids being fitted and the accessories and equipment being connected. The Engineer shall be informed when the trunking lids etc. are to be fitted giving at least seven days prior notice.

Terminations of cables shall be carried out in strict accordance with the manufacturer's recommendations. Special care shall be taken to ensure that all conductors are firmly gripped. When terminating one conductor into a terminal tunnel the conductor shall double back to ensure a positive connection is made. All terminating conductors shall be left with some slack cabling.

All conductors shall be identified in accordance with IEE Table 51A.

A separate circuit protective conductor of the size detailed in the schedule of distribution boards shall be provided in all insulated and flexible conduit systems.

3.5.7 ARMOURED CABLES

Materials

XLPE/LSF/SWA/LSF 600/1000 volt grade and shall be XLPE insulated, LSF bedded, steel wire armoured, and LSF sheathed conforming to BS 6724.

Cables shall comprise standard copper conductors with aluminium wire armour.

XLPE/PVC/SWA/PVC 6350/11,000 volt grade cable shall be XLPE insulated, extruded PVC bedded steel wired armoured and PVC sheathed coloured red, conforming to BS 6622.

Cables shall comprise stranded copper conductors with galvanised steel wire armour.

Unless otherwise stated, all multi-core cables shall be complete with full size neutral.

Cable glands shall comply with BS 6121 and shall be provided complete with PVC cable shrouds and brass earth tags. All glands shall be 'C' type with an outer seal for internal and external use, providing a degree of protection to IP66.

LSF cables shall be terminated with low smoke and fume gland kits.

Installation

Cables shall be installed in accordance with the relevant British Standard and the manufacturers recommendations.

Cables shall be delivered to site, and stored, on a cable drum with the manufacturer's label attached.

Cables shall be fixed to cable trays, the building fabric/structure, laid in trenches and installed in ducts as detailed on the drawings.

Cables shall only be installed when both the cable and the ambient temperature are above 0oC for PVC cables and -10oC for LSF cables and have been so for the previous twenty four hours, or where special precautions have been taken to maintain the cable above this temperature.

To facilitate the installation of cables the drums shall be supported by either Jack stands or a drum cradle to allow the cable to rotate freely whilst the cable is drawn through ducts laid in trenches or on cable trays.

Cables installed fixed to cable trays, racks or to the fabric of the building shall be fixed using proprietary cleats. Cables having an overall diameter up to 50 mm shall be fixed by claw cleats. Cables over 50 mm overall diameter shall be fixed by two bolt cleats.

Cables shall be supported and fixed in accordance with the manufacturers recommendations.

The minimum internal bending radius of the cables shall not exceed the cable manufacturer's recommendations.

Joints in cables shall only be made at equipment and accessories.

Cables installed within trenches shall be laid at a constant depth of 500 mm below finished ground level, for low voltage cables 800 mm below finished ground level for high voltage cables.

Cable trenches shall be bedded with 75 mm of sieved earth or sand and shall be clear of any loose stones, prior to the cables being installed.

The Sub-Contractor shall be in attendance whilst the back filling is being carried out to ensure the cables are covered with a minimum of 100 mm of sieved earth or sand then well compacted, then filled in 200 mm lifts hand or power rammed.

A continuous warning marker tape 250 mm below finished ground level shall be provided along the full length of the cable route.

Once cables have been drawn into ducts, all holes shall be sealed by a waterproof sealing compound to prevent the ingress of water, vermin etc.

Any coverings removed to facilitate terminations shall be made good by taping the gap between the PVC sheath and the termination and by extending the tape over the gland. The tape shall be applied "half lapped" and shall be fitted to all tape areas and PVC sheath and the gland (for external terminations) and fitted to extend over PVC sheath and the gland (for internal terminations). Gland shrouds shall be slotted over the cable before the gland is fitted.

When the termination is made into external equipment the gland shall incorporate a lead washer to ensure a watertight joint between the gland and the cut-out.

Steel wire armour will be used as the protective conductor. Care shall be taken at all terminations to ensure that the earth continuity is maintained. All glands, earth tags etc. shall be fitted and tightened to the manufacturer's recommendations. The earth tag shall be firmly fixed to the switchgear/equipment via a brass nut, bolt and shakeproof washer. A protective conductor shall be connected and installed between the brass bolt and the earthing terminal and the switchgear/equipment.

Where cables pass through walls, floors, ceiling etc. the holes shall be made good with incombustible material to prevent the spread of fire. Where the walls, floors etc. form a fire barrier the cable shall be enclosed in a steel sleeve and the space around the cable in the sleeve shall be plugged with insulating material.

Single core armoured cables shall have non-magnetic armouring bonded at a single point only. The unbonded termination shall be made on to an insulated gland plate.

3.5.8 MINERAL INSULATED CABLES

Materials

Mineral insulated cables and terminations shall comply with BS 6207 : Parts 1 and 2.

Pre-insulated saddles shall be used to support the cables. On multiple runs of cable multi-way saddles shall be used and these shall be secured by brass round headed screws.

All accessory boxes shall be provided with an earth terminal.

Installation

Cables shall be installed neatly running truly vertical, horizontal or parallel with the features of the building and shall not be installed closer than 150 mm to any other non-electrical service. Multiple runs of cables shall be installed without crossovers.

The fixing centres between saddles shall be as recommended by the cable manufacturer.

The installation of cables shall be carried out in accordance with the manufacturer's recommendations and only tools recommended by the manufacturer shall be used to bend, set, dress or terminate the cables.

Where cables pass through floors and walls short lengths of conduit shall be threaded over the cable for protection. Holes around the conduit shall be made good with cement and the conduit shall be packed with non-combustible material to structural steelwork the size and location of the holes shall be agreed with the Structural Engineer.

Joints shall only be made at accessories, e.g. alarm sounders, break glass contact; no joints being allowed in straight runs of cable.

Standard temperature seals (105oC) and compression ring type glands shall be used at terminations. All cables shall be terminated in accordance with the manufacturer's recommendations. Cable seals shall not project into the interior of any accessory switchgear. Shrouds shall be fitted over the cable prior to termination.

At all terminations care shall be taken to maintain earth continuity. All glands and locknuts shall be efficiency fitted and tightened, to the manufacturer's recommendations. Particular attention shall be paid to surfaces of termination boxes which have been painted and the appropriate serrated lock-washers shall be used in such conditions to ensure earth continuity. The earth tail of the seal shall be connected to the earthing terminals within the box and accessories.

When terminating conductors special care shall be taken to ensure that all conductors are firmly

gripped. When terminating one conductor into a terminal tunnel the conductor shall be doubled back to ensure positive connection is made. All terminating conductors shall be left with some slack cabling.

All conductors shall be insulated with 'neoprene' sleeving which shall be identified in accordance with IEE Table 51A.

3.5.9 INSULATED AND SHEATHED CABLES

Materials

LSF insulated and sheathed cables shall comply with BS 7211 having stranded copper conductors, XLPE insulation with an oversheath of LSF compound in accordance with BS 7655, rated at 300/500V.

Installation

Cables shall be run neatly and installed truly vertical, horizontal and shall not be installed closer than 150mm. to any other non-electrical service.

Cables shall be concealed within the fabric of the building, no surface installation being permitted.

All cables shall be installed in accordance with BS 7671 (IEE Wiring Regulations) Chapter 52. Within ceiling voids the cables shall be supported by a purpose made cable stirrup. The grouping of circuits in any cable stirrup shall not exceed the maximum indicated in the Distribution Board Schedules.

Where cables pass through walls, floors, ceilings, partitions, etc., the holes shall be made good with incombustible material to prevent the spread of fire. Where the walls, floors, etc. form a fire barrier, the cables shall be enclosed in steel sleeve (conduit or trunking) and the space left inside the sleeve shall be plugged with insulating material.

Where cables pass through steelwork, load bearing walls or floors, etc., the size and location of holes shall be agreed with the Structural Engineer.

At expansion joints in the building the cables shall be formed into a 100mm. long loop.

Where cables converge to enter distribution boards or other enclosures they shall be enclosed in steel cable trunking. The number of circuits contained within the trunking shall not exceed the maximum indicated in the Distribution Board Schedules.

Particular attention is drawn to the requirements of Regulations 522-06-04, 05 and 06 or 07 of BS 7671 (IEE Wiring Regulations).

The cable sheathing shall terminate inside the accessory.

A green/yellow PVC sleeve shall be fitted over bare protective conductors.

With this type of wiring system, where solid conductors are used on the smaller conductors, special care shall be taken when terminating conductors to ensure that all conductors are firmly gripped. When terminating one solid conductor into a terminal tunnel, the conductor shall be doubled back to ensure a positive connection is made.

All terminating conductors shall be left with some slack cabling.

3.5.10 FLEXIBLE CABLES AND CORDS

Materials

Flexible cables shall be to BS 6007. Flexible cords shall be to BS 6500 and BS 6141 and shall be suitable for the likely operating and ambient temperatures. Cords shall be colour identified as Table 51B of BS 7671 (IEE Wiring Regulations).

Flexible cables and cords shall have a minimum conductor cross-sectional area of 0.75 sq.mm be 300/500 volt grade and shall be circular construction with a white sheath unless otherwise stated.

Installation

Flexible cords shall be used only for final connection to equipment and not part of the fixed wiring installation.

Cables and cords shall be installed in such a manner that no mechanical stress is put on the conductor connections. The weight supported by a flexible cord shall not exceed the manufacturers' recommendations.

Connection to equipment shall be via either purpose made connection boxes with cord grip or via an approximately sized compression gland.

3.5.11 BUSBAR TRUNKING

Materials

Bus bar trunking shall be manufactured in accordance with BS EN 60439-2 and the IEE Regulations, for use on a 415 volt 3 phase 4 wire 50 hz supply.

The bus bar shall be manufactured from high conductivity copper.

The neutral conductor shall be full size unless otherwise detailed.

The whole assembly shall be manufactured to provide a minimum degree of protection to IP 23 as defined by BS EN 60947-1 or as otherwise detailed.

Installation

Where dimensions are critical, site measurements shall be taken prior to manufacture.

The bus bar system shall be complete with all necessary accessories, e.g. feeder units, tapping boxes, end plates bends, tees, brackets and fixings etc.

The bus bar trunking shall be supported in accordance with the manufacturers' recommendations.

Expansion joints and anchor points shall be provided as necessary to the manufacturers' recommendation.

Where the trunking run crosses building expansion joints purpose made expansion units shall be fitted.

Fire barriers shall be provided where bus bar trunking passes through a fire resisting element of the structure, to prevent spread of fire.

3.5.12 CONDUCTOR TERMINATIONS

Connections on all conductors shall only be made at accessory, switchgear or equipment positions. No other joints will be allowed.

Termination of conductors shall be carried out in strict accordance with the manufacturers' recommendations.

Care shall be taken when terminating conductors into accessories and equipment having clamping type terminal, to ensure a positive connection is made.

All conductors connected to bus bars and lug type connectors shall be terminated using compression lugs.

Compression lugs shall be selected to suit the conductor size only one conductor shall be terminated in each lug.

Compression lugs shall be crimped using a proprietary tool that cannot be released until the correct degree of compression has been achieved.

Compression lugs shall be securely fixed using an appropriately sized brass bolt, nut and locking washer.

All conduits shall be identified in accordance with IEE Regulations Table 51A.

3.6 LUMINAIRES AND LAMPS

3.6.1 LUMINAIRES

Materials

All luminaires shall be manufactured to BS 4533, Part 102 and BS EN 60598.

Luminaires shall be supplied complete with all accessories, fixings, etc. necessary to provide a complete installation.

Thermoplastic translucent diffusers for recessed luminaires shall have a TP(a) classification as defined in Part B of the Building Regulation.

Installation

All luminaires shall be rigidly supported on independent supports to the building structure unless otherwise detailed.

Final connection shall be via a heat resistant flexible cord terminated via a compression gland.

Recessed luminaires shall be connected to the fixed wiring installation via a plug-in ceiling rose, mounted adjacent the luminaire in a fully accessible position.

All luminaires shall be installed strictly in accordance with the manufacturers' recommendations.

3.6.2 CONTROL GEAR

Fluorescent luminaires shall be complete with control gear to BS EN 60928 and 60922 for electronic ballasts.

Discharge luminaires shall be complete with control gear to BS EN 60922 and BS EN 60923.

All fluorescent and discharge luminaires shall have a power factor of not less than 0.85 lagging. Capacitors to BS EN 61048 and 61049 and shall be fitted with a fused terminal block by the manufacturer suitably rated to BS EN 60127-2. Starters shall be BS EN 60926 and BS EN 60927.

E5.3 Lamp Holders

Lamp holders shall be manufactured to BS EN 60061 and BS EN 60838.

Edison screw lamp holders shall be to BS EN 60238

E5.4 Lamps

All luminaires shall be supplied complete with lamps complying with the following standards:

Fluorescent double capped:	BS EN 61195
Fluorescent single capped:	BS EN 60901 and BS EN 61199
Mercury vapour:	BS 3677
High pressure sodium vapour:	BS EN 60662
Low pressure sodium vapour:	BS EN 60192
Metal halide:	BS EN 61167
Tungsten filament:	BS 6179 : 1982
Tungsten halogen:	BS 1075 : 1989

3.6.3 LIGHTING COLUMNS

Materials

Lighting columns shall be manufactured to BS EN 40 and BS 5649.

Installation

Lighting columns shall be securely installed in accordance with the manufacturers' recommendations and shall be level and plumb.

3.6.4 LIGHTING TRACK

Lighting track shall be to BS EN 60570 and supplied complete with all necessary proprietary fixings and accessories.

3.6.5 EXTRA LOW VOLTAGE

All extra low voltage luminaires shall be fed via a safety isolating transformer to BS 3535 which shall be complete with overload and short circuit protection.

Multi-lamp transformers shall have voltage regulation to prevent over voltage on low load.

All underwater luminaires shall be fed via a separate transformer per luminaire or via a separate secondary winding on a multi-winding transformer.

3.7 ACCESSORIES

3.7.1 LIGHT SWITCHES

Light switches shall be manufactured to BS EN 60669-1 and shall be 15/20A rated unless indicated otherwise.

3.7.2 CEILING SWITCHES

Ceiling switches shall be to BS EN 6066-1 complete with pull cord, cut to the correct length.

3.7.3 CEILING ROSES

Ceiling roses shall be to BS 67 and shall be complete with adequate number and capacity of terminals.

Plug-in ceiling roses shall be to BS 6972 and BS 7001.

3.7.4 13A SOCKET OUTLETS

13A socket outlets shall be to BS 1363.

Switched socket outlets shall have double pole switches.

Where indicated, socket outlets shall be complete with neon indicators.

3.7.5 13A FUSED CONNECTION UNITS

13A fused connection units shall be to BS 5733 complete with a BS 1362 fuse of suitable rating for the equipment serviced.

Switched fused connection units shall have double pole switches.

Where indicated, fused connection units shall be provided with neon indicators and/or flex outlets.

3.7.6 DOUBLE POLE SWITCHES

Double pole switches shall be to BS EN 60669-1 and shall be either 20A or 45A rated as appropriate.

Double pole switches shall be provided with neon indicators and where required flex outlets.

3.7.7 COOKER CONTROL UNITS

Cooker control units shall be to BS 4177 and shall be complete with neon indicators.

3.7.8 13A PLUG TOPS

13A plug tops shall be to BS 1363 Part 1 1995 complete with cord grip and shrouded phase and

neutral pins.

3.7.9 DIMMERS

Wall mounted dimmers for tungsten filament lamps shall be to BS 60669-1 with radio interference suppression to BS 800.

3.7.10 TELEPHONE OUTLET PLATES

Telephone outlet plates shall be to BS 6312.

3.7.11 INDUSTRIAL PLUGS AND SOCKET OUTLETS

Industrial socket outlets shall be to and BS EN 60309 and shall be suitably rated for the voltage and current duty.

Sockets shall be provided complete with plugs and both shall be of the appropriate IP rating to BS EN 60529.

3.7.12 MOUNTING BOXES

All accessories shall be mounted on boxes to BS 4662.

Flush accessories shall be mounted on steel zinc electro-plated boxes with adjustable fixing lugs.

Surface mounted accessories shall be mounted on matching boxes provided by the accessory manufacturer.

All boxes shall be complete with a brass earth terminal.

A 2.5 sq.mm green/yellow earth lead shall be provided between the accessory and the box.

3.8 FIRE ALARM SYSTEMS

3.8.1 GENERAL

All fire alarm systems and equipment shall be installed in accordance with BS 5839.

3.8.2 CONTROL PANELS

Control and indicating panels shall be manufactured to BS 5839 : Part 4.

3.8.3 MANUAL CALL POINTS (MCP'S)

Manual call points shall comply with BS 5839 : Part 2 and shall be flush mounted on steel boxes. Where metallic sheathed cables are looped at MCP's earth continuity of the cable shall be maintained by installation of purpose made earth continuity links. MCP's shall be mounted at 1.4m above floor level.

3.8.4 SMOKE DETECTORS (SD'S)

Single Point Ionisation (SDI)

Ionisation type smoke detectors shall comply with BS 5445 : Part 7. They shall be surface mounted on a plug-in type mounting base. Cables shall be terminated in a mild steel BESA conduit box.

Attention is drawn to clause 25.4 and Appendix E of BS 5839 : Part 1 with respect to the installer's responsibility for compliance with any Statutory requirements for the storage, transport, use and disposal of radioactive materials and the manufacturers' advice should be sought in this respect.

Single Point Optical (SDO)

Optical type smoke detectors shall comply with BS 5445 : Part 7. They shall be surface mounted on a plug-in type mounting base. Cables shall be terminated in a mild steel BESA conduit box.

3.8.5 OPTICAL BEAM (SDB)

Optical beam smoke detectors shall comply with BS 5839 : Part 5.

3.8.6 DOMESTIC SMOKE DETECTORS (SDD)

Single point domestic smoke detectors and alarms shall be to BS 5446 Part 1 and shall be suitable for 220 Volt A.C. operation.

3.8.7 HEAT DETECTORS (HD'S)

Rate of Rise (HDR)

Rate of rise type heat detectors shall comply with BS 5445 : Part 5.

Fixed Temperature (HDF)

Fixed temperature type heat detectors shall comply with BS 5445 : Part 8, with an operating temperature of 60OC.

All heat detectors shall be mounted on a plug-in mounting base which shall be interchangeable with the smoke detector base. Cables shall terminate into a mild steel BESA conduit box.

3.8.8 REMOTE INDICATORS

Where required, automatic detectors shall be fitted with remote indicator lights. The indicator shall comprise a LED mounted on a single gang plate suitable for mounting on a standard one gang accessory box. Each indicator plate shall be engraved to indicate the location of the detector, i.e. "LIFT SHAFT", etc.

3.8.9 SOUNDERS

Sounders shall generally be mounted at 2.5 metres above floor level.

Sounders for external use shall be of the weather resistant type.

3.8.10 VISUAL ALARMS

Within areas where a high ambient noise level may be expected i.e. plantroom, a xenon flasher type visual alarm unit shall be installed on a mild steel BESA conduit box.

3.8.11 INSPECTION, TESTING AND COMMISSIONING

The whole of the installation shall be inspected, tested and commissioned in accordance with clause 26 of BS 5839 : Part 1 and as further described.

The fire alarm equipment manufacturer shall be employed to commission the system.

Commissioning shall be carried out in accordance with clause 26.5 of BS 5839 : Part 1, which shall include:

- a) An audibility test of the alarm devices. Audibility level readings shall be taken in each room using an instrument complying with BS EN 60651, type 2 with slow response and a weighting. Any sound pressure levels found to be lower than that required by clause 9.4.1 of BS 5839 : Part 1 shall be reported in writing to the Engineer.
- b) All trigger devices, i.e. manual call points, heat detectors and smoke detectors, shall be tested for correct operation.

- c) A mains failure test shall be carried out to verify the standby battery system complies with the requirements of this specification.

A certificate of installation and commissioning of the system, (see Appendix B and C of BS 5839 : Part 1) shall be provided to the Engineer. It should be noted that a Practical Completion Certificate will not be issued until this installation and commissioning certificate has been received, and the installation and commissioning certificate will not be accepted unless it is accompanied with the Record Drawings and User Manuals and the system Log Book (see Appendix D of BS 5839 : Part 1).

3.9 EARTHING AND BONDING

3.9.1 GENERAL

A full system of earthing and bonding shall be provided fully in accordance with BS 7671 (IEE Wiring Regulations), BS 7430 and the Regional Electricity Companies Regulations.

3.9.2 CONDUCTORS

All conductors shall be copper of the size and type as detailed on the drawings.

Conductors shall have green/yellow insulation throughout their entire length.

3.9.3 MAIN EARTH BAR

A main earth bar shall be provided adjacent the main LV switch panel.

The bar shall be a minimum of 300mm long, and formed from 50mm x 6mm hard drawn copper to BS 1433.

The main earth bar shall be wall mounted on insulators and shall be complete with disconnecter link between the main earth conductor and the bonding and conductors, as required by the IEE Wiring Regulations.

3.9.4 CLAMPS AND CONNECTIONS

All clamps and connections shall be made using proprietary accessories.

All conductors shall be terminated using crimp type cable sockets.

3.9.5 WARNING NOTICES

At the point of connection of every bonding conductor or to every earth electrode, a permanent label durably marked "Safety Electrical Connection - Do Not Remove", shall be fixed near to and visible from the connection.

The warning notice shall be no smaller than the example shown in the IEE Wiring Regulation.

3.9.6 EARTH ELECTRODES

Earth electrodes shall comprise steel core copper clad rods.

3.10 IDENTIFICATION

3.10.1 GENERAL

All electrical services shall be identified as required by BS 7671 (IEE Wiring Regulations).

3.10.2 LABELLING

Labels shall be manufactured from engraved thermosetting plastic laminate designed to BS 5378.

Labels shall be fixed using a minimum of two round headed screws either screwed into tapped holes or bolted through complete with washer nut and locking device.

Adhesive or self-tapping screws shall not be used.

Labels shall generally be black letters on a white background for information labels and white letters on a red background for warning labels.

Labels shall be provided for but not limited to:

Switchgear

All items of switchgear shall be labelled to indicate the function, protective device type and rating, outgoing and incoming cable sizes and types and details of equipment served.

Each outgoing way on main switch panels shall be provided with individual labels.

Distribution Boards

Distribution boards shall be labelled to indicate their function and reference.

Earthing System

The main earthing bars shall be labelled "Main Earth Bar". Each individual earthing or bonding conductor shall be labelled to indicate its function and size.

Isolator Switches

All isolator switches shall be labelled to indicate the function, equipment served and any circuit reference.

Ancillary Equipment

All ancillary equipment, e.g. junction boxes, contactors, control equipment, etc. shall be labelled to indicate their function.

3.10.3 ENGRAVING

All accessories, for which the function is not inherently apparent, shall be engraved to indicate their function.

Engraving shall generally be 6mm. high letters, coloured red.

3.10.4 NOTICES

All Statutory and other Regulatory notices shall be fitted, including:

- Warning notices
- Period inspection and test notices
- Electric shock notices
- Safety signs
- Emergency procedures
- Operational and Maintenance notices.

3.11 LIGHTNING PROTECTION SYSTEM

The complete lightning protection system shall be designed, supplied, installed and tested by a specialist member of ATLAS (Association of Technical Lightning & Access Specialists).

As part of the lightning protection system, the specialist installer shall allow to complete a full risk assessment in accordance with the requirements of BS EN 62305 Part 2.

The complete lightning protection system shall be designed, installed and tested in accordance with all relevant British Standards and associated Codes of Practice, specifically BS EN 62305, BS 7671 and BS 7430.

The lightning protection system shall be fully coordinated with the building Architecture and Structural components.

3.11.1 MATERIALS

All materials for use with the lightning protection installation shall be selected from BS EN 50164.

3.11.2 INSTALLATION

Air Termination Network

The air terminating network shall be provided either by surface mounted tapes, fixed to the structure with suitable clips or, subject to the agreement of the Architect and the Roofing Contractor, use of the roof sheeting profile. In the event of roof sheeting being used, a careful check must be made to ensure full continuity of the whole roofing structure and any metallic parts protruding past the roof line.

Earthing Mat

The earthing mat shall be formed by use of the reinforced concrete structure with PVC sheathed copper links using gunmetal clamps to provide, aided by reinforcement steel wiring, a continuous earth system across the full building dimensions.

Down Conductors

Down conductors shall be formed using structural steel reinforcement of the column with PVC sheathed copper interlinks bridging joints using gunmetal clamps. At the bottom of the column structural steel will be tied into the slab structure and a test point will be incorporated using a cast in four hole socket with cable connection within the column at points designated. At the top of each main column designated as a down conductor a further four hole socket shall be cast in to allow connection of the air termination network.

Test Points

Cast in flush sockets at a low level within the columns will provide a test and point of connection. Where indicated a facility will be provided to link with a reference earth rod, single 25 x 3mm PVC sheathed tape.

Bonds

All external exposed metalwork on the building must be effectively bonded to the lightning protection system including hand rails, rainwater goods, flashings etc.

A facility must be included for bonding from the general electrical earthing system, using an equipotential conductor.

Any metal services, e.g. pipework, cables, trunking and tray run within 2 metres of a down conductor must be securely cross-bonded to the lightning protection system at the nearest convenient point.

Corrosion

All possible measures must be taken to prevent corrosion due to electrolytic action during the installation. A suitable corrosion inhibitor may be used at all dissimilar metal joints or test points. Underground or cast in joints shall be wrapped with 'Denso' tape.

3.11.3 INSPECTION AND TESTING

On completion of the installation the whole of the system shall be inspected and tested by a qualified person.

Tests should be carried out to establish the resistance to earth of the earth termination network and each earth electrode. All joints and bonds shall be tested for continuity; the results shall be recorded and entered into a suitable log book.

3.11.4 RECORDS

The Contractor shall be responsible for obtaining information from the specialist installer to enable Record Drawings and User Manuals, as detailed elsewhere in this specification, to include the lightning protection system. This information produced shall comply with the requirements of BS EN 62305.

A label shall be attached adjacent to the main earth bar in the switchroom, worded as follows:

"This structure is provided with a lightning protection system that is in accordance with BS EN 62305 and the bonding to other services and the main equipotential bonding shall be maintained accordingly".

3.12 INSPECTION, TESTING AND COMMISSIONING

3.12.1 GENERAL

The whole of the works electrical installations works shall be inspected and tested in accordance with the latest edition of BS 7671 (IEE Wiring Regulations); including all appropriate Guidance Notes and On-Site Guides.

The safety procedures detailed in Guidance Note GS 38 'Electrical test equipment for use by Electricians' issued by the Health and Safety Executive should be observed.

The person or persons responsible for inspecting and testing the installation shall be fully trained and competent to carry out such duties. All electrical installation work shall be tested and certified by an NICEIC approved/certified Contractor.

All test equipment and instruments shall be provided correctly calibrated and certified for the limits of accuracy necessary which should be a minimum equivalent to Class 2 to BS 89.

3.12.2 INSPECTION AND TEST RECORDS

All inspection and test results shall be documented and included in the Operating and Maintenance Manuals.

Inspection records shall take the form of check lists based upon the IEE Wiring Regulations Guidance Notes.

Test results shall be recorded on the Test Record Sheet included in this specification.

Upon completion, a Completion and Inspection Certificate similar to the model in Appendix 6 of BS 7671 (IEE Wiring Regulations) shall be completed, signed and included in the Operating and Maintenance Manual.

3.12.3 COMMISSIONING

All systems shall be fully commissioned; where necessary commissioning companies shall be employed to carry out the function.

The commissioning shall comprise; the setting of the systems into their operational state and adjusting to obtain the required performance.

3.13 OPERATING AND MAINTENANCE MANUALS

3.13.1 DESCRIPTION AND SCOPE OF WORKS

The works under this section of the specification includes the supply to the Employer Operating and Maintenance Manuals for the installation. The Manuals shall be prepared by a specialist company and presented in both paper and electronic formats (Adobe Acrobat).

The manuals will be required to be handed over on or before practical completion of the works.

Draft copies of the manual shall be submitted to the Engineer for comment at least three weeks prior to practical completion.

The works shall not be deemed to be complete until satisfactory manuals, including all appropriate testing and commissioning data / certificates, have been provided to the Engineer.

To satisfy the provisions of the Health and Safety at Work Act the Engineer will not accept handover of the installations until full and adequate information concerning the installations is in the possession of the Employer.

3.13.2 CONTENTS OF OPERATING AND MAINTENANCE MANUAL

The format of the Manual shall be in accordance with the following sections, after a preface and index.

Section 1: Introduction, abbreviations, Health and Safety at Work Act and warning notices etc.

Section 2: A full non-technical description of each system together with the main plant components and locations.

Section 3: The complete plant technical data of each item of equipment, e.g. manufacturers' names and addresses, type and size of unit, serial number, order number, unit performance and protective device performance and duty details etc. This information shall be derived from a site inspection of identification plates together with information obtained from manufacturers.

Section 4: Shall describe in detail the operating procedures necessary for setting to work and powering down each individual system. This shall include the main switchgear, sub-distribution equipment, final circuits, specialist control panels starters and selection facilities, together with any alarm and safety interlocks all of which shall be derived from a site inspection.

Section 5: The maintenance operations on a daily, weekly, monthly etc. basis for each item of

plant. The preparation of this section shall be carried out by obtaining from the manufacturer his advice and recommendations for adjustment, tests and routine maintenance.

- Section 6: The emergency procedures to be adopted by personnel engaged on the operation and maintenance of the mechanical and electrical services, with respect to fire, first aid, general failures to the electrical systems, and call out procedures for maintenance personnel in working hours.
- Section 7: A recommended action on plant malfunction to assist both the user maintenance engineer in the event of a fault developing in a system by indicating the nature of the fault and recommended action.
- Section 8: A list of recommended spares and lubricants. The preparation of this section shall be carried out by obtaining the manufacturer's recommendations and also incorporating the Employer's requirements regarding spares.
- Section 9: A schedule of the record drawings together with reduced copies (A3 size) of the record drawings in numerical order. The reduced copies of the record drawings shall be printed on good quality paper identical to the paper used for the remainder of the Manual.
- Section 10: Test certificates and commissioning reports. Test certificates for equipment and installed works shall be supplied to the "Specialist Manual Supplier" by the Sub-Contractor.
- Section 11: A list of manufacturers including addresses and telephone numbers of equipment supplied. The list shall be in alphabetical order. The manufacturers' literature shall also be included and arranged in alphabetical order to match the manufacturers' list.

3.13.3 PREPARATION OF THE MANUAL

The Manuals shall be prepared within the contract and shall be particular to the electrical services of the contract.

The Manual shall be arranged with an index and referencing system.

The paper to be used in the final issue of the Manual shall be good quality high white 100g/m² and the reproduction method shall be dry photocopy. The material of the manufacturers' literature shall be as supplied by the manufacturers and the number of sets shall be in accordance with the number of Manuals required.

The covers shall be hard bound with four post loose leaf system. The contract details shall be embossed on the front cover. A matching flysheet shall give the names and addresses of the

principals involved on the contract and agreed with the Engineer.

Numbered card dividers shall be inserted between sections.

3.14 RECORD DRAWINGS

3.14.1 DESCRIPTION AND SCOPE OF WORKS

The works under this section of the specification shall include the preparation and supply to the Engineer of two full sets of bound Record Drawings and an electronic copy suitable for reading with the latest version of AutoCAD.

Record Drawings shall depict the building and services installations at the date of practical completion. All drawings shall be as defined in BSRIA application guides, specifically 'Handover, O&M manuals and Project Feedback'.

3.14.2 CONTENTS OF THE DRAWINGS

The drawings shall be provided in sets to indicate the following:-

1st set of Drawings: Main schematics and detail wiring diagrams indicating length, size and type of cables, earth loop impedances at all parts of the distribution system, fault levels at the main switchpanel and each distribution board.

2nd set of Drawings: Floor layouts clearly indicating the location of all electrical plant and equipment (including luminaires and their reference), wiring routes, protective bonding points, etc.

3rd set of Drawings: Detailed layouts (scale 1:20) of switchrooms, electrical risers and plant rooms indicating clearly the location of all electrical plant and equipment, wiring routes, protective bonding joints, etc.

3.14.3 PREPARATION OF THE DRAWINGS

The drawings shall be particular to the electrical services of the contract and provide a clear and precise record of all the systems and components installed. Prepare electrical drawings in accordance with BS EN 61082.

The drawings shall use a scale not less than that of the installation drawings. The drawings should not be dimensioned unless the inclusion of a dimension is considered necessary for location or access.

A draft set of the drawings shall be issued for approval if practically possible prior to Practical Completion or within 2 weeks of this date.

The paper to be used in the final issue shall be good quality high white 100g/m².

Each drawing shall be folded and inserted into a plastic wallet which shall be bound into a separate

manual compatible to the Operating and Maintenance Manual. The cover shall be hard bound with a four post loose leaf system. The contract details shall be embossed on the front cover. A preface and index shall be provided giving details of the drawings.