CONTENTS

GENERAL TECHNICAL SPECIFICATION
ELECTRICAL ENGINEERING SERVICES

1 REQUIREMENTS

All electrical installation works shall be designed, selected and erected in compliance with BS 7671: (2008) *Requirements for Electrical Installations* (including All Amendments plus any further amendments that may arise before or during the course of the Contract works.

Fire safety shall comply with BS5389, emergency lighting comply with BS5266.

Particular attention is drawn to the following which lists relevant statutory instruments, regulations and codes of practice. The list is not exhaustive and any omissions from the list shall not exonerate the Contractor from his responsibilities under his duty of care.

1. The Electricity at Work Regulations 1989.
2. The Electricity Supply Regulations 1988 & (Amendment) Regulations 1992.
3. The Construction, Design & Management Regulations 2007.
4. The Health & Safety at Work Act 1974.
5. The Management of Health & Safety Works Regulations 1999.
6. The Workplace (Health, Safety and Welfare) Regulations 1992.
7. The Health & Safety (Display Screen Equipment) Regulations 1992.
8. The Health and Safety (First-Aid) Regulations 1981.
9. The Safety Representative and Safety Committees Regulations 1977.
10. The Health and Safety Information for Employees Regulations 1977.
11. The Control of Asbestos at Work Regulations 1987, amended 1992, 2002 and 2006.
12. The Control of Substances Hazardous to Health Regulations 2002 (Updated 2003 & 2004).
13. The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995.
14. Building Regulations.
15. The Chartered Institution of Building Services Engineers (CIBSE) Recommendations.
16. The relevant Codes of Practice and British Standard Specifications as published by the British Standards Institution.
17. The Factories Act 1961.
18. The Offices, Shops and Railways Premises Act 1963.

19. The Manual Handling Operations Regulations 1992.
20. The Lifting operations and lifting equipment regulations 1998.
21. The Personal Protective Equipment at Work Regulations 2002.
22. The Provision and Use of Work Equipment Regulations 1998.
23. The Noise at Work Regulations 1989.
24. The Fire Precautions Act 1971.
25. The Fire Officers Committee Regulations and the Local Fire Officers requirements.
26. Local Bye Laws and the regulations and requirements of other Authorities.
27. The Gas Safety (Installation and Use) Regulations 1998.
28. The Highly Flammable Liquids & Liquefied Petroleum Gases Regulations 1972.
29. Signpost to The Health and Safety (Safety Signs and Signals) Regulations 1996
30. The Abrasive Wheels Regulations 1970.
31. Trade Association Recommendations, such as - Heating Ventilation Contractors Association Recommendations.
32. Water Regulations.
33. Water Fittings and Materials Directory.
34. Employers Site Access and Security Regulations.

The Contractor shall comply with :

- All Standards referred to within this Specification.
- CIBSE Publications.
- Fire Prevention on Construction Sites - Fire & Safety in Section 20 Building.
- The Construction/General Provisions (Lifting Operations) (Working Places) Health & Welfare Regulations.
- Regulations under the Electricity Acts.

All works shall be installed to facilitate ease of inspection, testing and maintenance.

The Contractor shall be responsible for the co-ordination of the electrical services with those of the Supply Authority.

The Contractor shall make good at no extra cost to the Contract any part of the works that has not been carried out to the full satisfaction of the Engineer.

Where these requirements cannot be met, the Contractor shall refer to the Engineer before starting that section of the works.

Temporary electrical installations shall comply in all respects with BS 7671 and all relevant codes of practice. Under no circumstances shall temporary electrical installations be allowed to compromise health and safety.

2 LV SWITCH PANEL AND SWITCHGEAR

1. Shall be ASTA-BEAD certified.
2. The switch panel shall comply with BS EN 60439-1 and in particular Form 4 b.) / Type 6 as a minimum.
3. The external enclosure shall be ventilated and have a minimum ingress protection rating of BS EN 60529:1992 / IP31.
4. The switch panel frame, enclosures cladding and access panels shall be manufactured from corrosion resistant steel of sufficient gauge so as to produce a rigid, sturdy and durable construction. Panels and members that will easily and significantly deflect or dent shall not be acceptable.
5. All the frame work and enclosure plates shall be finished with epoxy polyester low bake powder coating to a RAL colour to be decided after the contract is awarded.
6. Ample and suitable brass or aluminium (non-ferrous) cable glanding plates shall be provided at the top of each cubicle for the respective incoming and outgoing cables. These glanding plates shall each be earth bonded to the switch panel earth bar.
7. The switch panel shall be provided with a continuous (bolted) earth bar linking all cubicles to provide convenient and suitable earth connections for all incoming and outgoing cables plus the switch panel components. The earth bar shall be made of hard drawn copper and sized to comfortably accept up to 95 mm^2 csa cable terminations and have a minimum csa of 190 mm^2.
8. Air circuit breaker shall comply with BS EN 60947-3.
9. Incomer and bus-coupler devices shall be air circuit breakers to comply with BS EN 60947-2 and have a breaking capacity of 65 kA minimum plus short time withstand current of 65 kA for 1 second.
10. The air circuit breaker shall be provided with adjustable electronic trip units to give variable trip curve settings to for flexibility with discrimination and protection settings.
11. Air circuit breakers shall be 4 pole switching type with a minimum of 4 no. auxiliary volt-free change-over switch contacts and shall have a trip free mechanism with positive contact indication.
12. Air circuit breakers shall be mounted upon draw out carriages and have pad lockable shields over the mains and control sockets.
13. Air circuit breakers shall have pad lockable racking mechanisms with service, test, isolated and fully withdrawn positions.

14. Air circuit breakers shall have manually charged closing springs with options for fitting a motor charging mechanism.
15. Air circuit breakers should have mechanical life expectancy of 20,000 cycles.
16. Air circuit breakers shall have on and off push buttons mounted on the front fascia and these must have padlocking mechanisms to prevent unauthorised operation.
17. A compartment shall be provided within the switch panel with front opening hinged and lockable door for the secure storage of switch panel documentation, tools and spare fuses.

3 DISTRIBUTION BOARD

1. The distribution boards shall each be provided with an integral switch-disconnector on the main incomer arranged to break all three phase poles for a 3 phase type, and both phase and neutral poles for a single phase type. The switch-disconnectors shall comply with BS EN 60439-3 and have the facility to padlock the operating handle in the open position.
2. The distribution boards shall comply with BS EN 60439-2.
3. The external enclosure shall be ventilated and a minimum ingress protection rating IP31 to comply BS EN 60529:1992.
4. The distribution board frames, enclosures cladding and access panels shall be manufactured from corrosion resistant steel of sufficient gauge so as to produce a rigid, sturdy and durable construction. Panels, door panels and other members that will easily and significantly deflect or dent shall not be acceptable.
5. All the frame work and enclosure plates shall be finished with epoxy polyester low bake powder coating as per the manufacturers standard range.
6. Access for cabling and maintenance shall be arranged to be at the front of the distribution board.
7. Both incoming and outgoing cables shall be arranged to enter at the bottom and top of the distribution boards. Removable glanding plates shall be provided top and bottom for this purpose.
8. All final circuit conductors terminated at distribution boards shall be neatly arranged in the correctly numbered terminals plus each cable shall be fitted with numbered slip on nylon ferrules to identify the circuit to which it belongs.
9. Each distribution board shall be provided with a printed, detailed circuit chart to identify all the circuits, the protective devices and cable details. The circuit chart shall be laminated and framed then fixed with wall plugs and screws to the wall adjacent the distribution board.

10. All switchgears, Distribution Boards (DB's) and Consumer Units (CU's) shall be of the sizes, types and grades as detailed in the Specification of Work and on the Drawings.
11. All Distribution Boards (DB's) and Consumer Unit (CU's) shall comply with BS EN 60439-3:1991 as appropriate with a degree of protection not less than IP3X.
12. The busbars shall be arranged so that the protective devices can be arranged in a neat symmetrical appearance.
13. A main isolating switch shall be fitted and shrouding shall be provided to ensure no contact can be made with live parts when withdrawing protective devices.
14. Assemblies of switchgears and protective devices shall generally be arranged as described and to give a neat and pleasing arrangement.
15. Switchgear and DB's shall be complete with "Traffolyte" labels conforming to the description give on the distribution diagram.
16. Each distribution board shall be complete with a chart protected by transparent plastic and fixed securely to the inside of the lid indicating the details of each circuit controlled by the board.
17. Where the installation is concealed, DB's shall be mounted over recessed adaptable boxes of adequate size arranged flush with the wall surface. The back of the DB's shall be cut to allow cable entry. The aperture shall be swaged to avoid rough edges.
18. The DB's shall be fixed to the flush boxes by suitable screws and to the wall by supports ample to carry the weight of the boards. Separate earth connection of not less than 6 sq. mm earthing cable shall be taken from the DB's to the flush adaptable box.
19. Brass neutral and earth bars shall be provided within the distribution boards with a terminal on each bar for each outgoing circuit to correspond with the phase connections.
20. Each way shall be identified by numbering including the neutral and earth bars.
21. Switches, section and distribution boards shall be interconnected neatly by cable trunking where necessary and where multiple units are installed.
22. All DB's shall bear coloured phase discs indicating the phase to which each bank of fuses is connected and shall be complete with phase barriers and covers.
23. Assemblies of fuse switches and switchgear generally shall be arranged as described in the Specification and each shall bear "Traffolyte" labels affixed as previously described for DB's indicating the reference letter of the schematic arrangement of distribution and a brief description of its purpose.
24. All assemblies of switchgear, switches and distribution boards shall be bonded to each other and to the main terminal by means of earth bonding leads.

25. All DB's and CU's, shall be supplied with spare ways, generally 25% of total capacity of each size and type.

4 PROTECTIVE DEVICES

1. Semi-enclosed fuses shall not be used.
2. Fuses shall comply with BS 88.
3. Miniature Circuit Breakers (MCBs) shall comply with BS EN 60898, type A, B, C or D depending on the services.
4. Residual current operated circuit-breakers without integral overcurrent protection (RCCBs) shall comply with BS EN 61008.
5. Residual current operated circuit-breakers with integral overcurrent protection (RCBO's) shall comply with BS EN 61009.
6. The protective devices shall be complete with suitable voltage and ratings selected in accordance with the size of sub-circuit wiring in accordance with the IEE Wiring Regulations.
7. The type of protective devices shall be in accordance with the instantaneous tripping current, category of duty and frequency to comply with IEE Wiring Regulations.
8. Protective devices shall be selected from a single manufacturer and range throughout and have a fault withstand capacity suitable for the expected fault levels at the point of installation.
9. All HRC fuses shall comply with BS88 Part 2. Where specified, all switchgear and DB's shall be fitted with fuse carriers and bridges designed to accept high rupturing capacity fuse links of the appropriate rating and category of duty as otherwise specified.

5 MAIN EARTHING

Earthing and main equipotential earth bonding shall comply with the following:

1. BS 7430:1998 Code of Practice for Earthing.
2. BS 7671: 2008 Requirements for Electrical Installations.
3. BS EN 62305 Code of Practice for Protection of Structures Against Lightning.
4. Earthing and bonding conductors shall be 600 / 1000 volt grade single core stranded copper conductors to comply with BS 5467 and BS 7211 and insulated with XLPE, low smoke and fume. The cable sheath colour shall be green and yellow stripped.
5. The earthing conductor from the LV Distribution earth bar to the main LV switch panel shall comprise two 95 mm^2 csa cables connected respectively to the essential and non-essential panel sections.

6. Main equipotential earth bonding cables shall be 50 mm^2 csa cables bonded to the respective main service metallic pipe work or frames and connected back to the LV Distribution earth bar in the LV Switch Room.
7. A single cable shall not be connected to more than one earth bond.
8. The Contractor will install a suitably sized earth copper bar, protected against corrosion for the termination of all main earth leads and main bonding cables including, where specified, earth tapes used for the earthing of the main cubicle panels and lightning protection schemes.
9. The earth bar fixings shall be suitably spaced off the building fabric and be complete with a removable link for testing purposes.
10. The incoming supply authority's earth lead either from the incoming cable sheath or service head shall be connected to the main earth bar so as to allow this earth lead to be isolated when the link is removed.
11. A label engraved "Main Earthing Terminal" will be located adjacent to the earth bars.
12. Where the supply authorities services is existing and the main earth connection is obtained from the cable sheath. The Contractor shall ensure that the cable sheath is connected to the consumers main earth bar by means of thermosetting insulated cable. The size of the cable shall be dependant on the size of the supply authorities service head.
13. Main earth bonds to steel pipe work shall be by means of a welded steel M8 threaded studs or an approved earth bond pipe clamp, as appropriate.
14. For all connections to the LV Distribution Earth Bar (which shall be a 50 mm x 6 mm thick hard drawn copper type), the Contractor shall allow to drill the correct sized hole for each. The cable ends shall be terminated with crimp on lugs with minimum M8 bolt hole.
15. All terminations at the earth bars and main equipotential earth bonds shall be made with appropriately sized brass nuts, bolts and shake proof washers.
16. All the cables connecting to the LV Distribution Earth Bar shall have an engraved disc attached to identify as “Earthing” or “Main Earth Bond”, the service or system, and the cross sectional area of the conductor.
17. All earth cables shall be run either cleated to cable trays or fixed to walls or steel work when run singly.
18. The following services shall be bonded to the main earthing terminal by means of crimped lugs, nuts and bolts and labelled to denote size and destination:
    a) Incoming gas service
    b) Incoming water service
    c) Rising mains - hot and cold services
    d) Fire hydrant services or dry riser
    e) Lightning protection down conductors

f) Intake room switchgear/panels and other earth bars

6 EARTH ELECTRODE

1. The type of earth electrode used shall be appropriate to the soil type into which the electrode is placed.
2. Generally in clay type soils copper or copper clad steel rods shall be driven vertically to a minimum depth of 3 metres.
3. Soil containing chalk, limestone or rock sub-soil it may be necessary to lay a copper tape or cast iron/copper plates.
4. The earthing conductor shall not be less than 25 mm x 3 mm annealed copper strip.
5. Joints shall be made using an approved process or bolted, riveted or clamped. The Contractor shall ensure that copper jointing surfaces are twined.
6. Copper connections to iron earth plates shall be bolted and brazed with all bolts, rivets and clamps made of brass, bronze or similar non-ferrous material.
7. Joints and electrode connection shall be readily accessible and enclosed within purpose made inspection pits. Where access is not possible these joints shall be protected against moisture ingress.
8. Tapes shall be of soft high conductivity copper, tinned unless otherwise indicated and where fixed and liable to corrosion they shall be served with corrosion resisting tape or coated with corrosion resisting sheath. Where the tapes are run in the ground they shall be laid in sand and protected with tiles.
9. A removable test link shall be provided inside the building as near as possible to each earth electrode for isolation of the earth electrode for testing purposes.
10. The Contractor shall obtain test readings of the earth electrode in dry weather conditions and submit the results to the Engineer.
11. Where copper tape is fixed to the building structure it shall be by means of purpose made corrosion resistant saddles. Fixings shall be made using purpose made plugs and clamps and installed at intervals not exceeding 1.0 m.
12. All fixings shall be suitably corrosion resistant.

7 EARTH BONDING

1. Earthing shall be carried out to conform with the requirements of BS 7430:1991 and the IEE Regulations BS7671 latest Edition.

2. Earthing of distribution equipment, cables, sheaths, metal cladding on pipework and flues, metal conduits, trunking and accessories and all items of electrical equipment, plant accessories, BESA boxes, switch plates, socket outlets, etc., which are wholly or in part encased in metal.

3. All incoming services shall be effectively bonded to earth.

4. The whole of the metallic portion of the installation (other than current carrying parts) shall be electrically and mechanically bonded to the main earth point or points specified and shall comply with the IEE Wiring Regulations for Electrical Installations, in particular Part 5.

5. All items of electrical plant and equipment must be earthed with an earth continuity conductor of size not less than the minimum prescribed in the above mentioned Regulations.

6. All non-live metalwork associated with the electrical installation must be earthed. An earthing terminal must be provided in each outlet box and switch box.

7. Each final circuit protective conductor/main earth bonding conductor shall be connected to a multi-way earth terminal block supplied and fixed within the distribution gear.

8. The Contractor shall supply, erect and connect a cable link between the earth terminal block and the main earth point, using a thermosetting insulated cable coloured green/yellow or copper tape of adequate size and rating.

9. All earthing cables shall be properly fixed, cleaned and clipped to the building structure in an approved manner along selected routes.

10. The Contractor shall include for the supply and installation of all necessary approved earth clamps, cables and connections.

11. The Contractor shall allow in his tender for compliance with the IEE Wiring Regulations for Electrical Installations Part 4 with particular reference to Section 412 and Section 413 Clauses 413 02.27 and 413 02.28 and also Section 601. It must be pointed out that any claim for extra costs in relation to Part 4 of the above regulations will not be accepted.

12. Where lengths of flexible metallic conduit connect to machines or other equipment, the earth continuity of the conduit shall be supplemented by an internal earth cable in accordance with the requirements of Chapter 54 of the IEE Wiring Regulations for Electrical Installations with tinned copper conductor, connected between the rigid conduit and the earth terminal on the equipment. The conductor shall be green/yellow thermosetting insulated.

13. The whole of the electrical installation and all other equipment connected therefore will be earthed in conformity with the I.E.E. Regulations and to the requirements of the Supply Authority.

14. The complete trunking, tray, conduit and accommodation systems including the sheaths of all M.I.C.C. cables will be electrically continuous and connected securely to all conduit boxes, switchgear and

distribution boards and other electrical apparatus forming part of the installation.

15. The armouring and metal sheathing of all armoured/screened cables shall be solidly bonded together and finally connected to the panels serving the cables.

16. The earthing continuity of the metal sheath of each sheathed cable shall be maintained by efficient bonding of the main switch, switch fuses, distribution boards or other metal clad accessories or appliances at which the cable terminates.

17. If there is more than one entry of any of the above services into each building, or each separate dwelling forming part of a building, then each entry must be bonded.

18. The earth bonding connection will be made as near as practicable to the point of entry, except in the case of the gas service where the connection shall be on the consumers side of the meter, and must in all cases be in such a position that it shall be easily accessible for inspection.

19. The earth bonding lead shall be thermosetting insulated cable coloured green/yellow and enclosed in either PVC or H.G. steel conduit installed as indicated on the Drawings and Specific Specification. This cable must be of continuous length of minimum size in accordance with the relevant I.E.E Tables and the Supply Authority's requirements for PME (protective multiple earthing).

20. All switchgear and sub-distribution panels will be bonded to earth as previously described.

21. Bonding clamps complying with BS 951 complete with a permanent label indelibly marked with the words "SAFETY ELECTRICAL EARTH - DO NOT REMOVE", used throughout the bonding installation.

22. The earthing terminal of each outlet position will be connected to the earthing terminal within the accessory box mounted thereon with a short fly with a cross sectional area equal to the circuit served circuit protective conductor.

23. At distribution boards the Contractor shall ensure C.P.C.s are terminated to the correct earthing terminal corresponding to the phase and neutral connections.

24. Where flat PVC insulated PVC sheathed wiring systems are installed the C.P.C. will terminate directly into the outlet point with a short fly lead between the outlet and accessory box.

25. When PME (protective multiple earthing) conditions apply, the Contractor shall consult the Electricity Board to determine any special requirements and shall include in his tender for the costs of any such requirements.

26. If the Electricity Board's earthing Terminal is not available then the main earth point shall be derived from Earth Electrodes of sufficient number and size to give the requisite resistance as laid down in Code of Practice on Earthing. The connection point of the bonding bar/strip and the

earth electrode shall take the form of a suitably protected and labelled link to afford ease of testing. In addition when earth electrodes are utilised, if not specifically stated otherwise in subsequent sections of the Specification the installation shall be protected by a Residual Current Device.

27. A separate insulated, earth continuity conductor of adequate size for the duty shall be installed in all non-metallic trunking/conduits.

8 XPLE INSULATED & ARMOURED CABLES

1. XLPE insulated power cables shall be manufactured and approved by BASEC, for voltages up to 3.3 Kv, to comply with BS5467 and to BS6724 where conductors are copper and cables armour has an overall sheath of LSF (low smoke and fume) insulator.
2. XLPE insulated power cables rated between 3.8 kV and 22 kV shall be manufactured to and be certified and comply with IEC502.
3. XLPE and thermosetting insulated cables shall be terminated at the apparatus by means of armour lock glands.
4. Where aluminium conductors are to be connected into the tunnel type terminals, the swage term system of termination shall be used in accordance with the manufacturer's recommendation.
5. Where bolted connections are to be used, standard compression terminals shall be affixed.
6. The armouring of the cable at both ends shall be bonded to the earth terminal of the switchgear or equipment to which it is connected. A proper earth bonding clamp shall be used for this purpose and NOT the armour clamp.

9 PVC INSULATED & ARMOURED CABLES

1. Where PVC cables are specified within the specific section of this Specification and/or indicated on the accompanying Tender Drawings. This will mean thermosetting insulated and sheathed steel wired armoured cables comply with BS 6724 and BS 7211 LSF cables.
2. All cables are to be of the 600/1000 volts grade, unless otherwise specified, and will comply with the requirements of BS 6724 for copper cables.
3. The conductors will be of high conductivity copper wire unless specified otherwise.
4. Cores shall be identified as follows:-
5. Twin core cable One core brown and one core blue
6. Three core cable One core brown, black and grey

7. Four core cable One brown, black, grey and blue

8. All cables shall be installed in one length without intermediate joints. The minimum installation temperature is 0°C. If cables are being installed during sub-zero temperature conditions, they should be stored at a temperature above freezing point for at least 24 hours immediately prior to handling.

9. Each cable shall be marked at both ends with white ivorene or traffolyte engraved labels denoting cable size.

10. The ends of all cables shall be terminated by means of compression type glands complete with earth terminating rings and PVC shrouds. These glands shall be of the same manufacture as the cable.

11. The earth terminating rings will be securely bolted to the electrical apparatus with the use of brass round headed screws and nuts complying with their respective British Standards. Within the electrical apparatus an earth fly lead will extend from the earth ring with the use of crimp lugs and terminate within the earth terminal of the apparatus.

12. Cables shall be installed throughout with the greatest possible care and any damage caused to the cable during installation or the progress of the work will necessitate the rejection of the cable and the replacement and re-erection of a corresponding new length by the Contractor free of charge.

13. Where cables are to be run on the surface they shall be supported by means of claw type cleats, as manufactured by BICC Ltd, or equal and approved, and the spacing of the supports must not be greater than those given in the following Tables:

OVERALL DIAMETER OF CABLE	MAXIMUM SPACING OF CLIPS FOR ARMOURED CABLES	
	HORIZONTAL	VERTICAL
From 10 mm to 15 mm	350 mm	450 mm
From 16 mm to 20 mm	400 mm	550 mm
From 21 mm to 40 mm	450 mm	600 mm
Over 40 mm	Refer to the cable manufacturers instructions recommendations	

14. Where the cables pass through walls or floors of fire zones the holes shall be filled with fire resisting infill after the installation of the cables.

15. Each cable shall be protected from mechanical damage to a height of 2 m above floor level, where run on the surface of walls.

16. Where cable access to buildings is required the cables shall be run in short lengths of glazed earthenware, PVC or asbestos fibre cable ducts to ensure that the cables are not damaged when drawn into the duct. The entry point is sealed to prevent ingress of moisture and vermin.

17. The Contractor will allow for all abnormal brackets required for cradle support on site. The Contractor will also allow for drilling of installed steelwork to take the studs for the cleats.

18. Cables will not be bent during installation to a radius smaller than eight times the overall cable diameter.

19. Cables will be segregated from the finished face of other services by a minimum distance of 75 mm, unless as instructed by the Engineer.

20. Cables laid directly in the ground will be installed to a depth of not less than 460 mm below finished ground level.

21. In normal soil the cable will be laid on 75 mm of sand and covered with a minimum of 75 mm of sand and taped over its entire length underground. The Contractor must include for supplying and laying of the same and "Heptape" protection tape, the latter to be laid at a depth of 300 mm below ground level. The "Heptape" shall have the following words printed thereon: "CAUTION. ELECTRIC CABLES BELOW"

22. Heptape is available from Hepworth Iron Co. Ltd, Hazel Road, Stockbridge, Sheffield. Before the cable is finally covered The Engineer will be invited to inspect the cable along its entire length.

23. Where cables are to be run under paths, paved roadways or enter buildings, they will be drawn into earthenware ducts which shall be provided and laid by the Contractor to a depth of not less than 600 mm, below finished ground level. All duct terminations in buildings will be made with the use of manufactured easi-bends.

24. Cables shall also be protected by earthenware ducts where they cross the route of the other services, to a minimum of 450 mm each side of the crossing points.

25. Purpose made concrete cable markers laid flush with the finished surface will be supplied and installed by the Contractor to indicate cable routes.

26. The use of underground cable joints will only be permitted by written instruction by The Engineer or specifically called for within the specific section of this Specification and/or Tender Drawings.

27. All underground cable joints shall be made by a proficient cable jointer using cast iron, joint boxes and suitable resin compound to the strict recommendations of the cable manufacturer.

10 MICC CABLES

1. Where M.I.C.C.. cables are specified within this Specification and/or on the accompanying Tender Drawings, this will mean mineral insulated copper sheathed cables manufactured in accordance with BS 6207 and BS EN 60702 and all relevant later amendments.

2. Generally cables will be light duty, rated at 600V, and may be used for fire alarms, general lighting and small power circuits. Heavy duty cables, rated at 1000V, will be used for all other services.

3. Cable terminations will comply with the requirements of BS EN 60702 and comprise ring type glands, screw on pot type seals, cold plastic compound suitably for temperatures up to 105°C, anchoring bends and neoprene sleeving. The Contractor will terminate M.I.C.C.. cables in an approved manner and procedure recommended by the cable manufacturer.

4. All seals and lengths of M.I.C.C. cable shall be tested not less than 24 hours after completion with a Megger insulation test at a pressure not less than 500 volts. Nothing less than an infinity reading must be obtained between any conductors and the cable sheath, all conductors being disconnected from any apparatus. All M.I.C.C. cables requiring to be "covered up" shall be tested before and after "covering up".

5. The specified tools recommended by the manufacturer will be used throughout the installation.

6. Low insulation resistance readings due to faulty cable termination procedures will be rectified by the Contractor at his/her cost.

7. Before proceeding with the installation of MICC cables the Contractor may be required to demonstrate to The Engineer the ability on their site personnel to apply a complete termination to one end of an installed cable.

8. All conductor tails will be marked with coloured sleeves of' an approved pattern to identify the conductors.

9. The colours used will be in accordance with the recommendations of the latest Edition of the I.E.E. Regulations.

10. Sub-main cable conductors will be marked with coloured sleeves indicating the colour phase they originate from.

11. All M.I.C.C. cables will be securely fixed by single or multiple heavy gauge saddles to the surfaces of the walls, ceilings, ducts, etc., by 25 mm No. 6 round head brass screws.

12. Where several cables are installed together multiple saddles shall be used only.

13. Where cables are to be supported onto a perforated cable tray the fixing screws will be round head brass to comply with BS 450 and the securing nuts will be of the brass square pressed type complying with BS 2827.

14. The spacing of saddles or clips will not exceed the distances indicated below:

    a) Cables up to 9 mm overall diameter single or multi-bank: 230 mm

    b) Cables of over 9 mm diameter up to 12 mm overall diameter, single or multi-bank: 300 mm

c) Cables of 12 mm overall diameter and greater, single or multi-bank: 375 mm

d) Multi-bank saddles containing cables of various sizes, will be directed on site by The Engineer but on no account will they exceed: 375 mm

15. Cable bends will not be less than six times the diameter of the cable. At terminations, there will be at least 75 mm of straight cable at the gland position.

16. Where surface cables rise through floors to serve an accessory point, the cable will be protected through the floor up to a height of 2 m above f.f.l. with heavy gauge galvanised conduit. The space between the cables and conduit in each instance will be filled with cold setting mastic compound.

17. Where cables pass through any structure, ego walls and floors, these cables will be protected by heavy gauge galvanised conduit provided with female brass bushes at either end of the conduit.

18. M.I.C.C. cables provided with a PVC outer sheath will be provided to the following exposed corrosive atmospheres:-

a) Damp situations, ie. externally run cables.

b) Boiler houses/plant rooms.

c) Service ducts.

d) Embedded within plaster or floor screeds.

e) Secured to cable trays.

f) In areas specifically specified within the specific section of this Specification and

g) Contract Drawings.

19. Where PVC sheathed cables are installed a PVC shroud will also be employed.

20. All cables will terminate directly into main switches, BS Besa boxes, socket outlet boxes and fixed apparatus only.

21. No joints will be allowed in joint boxes, nor will any through joints be allowed, unless as specifically instructed by the Engineer.

22. Where M.I.C.C. cables terminate directly into luminaires or BS Besa boxes to which luminaires will be directly attached, high temperature sleeving will be used to protect the conductors.

23. Where M.I.C.C. cables terminate within accessory boxes in damp situations the boxes will be of the watertight pattern with tapped thread entries, external fixing lugs and machine faced lids. The lids will be rendered watertight by means of waterproof jointing compound or rubber gaskets. In no circumstances will it be permissible to drill boxes internally for fixings.

24. Where surface mounted run M.I.C.C. cables terminate within a plain hole accessory box, ie. switch, socket outlet or distribution board, etc.,

the cable will terminate with the use of internally threaded space ranger glands provided with brass locknuts and zinc plated lockwashers (where applicable).

25. M.I.C.C. cables terminating direct to apparatus which will be subject to vibration or which is adjustable, Le. motors or pumps will be formed into a double turn loop coil immediately prior to the termination.

26. Where M.I.C.C. terminates within PVC accessory boxes suitable earth tail pots or earthing rings shall be used to ensure earth continuity.

11 INSTALLATION OF POWER CABLES

1. Cables shall generally be installed along the routes indicated and shall be installed in accordance with good practice as laid down by the cable manufacturers.

2. Cables shall not be run out or installed when temperatures are 0 degree or below.

3. Minimum bending radii, as indicated in the IEE Regulations shall be strictly observed.

4. Single core cables shall be run in trefoil formation. Where this formation is abandoned below the switchgear, the lead sheaths shall be exposed bonded together with a copper bond wiped on to the cable sheaths and earthed at this point only.

5. Where three phase cables are specified then a separate 600 / 1000 volt grade single core LSF cable shall be run with the supply cable and used as the circuit protective conductor. The selected conductor cross sectional area shall equal at least half that of the associated phase conductor and be a minimum of 25 mm^2.

6. Where cables are installed in service ducts or on wall surfaces, they shall be adequately supported on approved cable hangers, or cleats at spacing not greater than 60mm. The cable hangers shall be designed to give support without damage to the cable.

7. Low voltage cables laid in trenches shall be laid to a minimum depth of 600mm blinded with sand to a radial thickness of 100mm covered and protected by interlocking cables tiles 75mm clear and projecting 75mm beyond outer cables in the trench. The tiles shall be covered by 300mm of hand placed selected backfill well compacted. A continuous strip of plastic marker tape shall be run above this layer so as to adequately cover the cables. The tapes shall be run above this layer so as to adequately cover the cables. The tape shall be deemed to have been included in the Tender costs, whenever cables are used in such circumstances. Cutting of excavations blinding with sand and backfilling will be carried out by the Contractor.

8. Low voltage cable laid under road ways and other prepared surfaces shall be laid to a minimum depth of 750mm installed in glazed earthenware or other approved pipes, having a nominal MINIMUM

internal diameter of 100mm and having self-aligning water tight joints. Pipes shall be surrounded by 75mm of concrete and interlocking cable tiles shall be laid over the concrete. Cutting of excavations, supplying and laying of pipes and backfilling will be carried out by the Contractor.

9. After cables have been pulled through, the ends of all pipes including spare ways shall be sealed by the Contractor. Cables entering buildings below ground level shall have watertight seals.

10. Where cables are laid in open ground they shall be located by indestructible cable markers placed at not more than 22.5 metre intervals and at points where the cable changes direction. Elsewhere cable markers shall be attached to permanent walls in positions to be agreed by the Engineer. All markers shall give sufficient information to locate the position of the cable.

11. Where cables rise above ground or floor level in other areas they shall be protected to a height of not less than 1800mm above that level by a heavy gauge, galvanised metal channel firmly secured to the wall by sheradised holdfasts.

12. High voltage cables shall be laid to a minimum depth of 900mm in trenches or under roadways and paved areas.

12 PVC & BUTYL INSULATED SINGLE CORE CABLES (LSF)

1. These cables will be copper conducted thermosetting insulated conforming to BS 7919, BS 7889, BS 8436 and BS 7211, and having low emission of smoke and corrosive gases when affected by fire.

2. All PVC and butyl insulated single core cables will be protected throughout their length by heavy gauge conduit mini trunking or steel trunking.

3. This unsheathed cable shall be used where specified and shall generally be contained in conduit or trunking.

4. Heat resistant cables shall be used for installation of all circuits where conduits run alongside or in close proximity to heating pipes.

5. All single core cables will have copper stranded conductors and for normal conditions will be PVC insulated. In schools and other areas where the ambient temperatures exceed 20°C PVC/HR or butyl cables shall be used.

6. With the exception of cables used for earth continuity conductors, all cables shall be enclosed throughout their length in conduit, trunking etc.

7. PVC cables shall under no circumstances be connected direct to heating equipment, to lampholders or used for internal or through wiring of luminaires where they may be affected by the heat of the lamp.

8. The current rating of the cables shall not exceed those detailed in the IEE Regulations with the correct rating factors applied for ambient temperature, grouping of circuits and class of excess current protection.
9. The number of cables drawn into any conduit or trunking in a particular section is complete and shall not be installed when the ambient temperature is lower than 0°C.
10. In areas subject to elevated temperatures such as Boiler Houses, Kitchens etc, high temperature PVC or Butyl insulated cables shall be used instead of the standard PVC grade.
11. Where installed within switches, distribution boards, control panels and the like, wiring shall be neatly and carefully bunched, being adequately supported and held in position by means of supports or brackets of insulating material as necessary.
12. No more than one phase shall be installed in an outlet box, switchbox, etc, unless this has been specially designed for multi-phase use and in which case it shall be suitably labelled "Caution 415V".

13 FLAT INSULATED & SHEATHED CABLES (LSF)

1. These cables will be copper conducted thermosetting insulated and sheathed, twin and earth or three core and earth conforming to BS 7919, BS 7889, BS 8436 and BS 7211, and having low emission of smoke and corrosive gases when affected by fire.
2. The conductors will be insulated with special grade insulation, which provide low smoke emitting (LSF) rubber.
3. The uses of cables with phase conductors having a cross-sectional area of less than 1.5 mm² are prohibited. Where 1.5 mm² PVC insulated and sheathed cables are used, the circuit protective conductor will not have a cross-sectional area of less than 1.5 mm².
4. Wiring will be carried out on a "loop-in, loop-out" system with all cables terminating directly within main switches, distribution boards, etc., socket outlets, luminaires and switches only. Joints made within junction boxes and the use of through joints will not be permitted.
5. Cables will be concealed as far as possible in roof spaces and under floors, where they will be run parallel, or at right angles to all joists, etc.
6. Cables in the roof void will be secured to the sides of the joist by means of plastic cable clips at not more than 250 mm centres and will be secured to battens when running across the joist.
7. All cables will be installed not less than 100 mm clear of any gas, heating, hot water or steam pipes, radiators or other heated fittings, except where the pipe or fittings are effectively insulated and, in this

instance, a 10 mm air gap will be provided between the insulation and the cables.

8. Where cables pass across a timber floor joist they will be taken through holes drilled in the centre of the joist and the diameter of the hole shall not exceed 1/5 th depth.

9. All cables will be dressed flat, will be free from twists, kinks and mechanical strain.

10. Where cables are installed in a Durabella or floor screed they will be protected by plastic conduit for the full length of the run, all in accordance with the relevant Clause of this Specification.

11. Where cables are installed in a wall finish they shall be protected by one of the following methods:- .

    a) Galvanised conduit to conform with protection against corrosion in compliance with BS 31 (1940) 1988 Class A or screwed shall conform to BS 4568 Part 1 and BS EN 50086-1.

    b) PVC conduit to comply with BS 4607 Part 1 and BS 6099 Part 1 & 2.

    c) Non-circular conduit or channelling manufactured from PVC.

12. The conduit shall run from a position inside the accessory box and will extend into the floor or roof space for at least 50 mm. The conduit will terminate in the accessory box by means of a PVC adapter and screwed male bush.

13. The ends of the conduits will be finished so as to prevent abrasion of the cable installation when cables are being drawn into or out of conduits or connected to apparatus.

14. Cables passing through walls or concrete floors will be enclosed in PVC conduits.

15. Where it is not possible to conceal the cables in walls, etc., they will be installed on the surface, but in these instances, they will be protected by surface mounted conduits or mini trunking.

16. Cables terminating at ceiling switches or luminaire points will terminate within a standard Besa box complete with fixed earth terminal and 51 mm fixing centres, complying with BS 4568 and BS EN 50086-1.

17. Where standard Besa boxes are installed within plaster ceiling they will be securely fixed to wooden noggins provided and installed by the Contractor a sufficient height above the ceiling to permit the face of the box to be flush with the finished ceiling surface. .

18. Where wall or ceiling mounted luminaires and ceiling mounted switches are installed the fixed wiring will terminate directly into the accessory terminals.

14 FLEXIBLE CABLES AND CORDS

1. Where used for pendant luminaires, or making connections to equipment fixed or portable with a heating element or equipment fixed to pipework or appliance forming part of a heat distribution system, the flexible shall be 450/750 volt special grade PVC, which provide low smoke emitting (LSF) rubber insulated, white circular glass braided with tinned copper conductors.
2. Flexible cords in dwellings will be 450 volt grade single phase and in all other instances will be 450/750 volt grade single and three phase.
3. These cables will be copper conducted thermosetting insulated conforming to BS 7919, BS 7889, BS 8436 and BS 7211, and having low emission of smoke and corrosive gases when affected by fire.
4. Conductors will be plain annealed copper strand for PVC cords and will be tinned annealed copper strand for elastomeric cords.
5. Cores will be laid up and the interstices filled where necessary with suitable filling for the working temperature of the cable and sheathed with special grade low smoke emitting (LSF) rubber.
6. Flexible cables will be of circular type.
7. The cores of each flexible cable will be identified as follows:

NUMBER OF CORES	FUNCTION OF CORES	COLOUR(S) OF CORE
2	Phase conductor	Brown
	Neutral conductor	Blue
3	Phase conductor	Brown
	Neutral conductor	Blue
	Protective conductor	Green & Yellow
4 or5	Phase conductor	Brown, Black, Grey
	Neutral conductor	Blue
	Protective conductor	Green & Yellow

8. The weight supported by any flexible cord shall not exceed 3 kg for 0.75 sq.mm² or 5 kg for 1.5 mm².

15 CONNECTIONS TO EXISTING CIRCUITS

1. Connections shall be made to the existing mains supply system at the position(s) indicated, but no alterations shall be undertaken with first obtaining the approval of the Engineer.

2. The work shall be executed in such a manner and at such times as may be necessary in order to cause the minimum of interference with existing services.
3. Where it may be necessary to interrupt existing services, notice of such intention shall be given by the Contractor to The Engineer in advance to enable any necessary arrangements to be made.

16 CONDUCTOR & PHASE IDENTIFICATION

1. Each conductor shall be plainly marked adjacent to its termination by coloured sleeves to indicate the phase to which it is connected.
2. The interior of all items of distribution equipment shall have the phases marked using coloured discs or markers secured by non-ferrous screws.
3. The cores of cables shall be identified throughout their length by colour in accordance with Section 514 of the IEE Wiring Regulations.
4. The cores of armoured PVC insulated cables shall be identified by numbers in accordance with BS 6346 and 6747. Where numbers are used the numbers, 1, 2 and 3 shall signify line conductors and the number "N" the neutral conductor.
5. Conductors of mineral insulated cables shall be identified by the application of sleeves or discs of the appropriate colours prescribed in Section 514 of the IEE Wiring Regulations.
6. Bare conductors, other than earth continuity conductors and earthing leads shall be identified by means of sleeves or discs of the appropriate colour prescribed in Section 51 of the IEE Wiring Regulations.
7. The cores of flexible cords shall be coloured throughout to the requirements of Table 51 of the IEE Wiring Regulations.
8. Identification of connections to individual phases or poles shall be by colouring in accordance with Table 51 of the IEE Wiring Regulations. In addition to items above the cores of cables connecting, control gear etc., which have marked terminals shall be identified by sleeves or marker beads bearing the same markings as the terminal to which they are connected.
9. Where single phase cables are specified the cable shall be a 3 core type with the third conductor (coloured grey) used as the circuit protective conductor and this shall be identified by the addition of a yellow and green stripped PVC earth sleeve fitted at each termination.
10. Cables forming special circuits such as extra low voltage and data communication circuits for outstations, sensors etc., shall be distinctively coloured or marked, but the colour shall be different from any of those specified for the purpose in Table 51 of the IEE Wiring Regulations.
11. Each cable shall have an engraved discs attached to identify the circuit reference, load supplied and the number of cores / cross sectional area of the conductors. These discs shall be installed at the switch panel plus

the load cable ends and at 10 metre intervals between along the cable routes.

12. All cables will be copper conducted, unless specified otherwise, and comply with the appropriate British Standard Specification. Types and sizes will be as specified on the Drawings and Schedules.

13. Unless otherwise specified, no cables of lesser section than 1.5mm² will be used. The use of solid core cables is prohibited. The cables shall be installed without joints.

14. No reduction of strands forming the conductor will be allowed at switch or other terminals and all strands shall be efficiently secured by screws, nuts and washers or other approved means.

15. Unless particularly detailed in this Specification or Drawings, cables will not run through lighting fittings.

16. Cables shall be coloured as follows:

Phase cables on single phase circuits:	Brown
Phase cables on three phase circuits: Neutral cables throughout:	Brown, Black, Grey corresponding to the phase to which it is connected Blue
Earth continuity conductor:	Green/Yellow

17. Every coil of cable and flexible cord shall bear the maker's label firmly attached, containing the following information:

18. Name of manufacturer, description of cable, classification, length, size and grade.

19. The cables and seals will be intact when delivered on site. No coil or cable or flexible cord manufactured more than one year prior to delivery on the site shall be used in the installation.

20. Before wiring the conduit/trunking enclosure shall be complete, free of dirt, water and condensation.

21. Where cables are concealed in flush conduits the cables will be installed easily via draw boxes so that the cables can be withdrawn or rewired without disturbance to the building fabric.

22. Cables will always be so bunched that cables of all phases and neutral are drawn into the same conduit.

23. The conduit cable capacities laid down in the I.E.E. Regulations will be strictly adhered to.

17 CABLE TRAYS

Cable trays shall be made of galvanised steel and be of the heavy duty pattern in compliance with current British Standards.

1. Cable trays shall in every instance be galvanised and as manufactured by Greenings Limited, or equal and approved by the Engineer.
2. Where necessary the Contractor shall provide and install all supporting steelwork brackets, hangers etc., which shall be hot dip galvanised.
3. Cables shall be securely saddled to tray work in a neat manner and a margin of 25% reserve space shall be made.
4. The Contractor shall erect and install all tray work using where appropriate, purpose made bends and tees etc.
5. Cable trays shall comprise of perforated steel pre-galvanised before manufacture to BS EN 10143 bending and profiling quality.
6. The cable tray shall have return flanges and comprise of the following thickness:

Up to & including 100 mm wide	0.9 mm
Up to & including 150 mm wide	1.25 mm
Up to & including 300 mm wide	1.6 mm
Above 300 mm wide	1.0 mm

7. The tray shall be galvanised for internal applications unless indicated elsewhere in the Specification.
8. The cable tray accessories to be installed shall be of the same specification as the cable tray.
9. All joints shall be made using manufactured fish plates, shouldered ends and couplers with galvanised or zinc plated slotted domed head roofing bolts.
10. All flat bends and intersections shall be of the gusseted type.
11. All galvanised steel channel supports and threaded drop rod suspensions shall be sized and spaced to adequately support at least twice the number of cables to be installed.
12. The tray shall be supported by purpose made galvanised brackets at intervals not exceeding 1200 mm and 230 mm from all fittings and with a minimum 20 mm clearance behind the cable tray.
13. The brackets shall be securely fixed to the building fabric using suitably sized masonry plugs and screws. The screws shall be zinc plated (electro galvanised) complying with BS EN 12329 and BS EN ISO 2082:2008 and be no less than 32 mm X No. 8 in size.
14. The tray shall be fixed to the galvanised brackets using zinc plated slotted' domed head roofing bolts.

15. Cable tray shall only be cut along a line of plain metal and all cut edges of galvanised cable tray shall be prepared and treated with a zinc rich paint, primer and top coat.
16. All cut threaded drop rods and galvanised steel channels shall have the sharpened ends de-burred and rounded plus any protrusions kept to a minimum.
17. Holes cut in cable tray to allow cable to pass through shall be suitably bushed.
18. The cables shall be fixed to the tray by means of proprietary form of plastic or copper cable clips, saddles, strips or ties. When installed in situations where high temperatures or humid conditions are likely to occur copper or brass saddles and clips shall be used.
19. All cables attached to cable trays shall be cleated at regular intervals in accordance with BS 7671.
20. Earth continuity throughout cable trays shall be maintained from the switch panel to all loads by means of supplementary earth bonding and copper earth links between section pieces.

18 CABLE TRUNKING

1. The cable trunking used throughout the installation will be manufactured from galvanised sheet steel and constructed to conform with the requirements of BS EN 50085.
2. Metal trunking shall be of first quality and as manufactured by one of the following firms:-
    a) Power Centre Ltd, (Simplex-GE Ltd)
    b) Davis Trunking Ltd
    c) Salamandre Sheet Metal td
    d) Wm Curry Ltd
    e) Walsall Conduits Ltd
    f) or approved alternative
3. Trunking sizes up to and including 150 mm X 50 mm, or equal, cross-sectional area is to be produced from 1.2 mm minimum thickness sheet steel, above these sizes 1.6 mm minimum thickness sheet steel will be employed.
4. Cover lids will be fastened to the trunking body with turnbuckle screws rigidly secured to the inwardly turned flanges on the trunking body.
5. All straight trunking joints will be made with the use of purpose made coupler connectors secured with electro-tinned screws, nuts and shakeproof washers.
6. Trunking accessories will comprise gusset type bends, tees and angles of similar gauge, type and manufacturer as the trunking body.

7. All trunking and accessories will be provided with a hot dip galvanised finish to comply with BS EN 10143:2006.
8. Fabrication of any components on site is prohibited and only the manufacturers listed accessories will be accepted.
9. All trunking will be made continuous electrically and mechanically by means of copper links across each joint on the system. The galvanising material will be removed within 6 mm of the jointing strap to ensure good earth continuity.
10. Vertical sections of trunking will be provided with pin racks at not more than 2 m intervals.
11. Continuous sheet steel segregation barriers will be provided, securely fixed to segregate final sub-circuits and ancillary circuits, ie. telephone and door porter systems.
12. Purpose made fire barriers shall be inserted into sections of trunking at points of entry and exit from roof spaces between rooms and floors.
13. Where trunking passes through holes in the building structure, a cover plate will be fixed to the face of the trunking before installation and will be arranged to project at least 50 mm beyond the finished structure.
14. Where trunking is to be used to connect switch gear or fuse boards, such connections will be made by trunking fittings manufactured for this purpose and not by multiple conduit coupling.
15. Due allowance shall be made for expansion on long lengths of installed trunking.
16. The cable trunking will have a total air space of 66% giving a cable carrying capacity of 34% within the internal area of the trunking.
17. All trunking will be rigidly attached to the building fabric at intervals not exceeding the following Tables:

CROSS-SECTIONAL AREA OF TRUNKING	MAXIMUM DISTANCE BETWEEN SUPPORTS FOR METAL TRUNKING	
	HORIZONTAL	VERTICAL
Exceeding 300 mm² and not exceeding 700 mm²	750 mm	1000 mm
Exceeding 300 mm² and not exceeding 1500 mm²	1250 mm	1500 mm
Exceeding 1500 mm² and not exceeding 2500 mm²	1500 mm	2000 mm
Exceeding 2500 mm² not exceeding 3500 mm²and	1500 mm	2000 mm
Exceeding 5000 mm²	1500 mm	2000 mm

18. Unless otherwise stated trunking shall be installed in such a manner that the coverplate is located either at the top or side.

19. Trunking lids shall be secured by means of brass bolts and fixed nuts or galvanised screws at 300mm intervals.

20. Fixings will be provided within 300 mm intervals of all bends, angles and fittings. Small individual pieces of trunking will be independently supported accordingly.

21. All trunking will be fixed by means of round head wood screws of sufficient size and length to obtain a firm fixing into the building structure with a minimum length 32 mm X No. 10 screws. The fixing screws will be zinc plated (electro-galvanised) complying with BS EN 12329 and BS EN ISO 2082:2008 coating.

22. Each final sub-circuit contained within trunking will be taped at 600 mm intervals with two laps of good quality transparent tape with additional wrapping at bends.

23. Circuit identification tapes will be attached under one layer of transparent tape at 4 m intervals.

24. Securing spring clips shall be fitted at intervals not exceeding one metre.

25. All lengths of trunking shall be connected together by internally fitted rectangular couplings of sufficient width to provide a minimum bearing face of 25mm to which the lengths shall be bolted or welded. Earth continuity shall be made by utilising purpose made copper earth continuity link as manufactured by Walsall Limited or equal and approved at each joint.

26. Adequate provision shall be made to allow for expansion on all installed lengths of trunking.

27. All tee pieces and bends shall be formed with similar means of connection and the inner radii shall be such that cables will not be bent through a radius less than that prescribed in the IEE Wiring Regulations for Electrical Installations. Only bends and tees of an approved pattern will be accepted.

28. Wherever installed trunking valves in direction by more than 45^{o} then a purpose made unit shall be used. Trunking shall not be manipulated.

29. Trunking shall be firmly attached to its respective equipment either by flange bolts or by hexagonal male bushes and locknuts as appropriate to the installation.

30. Open ends shall be capped by means of a purpose made flanged cover, bolted in position.

31. Where it is intended to use trunking to facilitate wiring for varying services then compartmented trunking shall be used to afford segregation of services.

32. Wherever trunking passes through walls, doorways or vertical partitions, that constitute a fire barrier in a building, care shall be taken to see that no orifice is left between the trunking and the building structure through which fire might spread. In addition a suitable barrier of incombustible material shall be provided and fitted inside the trunking in accordance with the IEE Wiring Regulations for Electrical Installations.

33. All vertical runs of trunking which pass through floors shall be fitted with fire barriers in accordance with the IEE Wiring Regulations for Electrical Installations.

34. All trunking shall be rigidly secured at fixing centres not exceeding 500mm. All trunking shall be fixed so as to drain off any condensed moisture.

35. Where underfloor trunking is installed the Contractor shall take care to prevent the ingress of rubble etc. All extraneous matter shall be cleared from the trunking before cables are installed.

36. All necessary trunking support work, hangers, brackets and fixing requirements shall be provided within the scope of this contract which shall be suitably bonded. In all instances the Contractor shall observe the requirements of the manufacturers installation instructions.

19 STEEL CONDUIT & CONDUIT FITTINGS

1. All steel conduit and conduit accessories used throughout the installation will be manufactured by comply with the requirements of BS 4568, the Specification for Steel Conduit & Fittings with Metric Threads of ISO Form for Electrical Installations, Steel Conduits, Bends & Couplers, Fittings & Components, together with all amendments.

2. Only brass screws shall be used with galvanised boxes and saddles.

3. All steel conduits will be heavy gauge screwed and seam welded medium protection Class 2 for stove black enamelled type conduit and Class 4 hot dipped for galvanised type conduit.

4. All steel conduits to. be installed will net be less than 20 mm diameter and will net exceed 32 mm diameter unless specifically specified within this Specification or as indicated en the Contract Drawings or by written instruction by the Engineer.

5. All steel conduits and conduit accessories, i.e. fittings, adaptable boxes, saddles, etc., will match the type of conduit specified and will be of the same manufacturer.

6. All conduits and fittings shall be manufactured by a member of BESA and each length of conduit shall bear the manufacturers mark.

7. Each steel conduit installation will be installed to. Comply with the requirements of BS EN 61386-1:2008, Specification of General Requirements.

8. Conduit screw threads will be of the ISO Form and will be cut by means of efficient sharp stocks and dies. Under no circumstances will broken or loose threads be accepted.

9. Where practicable, all threads will be half the length of the appropriate standard straight coupler and no thread will be exposed, except at "running couplers". In these instances the exposed threads will be painted immediately after instillation.

10. All threads will be cleaned and free from oil prior to installation and all threads will be thoroughly clean and free from paint, enamel, dirt, grease, etc.
11. All steel conduits will be free from rust patches and mechanical damage en delivery to site. The steel conduits will be stored in a dry and secured area to maintain an acceptable quality as previously specified.
12. No conduits of less than 20mm diameter shall be used. All runs shall be so arranged that any condense moisture can drain to the lowest point where a screwed plug shall be provided for the purpose of 'draining off'.
13. Conduit shall be installed in a neat and inconspicuous manner. Full consideration shall be given to other services. It is the Contractor's responsibility to co-ordinate his installation and in this respect he shall be responsible for determining the true nature and extent of the works, as applicable to himself and other services. No claims on the grounds of lack of knowledge or prevailing site conditions will be entertained.
14. All bends shall be made on a pipe bending machine, with formers of the correct radii. Where bends and sets occur in multiple conduit runs they shall be arranged symmetrically to present a uniform and neat arrangement. Not more than 2 N° right angle bends will be allowed between 'draw-in'boxes.
15. Solid dies of the proper standard shall be used for cutting of screw threads, to ensure a good fit. All burrs shall be removed from the screw and surplus screwing lubricants wiped from threads prior to fixing of conduit.
16. No diagonal runs of conduits will be permitted on walls of buildings.
17. Concealed conduit installations shall be installed in such a manner that wiring can be readily installed after the whole of the conduit installations has been erected and all wall, floor and ceiling finishes completed. All conduits chased into walls shall be fully recessed to permit a minimum thickness of 15mm plaster or other finish to be obtained.
18. All conduits that are required to be cast in situ or laid into floor screeds shall be securely fixed and protected against mechanical damage, details of proposed clips and/or brackets shall be submitted to The Engineer for approval prior to manufacture. Conduits installed into wall chases shall be secured by means of galvanised crampets, in roof voids and floor ducts galvanised spacer bar saddles shall be used.
19. Conduits terminating at accessory and adaptable boxes using clearance holes shall be joined by means of a screwed coupling. A screwed coupling shall be installed in the conduits at a position 300mm below the ceiling soffit above all accessory points.
20. Sufficient 'draw-in' boxes shall be installed to ensure that the installation can be completely rewireable, locations to be agreed with the Engineer.
21. All exposed threads, joints, bends and any points where the galvanising appears damaged, shall be cleaned, primed and painted with a metallic based paint.

22. The wiring of the installation shall be done in strict accordance with the main schematics cable sizes and circuit details given in the relevant specification, schedules and drawings.
23. All wiring shall be carried out using the 'loop-in' system, no joints or connections, other than those required at specific plant and accessories will be accepted.
24. The quantity and size of cables contained in any one conduit shall not be in excess of the capacities of conduits as prescribed in the IEE Wiring Regulations for Electrical Installations.
25. Adequate provision shall be made to allow for expansion at all building expansion joints.
26. Floor inspection boxes shall be fitted with non-ferrous metal or galvanised lids, which shall be supplementary, bonded to the box.

20 CIRCULAR CONDUIT B0XES

1. BS circular boxes will be manufactured from malleable iron with internal dimensions 60.3 mm diameter X 28.5 mm depth and cover fixing lugs at 50.8 mm centres. Each box will be provided with a tapped hole in the base of the box for a M4 earth screw.
2. BS circular boxes will be fitted with a flat circular steel cover plate fixed by 2 No. round raised head M4 screws. Where the boxes are flush mounted, the cover plate will be of the overlapping type.
3. Where BS circular boxes are installed to external areas, moisture and semi-exposed situation each box will be provided with a rubber gasket sited between the outer ring of the box and the cover lid.
4. All BS circular boxes will be fixed to the building fabric by means of 2 No. round head screws of sufficient size and length to obtain a firm fixing into the building structure with a minimum length of 32 mm X No. 8 screws. The fixing screws will be zinc plated (electro-galvanised) complying with BS EN 12329 and BS EN ISO 2082:2008 Class B coating.

21 ADAPTABLE BOXES

1. Adaptable boxes will be manufactured from heavy gauge rust proofed mild steel, fully welded seams and heavy gauge flat flanged lids. The width gauge will be as follows:

Boxes up to 150 mm X 150 mm X 75 mm:	14 gauge
Boxes up to 355 mm X 354 mm X 100 mm:	12 gauge

2. Each box will be manufactured with plain sides necessitating drilling of holes on site, the use of knockout boxes is prohibited.

3. Adaptable boxes installed to external, moisture and semi-exposed areas will be galvanised and provided with rubber gaskets situated between the outer face of the box and the lid.
4. All adaptable boxes will be fixed to the building fabric by means of 4 No. round head screws of sufficient size and length to obtain a firm fixing into the building structure with a minimum length of 32 mm X No. 8 screws. The fixing screws will be zinc plated (electro-galvanised) complying with BS EN 12329 and BS EN ISO 2082:2008, Class 8 coating.
5. Earthed steel barriers will be provided where necessary to suitably segregate services.

22 CONDUIT DISTANCE SADDLES

1. Surface mounted steel conduit will be rigidly secured to the building structure with the use of heavy gauge distance saddles provided with two no. M4 metric roundhead brass screws securing the saddle clip to the base ensuring the conduit standards not less than 6 mm clear from the building surface.
2. Each distance saddle will be fixed to the building structure by means of 1 No. countersunk screws of sufficient size and length to obtain a firm fixing into the building structure with a minimum length of 32 mm X No. 8 screws. The fixing screws will be zinc plated (electro-galvanised) complying with BS EN 12329 and BS EN ISO 2082:2008, Class 8 coating.
3. Distance saddles will be provided within 300 mm either side of each steel conduit bend or set and at a maximum distance of 900 mm between saddle centres for straight sections.
4. Where conduit boxes, accessories, etc., are situated distance saddles will be provided 300 mm either side from the centre of the box.
5. The Contractor will carefully arrange the layout of the saddles to achieve an even workmanship and aesthetically pleasing appearance.

23 ACCESSORY B0XES FOR STEEL CONDUIT INSTALLATIONS:

1. Each accessory box will be manufactured from pre-coated galvanised steel to comply with BS 4662: 2006, Specification for boxes for the enclosure of electrical accessories.
2. Each accessory box will be suitable for recessed mounting within the building structure and will be provided with ample knockouts for conduit entry.

3. Each accessory box will be provided with robust tapped accessory fixing lugs to accept M3.5 metric screw. One fixing lug will be adjustable to enable true alignment of the fixed accessory. .
4. The minimum depth of all accessory boxes will be 35 mm unless as instructed by the Engineer.
5. Each accessory box will be fixed to the building structure by means of a minimum of 2 No. roundhead screws of sufficient size and length to obtain a firm fixing into the building structure with a minimum length of 32 mm X No. 8 screws. The fixing screws will be zinc plated (electro-galvanised) complying with BS EN 12329 and BS EN ISO 2082:2008, Class B coating.
6. All recessed accessory boxes will finish flush with the finished surface (within practical limits). Under no circumstances may the accessory box finish proud of the finished surface.
7. In the event that the final location of the front edge of the accessory box is 16 mm or greater from the finished surface. The Contractor will supply and install an extension box to allow the accessory box to finish flush with the finished surface. The use of extension screws in these instances is prohibited.

24 FLEXIBLE METALLIC CONDUIT

1. Flexible conduit complying with BS EN 61386-1:2008 shall be used for the final connection of the rigid conduit installation to the terminal boxes of all plant where vibration is likely to occur.
2. Unless specified otherwise, galvanised and non-watertight type flexible conduit shall be used under normal conditions, but watertight flexible conduit shall be used where exposed to the weather or is likely to be splashed or subjected to heavy moisture conditions. .
3. Unless otherwise stated flexible conduit shall comprise Kopex type LS/s with PVC sheath, or equal and approved by the Engineer.
4. Flexible conduits shall be terminated using approved glands of Kopex manufacture or equal and approved by the Engineer.
5. In all instances separate PVC insulated earthing lead coloured green and yellow complying with Chapter 54 of the IEE Wiring Regulations of Electrical Installation, shall be installed internally which shall be securely bonded at each end into purpose made earthing terminals.
6. Flexible conduit shall also be provided to semi-portable equipment such as cookers, washers and similar machines where a limited amount of movement is required for cleaning and maintenance purposes. This does not apply to small machines normally connected to socket outlets by flexible cables.
7. The flexible conduit shall be PVC sheathed, of ample capacity for the number of cables and have a minimum length of 300 mm with sufficient

length to allow the full range of withdrawal, adjustment or movement necessary.

8. No flexible conduit shall exceed an unstretched length of 800mm.
9. Under no circumstances will flexible conduit be accepted in lieu of sets and bends in rigid conduit installations.

25 PLASTIC CONDUITS

All the requirements outlined in the preceding Clause on 'Metal Conduits' shall apply, in addition the following requirements shall apply:-

1. PVC conduit shall of low smoke and zero halogen of fume emissions.
2. All tubing and accessories shall be of super high impact heavy gauge rigid polyvinyl chloride, all accessories and tube shall be of the same manufacture.
3. Tube shall be joined with plain couplings and the manufacturers purpose made adaptors shall be used at all accessories, adaptable or equipment boxes and sealed with a vinyl solvent adhesive for making watertight joints. Expansion couplings shall be installed in accordance with the manufacturers instructions and sealed with an adhesive that remains flexible although providing watertight joints.
4. Saddles shall completely encircle and shall be of the 'spacer bar' type. Spring in type clips will not be accepted. Under no circumstances shall crampets be used with plastic conduit. In concealed installation preformed single hole plastic or aluminium fixing clips shall be used, secured by means of cadmium coated or sheradized wood screws.
5. Where it is proposed to cast plastic conduit in concrete the Contractor shall ensure that the conduit is effectively secured to the shuttering and protected against all hazards of fracture and deformation.
6. An earth continuity conductor shall be provided and installed with the whole of the plastic conduit installation which shall comply with the IEE Wiring Regulations for Electrical Installations.

26 PLASTIC TRUNKING

Rigid PVC trunking shall generally be installed in accordance with preceding clause cable trunking and ducting and the following requirement:-

1. PVC trunking shall of low smoke and zero halogen of fume emissions.
2. PVC trunking shall in all instances be of the same manufacture as the plastic conduit installation with which it is associated. It should be noted that PVC trunking shall only be used in conjunction with a plastic conduit installation and in this respect the Contractor shall provide and install the trunking in strict accordance with the manufacturers instructions.

3. Trunking shall be rigidly supported at distances of not less than 500m. All fixings shall be effected by means of cadmium plates or sheradized wood screws. Where appropriate, purpose made brackets or supports shall be provided for fixing purposes.
4. 'Snap-in' type lids are acceptable where the trunking faces upwards or sideways.
5. All conduit entries shall be made by means of purpose made bushes and adapters.
6. Each circuit shall have its own separate earth continuity conductor which shall meet the requirements of the IEE Wiring Regulations for Electrical Installations.

27 GENERAL INSTALLATION:

1. The conduit and conduit accessory installation for each sub-circuit and final sub-circuit will be completely erected prior to the installation of any circuit wiring.
2. During construction of new built projects the building will be made watertight prior to commencement of any conduit installation. Additionally circuit wiring may only be drawn into the conduit installation upon completion of the wet trades, ego plastering.
3. The conduit will be installed at least 150 mm clear from all other services wherever possible and must not come into contact with water, gas, heating or steam pipework.
4. Where conduits are specified to be installed in voids above suspended ceilings, they shall be fixed to the structure using the recommended method of fixing, ego saddles.
5. The complete conduit system will be electrically and mechanically continuous including all boxes, etc.
6. All conduits will be reamed clean internally to ensure freedom from burrs and other defects.
7. All conduits will be installed in straight lines with easy bends or sets to harmonise with the architectural features of the building.
8. The use of diagonal runs is prohibited, all branches will be sub-divided at right angles.
9. All conduits to be set will be bent cold without damaging the overall section with an approved bending machine and former. The use of manufacturer bends, etc., is prohibited unless as instructed by the Engineer.
10. Draw in points will be spaced at a maximum of 8 m centres and not more than two 90° bends (or equivalent) will be permitted.

11. Where conduits pass through structural floors, walls, etc., .over sleeves will be provided. The sleeve will take the form of a larger size steel conduit.
12. Open BS boxes, etc., will be suitably protected to avoid the ingress of concrete, plaster slurry or any other material.
13. Running couplers will be used where absolutely necessary. All running couplers will be locked together by means of ring locknuts.
14. All conduits forming the couplers will be butted together inside the coupler.
15. In the instances where a conduit is to be connected to the back of a Besa box. The Besa box will first be drilled clear. A male brass bush will be inserted between the box and connect onto the conduit coupler from inside the box to ensure a rigid mechanical and electrical connection is achieved.
16. Recognised good engineering practice shall be adopted throughout and no conduit shall run in such a way as to provide a trap for moisture or condensation. Precautions shall be taken to prevent the ingress of moisture, silt, brick and concrete chippings, etc., during and after the installation of the conduit system. Stopping plugs shall be fitted to the ends of all conduits not connected to fixing and outlet boxes. Where condensation has occurred the conduits shall be thoroughly dried by drawing swabs through them. The inside of all conduits shall be free from burrs or other obstructions.
17. Where conduits are installed side by side all "off-sets" will be similar and where "offsets" are necessary at switch boxes, distribution boards, etc., these will be as short as practically possible.'
18. Under no circumstances shall conduits from different distribution boards be connected at the same junction box.
19. The exact routes of all conduits and locations of all Besa boxes, adaptable boxes and the like will be indicated on the working drawings produced by the Contractor.
20. Unless otherwise indicated herein, the installation shall be carried out in accordance with the I.E.E. Regulations and conform to the relevant British Standard.

28 CONCEALED CONDUIT SYSTEMS:

1. Conduits which are to be cast in concrete floors will be laid directly above, but not in contact with, the lower steel reinforcing bars before the floors are poured. Conduits or boxes cast into structural floors will be of spout type securely fixed by the Contractor before pouring starts and all boxes will be positioned to allow for the correct thickness of finishing. Extension rings will be used on all ceiling outlets where the box is not flush with the finished surface.

2. In circumstances where a terminal box would normally be used, the Contractor is to fix a through type box with the spare spout plugged with a screwed brass stop so as to provide a secure anchorage.
3. In special or pre-fabricated floor construction where the conduits cannot be installed as described above, they shall be run in or upon the pre-fabricated sections and 'set' down into 'loop-in' type boxes. In the case of certain pre-fabricated floors it may be necessary for the Contractor to withhold the installation until the structural cement topping on the pre-fabricated section has been laid and set. In this event, the Contractor shall, prior to the laying of the topping, mark accurately the positions of all points and down drops so that preformed holes may be left.
4. A space of 13 mm shall be left between adjacent conduits where they are to be covered with plaster, cement or the like.
5. At expansion joints of cast in-situ concrete the conduit shall terminate flush at one side of the joint in a screw to slip solid coupler. From the other side of the joint the conduit shall bridge the expansion gap to engage the slip section of the coupler to allow not less than 13 mm movement of the conduit without separation. An insulated flexible earth continuity conductor of cross sectional area not less than 1.5 mm^2 shall be installed within the conduit between boxes on either side of the expansion joint and secured to the back of the boxes with M2 metric phosphor bronze screws and Ross Courtney connectors.
6. Circular boxes shall not be used in flush systems solely for the purpose of 'drawing-in' cables except by permission of the Engineer.
7. Where Besa boxes are recessed into the walls or ceilings and flush with the finished surfaces, the box lids will overlap the diameter of the box by not less than 6 mm.
8. Conduits in wall chases will be secured to the building structure by means of heavy gauge cram pets at least 40 mm long.

29 WIRING CONDUIT/TRUNKING SYSTEMS

1. The whole of the electrical 'first fixing' installation, inclusive of accessory boxes and equipment boxes, etc, shall be completed before wiring shall commence.
2. Prior to wiring commencing, The Engineer will be at liberty to apply a 'dead' load test of 50 lbs to any part of a steel conduit or trunking installation and 20 lbs dead load to any part of a plastic conduit or trunking installation. Any part of the installation failing such a test shall be replaced by the Contractor at 'no charge'.
3. All wiring shall be carried out in strict accordance with the schematic diagrams, cable sizes and circuit details given in the specification, schedules and drawings.

4. Wiring shall be carried out in such a manner that it is easily withdrawable. No joints or connections will be permitted, other than those required for specified purposes. Care shall be taken to ensure that an all phase and associated neutral conductors are contained in the same conduit. As much free cable as is practicable shall be left in conduit boxes and accessory and distribution points. The contractor shall at the Engineer's request, be required to demonstrate the free movement of cables within conduits, this work shall be carried out at no charge.
5. The quantity and size of the cables enclosed within conduits shall comply with the IEE Wiring Regulations for Electrical Installations, leaving a 25% margin for future wiring.
6. A swab shall be drawn through all conduits prior to the installation of wiring.
7. Cables shall be drawn into conduits directly off reels and care shall be taken to avoid abrasion, chaffing, contact with the floor and accidental damage.
8. Final circuit wiring and sub-main cables shall not be installed in the same conduits.
9. Segregation of services with regard to voltage and frequency differentials shall be observed in accordance with the requirements of the IEE Wiring Regulations for Electrical installations.
10. In the event of cables being damaged during installation then the Contractor shall be responsible for replacing same at his own expense.

30 FINAL SUB-CIRCUITS

1. The cables shall be 600 / 1000 volt grade copper conducted with thermosetting insulated conforming to BS 7919, BS 7889, BS 8436 and BS 7211, and having low emission of smoke and corrosive gases when affected by fire.
2. The minimum cross sectional area of conductors shall be 1.5 mm^2.
3. All final circuits shall include a dedicated circuit protective conductor with the same cross sectional area as the associated final circuit conductors.
4. 110 Volt to 400 Volt circuit wiring may share the same wiring containment.
5. 24 Volt wiring for the safety lighting socket outlets installation shall be run within a dedicated conduit system kept segregated from all other wiring.
6. Every final sub-circuit will be connected to a separate way of a fuses, switchfuse or circuit breaker.
7. The wiring of each final sub-circuit will be electrically separate from every other final sub-circuit.

8. Generally, no more than two conductors may be bunched in anyone terminal unless necessitated by the type of installed system, and except for ring circuits, may more than one conductor be connected to a protective device sited within distribution equipment, ie. CU's, etc.
9. Neutral conductors shall be connected at the DB or CU in the same order as the live conductors.
10. At termination points such as switch or socket outlets, etc., sufficient length must be left on cable ends to ensure that there is no tension on the connections.
11. The conductor insulation must be removed for a minimum length to facilitate connections and no excess length of exposed conductor shall be left.
12. When preparing cable ends, the Contractor shall ensure that none of the conductor strands are damaged and the strands will be twisted together with pliers to ensure a neat firm connection.
13. The circuit requirements are indicated on the Tender Drawings and the Contractor shall ensure that the circuits are wired strictly in accordance with these requirements.

31 SINGLE PHASE CIRCUITS IN PROPERTIES WITH 3 PHASE SUPPLIES:

1. Single phase lighting and power circuits shall be connected on the same phase in any given area. The exception being as follows:
2. Where the property has a large connected load on a common level the electrical load shall be equally balanced over the 3 phases. However, accessories and supply points on different phases shall be kept to a minimum distance of 2 m apart. Multi-gang lighting switches with 415 volts present shall be fitted with a grid clearly indicating that 415V is present. The Contractor shall however endeavour to avoid this situation wherever possible.
3. Where accessories are required to be on different phases within a given area this will be referred back to The Engineer for clearance and in these instances, the phase and voltage present shall be displayed on the equipment by means of an engraved Traffolyte label.

32 WIRING FOR MECHANICAL SERVICES AND CONTROLS

The H&V plant controls wiring installations shall also comply with the requirements as follows:

1. The number and disposition of H&V plant and controls items that require wiring are shown upon the mechanical services schematic and layout drawings.
2. The controls wiring in most cases shall be connected to the H&V plant items and other control panels from the terminals provided in the relevant H&V plant control panels provided by the Mechanical Services Contractor.
3. The mechanical services schematic drawings specify the plant and controls items along with the controls details and the cable type and number of cable cores required for wiring.
4. The mechanical services layout drawings locate the items of H&V plant controls.
5. The flexible cables to mechanical equipment shall be 450/750 volt grade thermosetting insulated cable and having low emission of smoke and corrosive gases when affected by fire.
6. The cables for controls wiring shall be as Beldon – twisted pairs (as required), 20 AWG, 16 / 0.2, 0.5 mm^2 to comply with BS 5308: Part 2 and include individual screens for each pair / steel wire armoured with pvc sheath overall.
7. Data cable required to link BMS outstations shall be as Beldon – 2 no. twisted pairs, 20 AWG, 16 / 0.2, 0.5 mm^2 to comply with BS 5308: Part 2 and include an overall screen / steel wire armoured with pvc sheath overall.
8. All other controls wiring shall be multi-core 1.5 mm^2 XLPE/SWA/LSF.
9. The controls cables shall share the cable trays and ladders provided for power cables and the controls cables shall be grouped and run neatly separated from the power cables.
10. The LVES Contractor shall provide and fix engraved traffolyte labels to the controls items to identify the item plus attach suitable and permanent identifying labels to the cables at each termination.

H&V POWER CABLE SCHEDULES

Number of Phases	Power Rating (kW) Quoted Upon Schematic Drawing	Required Cable Size (mm^2)
1	0 - 1.1 kW	1.5 mm^2
1	1.5 – 2.2 kW	2.5 mm^2
1	3.0 – 3.75kW	4.0 mm^2

3	0 – 3.75 kW	1.5 mm^2
3	5.5 – 7.5 kW	2.5 mm^2
3	9.3 – 11.0 kW	4.0 mm^2
3	15 kW	6.0 mm^2
3	18.5 kW	10.0 mm^2

For cable runs in excess of 50 metres the Contractor shall select the next up cable csa size.

33 POSITION AND ROUTES OF CABLES WITH RESPECT TO MECHANICAL SERVICES

1. All cables shall be routed and supported to be a minimum distance of 100mm clear of steam, water, gas or other pipework and ventilation duct work when fully lagged or insulated. 200mm minimum shall be allowed between any other heat emitting surface of plant or equipment or the above pipework if not lagged.
2. Where these requirements cannot be met, the Contractor shall refer to The Engineer before starting that section of the work.
3. Electrical services which run parallel with hot water or heating services pipes shall be installed below such pipes.

34 LUMINAIRES

1. The Contractor will supply, install and terminate the circuit wiring to luminaires of the type indicated by the Reference Letter or Luminaires Schedule marked on the drawing or accompanying this Specification.
2. All luminaires (inclusive of ceiling roses and batten holders) will be inclusive of lamps.
3. Wiring through luminaires is prohibited unless as otherwise specified or agreed with the Engineer.
4. Every surface mounted luminaires shall be fixed to a conduit box (or boxes). Fixings shall be by a backplate, or via a ceiling rose in cases where the fittings are of a flexible pendant type.
5. All luminaires and pendants shall be fixed with brass roundhead screws.
6. For the purpose of the Tender, all pendant type luminaires shall be included with standard lengths of suspension unless these lengths or mounting heights are given elsewhere.
7. All metalwork on luminaires shall be connected to the protective conductor and shall have proper and approved earthing arrangements.

8. Luminaires which are fixed on to, or recessed into suspended ceilings shall not have their weight borne by the ceiling unless written approval is obtained. Luminaires shall be suspended from the roof structure or ceiling beams over.

    a) Two fixings at least are required for luminaires up to 300mm wide and four fixings for sizes over 300m wide.

    b) At each recessed luminaire in a suspended ceiling an incombustible 3 pin socket outlet with a plug secured by a locking ring or screw thread shall be installed in a convenient accessible position.

    c) Where surface luminaires are to be fixed to conduit boxes, the boxes shall be securely fixed to the roof structure or ceiling beams over, as specified above.

    d) All fixing and materials shall be supplied and fixed by the Contractor.

9. Where light fittings are specified to be installed at a level below the ceiling in the area concerned then the method of installation shall be by means of multiple chain or stranded steel wire suspensions from domed conduit BESA box lids with purpose made hooks. The lids shall be fixed to a circular conduit BESA boxes forming part of the lighting installation conduit system. The Contractor shall ensure that all fixings and suspension component materials used are more than adequate to safely suspend the light fittings.

10. The luminaires backplate must fully cover the conduit box in concealed installations. Where backplates can be supplied by the manufacturer to comply with this requirement these shall be used. As a final alternative, white break joint rings shall be employed.

11. Fluorescent luminaires shall not be used for through-wiring unless specifically permitted, in which case the cables shall be heat resistant 150^{o}C grade.

12. Fluorescent luminaires shall be individually power factor corrected 0.85 minimum.

13. Luminaires shall be thoroughly cleaned before installation and shall be in a new, clean condition at handover. The permanent lighting installation shall not be used for temporary lighting purposes during the contract unless prior written approval is given by the Engineer. In such case the Contractor shall provide new lamps at the handover for the Employer's use.

14. Light fittings shall be protected throughout the contract and should not be installed until the area concerned is dry and where they will not impede other installation works and risk damage. At the end of the on-site construction phase the Contractor shall re-lamp any light fittings where the lamp has failed or appears in poor condition.

15. All emergency lights shall be wired to the local lighting circuit and be arranged to operate when this supply fails. All emergency lighting shall be of 3 hour duration, self test, and maintained type. For each group of

emergency lights within a room or area that are connected to the same lighting circuit, a common key operated test switch shall be provided as part of the local light switch plate. The switch shall be engraved with a label to identify as an emergency lighting test switch. All emergency lights shall have a clearly visible label attached to identify as an emergency light and include a unique reference for testing purposes.

16. The control of lighting in dark rooms shall be that the main lighting switch shall be the master switch and a two-way cord operated pull-switch shall select either main lighting or 'safelight'.

35 LAMPS

1. Lamps shall be supplied and fixed by the Contractor and shall be for the correct voltage and of the specified wattage either plain or pearl as required in the case of tungsten lighting and of the correct wattage, length and colour rendering for fluorescent lighting, all as detailed in the drawings.
2. All lamps shall be new at handover, allowing reasonable time for testing etc. They shall not be used for temporary lighting for building purposes. Fluorescent lamps being used on dimming circuits shall be "broken-in" for at least forty hours.

36 LIGHTING SWITCHES

1. Lighting switches shall comply with BS EN 60669-1:2000 and unless otherwise specified, have white faceplates.
2. Switches shall be capable of switching the full rated inductive or resistive load and be of a 20A minimum rating.
3. Ceiling type switches shall be to BS EN 60669-1:2000 insulated pattern finished white with single cord operation and mounted on a matching plastic insulating pattress as required. These switches shall be of a minimum rating of 15A.
4. All switches shall be with boxes of 35mm minimum depth complete with suitable mounted brass protective conduit terminal and adjustable lugs to ensure switch plates are true and square. Boxes shall be flush with wall finish and any adjustment to depth shall be made with extension rings.
5. All switches shall have suitable boxes as specified for wiring system used.
6. All boxes for housing accessories shall be secured by a minimum of two round head fixing screws.
7. Where several switches on phase are required at the same position, a multi-ganged switch box shall be used to accommodate all switches on a common faceplate.

8. Where switches are mounted in Class 4 installations in situations exposed to weather or continual dampness, they shall be watertight pattern with approved gaskets.
9. Where different phases are present at one switch position, each phase shall be segregated in a separate compartment with each compartment covered by its own integral warning plate suitably engraved.

37 ISOLATORS/SWITCH DISCONNECTORS FOR FIXED APPLIANCES

1. The Contractor shall include for the supply and installation of a local isolator or switch disconnector for every fixed appliance, whether or not such a device is explicitly specified.
2. Each isolator/switch disconnector shall have the rating and number of poles suitable for the particular appliance and shall be of the approved type and manufacture, flush or surface-mounted as required. All devices shall be mounted in accessible positions local to the particular appliance which they serve. They shall be generally mounted at a height of 1.35m above finished floor level to the centre line of switch. All isolators shall be metal clad, or insulated body complete with "On"-"Off" indication and padlocking facilities.
3. Each device shall have an engraved plate of approved pattern, labelled to indicate the equipment which it serves.

38 FUSED CONNECTION UNITS

1. These shall be to BS 5733 double-pole switched with cover plate to match the socket outlets. Indicating type as for socket outlets.
2. Where used as a flexible outlet to an appliance, they shall be of the flexible outlet pattern with cable anchoring clamp.
3. Fusing and spare fuses as for socket outlets.

39 SOCKET OUTLETS

1. Socket outlets are to be provided must comply with: –
    a) 13 Amp, 230 volt, L + N + E, BS EN 60309-2.
    b) 16 Amp, 230 volt, L + N + E, BS EN 60309-2.
    c) 16 Amp, 400 volt, 3P + N + E, BS EN 60309-2.

d) 16 Amp, 110 volt, L + N + E, BS EN 60309-2.

e) 24 volt SELV lighting supply outlets, BS 196.

2. Each Socket outlet shall have an engraved label attached to the outlet or fixed alongside to give the voltage, maximum current supplied and the circuit reference.

3. Socket outlets shall be mounted at between 1000 mm and 1200 mm above finished floor level. A suitable mounting height for each type of outlet shall be proposed by the Contractor prior to installation for approval by the Engineers.

4. Socket supplies to fixed items of equipment shall be by means of either a local 13 Amp switch fuse connection unit or local switch-disconnector as shown upon the layout drawing. Where the item of equipment supplied power produces vibration or has free movement then the final wiring connection shall be by multi-core heat resistant flexible cable to comply with BS 7211 and a conductor csa sized to accord with the protective device rating fitted.

5. The 110 volt supplies unit shall be have a rated output of 2 kVA, with miniature circuit breaker protection to the input and four outputs. The outputs shall be terminals for hard wiring to remote 110 volt socket outlets as shown upon the drawings. The unit shall be wall mounted in the LV Switch Room.

6. The 24 volt supplies unit shall be have a rated output of 0.5 kVA, with miniature circuit breaker protection to the input and four outputs. The outputs shall be terminals for hard wiring to remote 24 volt socket outlets as shown upon the drawings. The unit shall be wall mounted in the LV Switch Room.

7. Socket outlets shall be to BS 1363 switched and shuttered and mounted in single or multiple assemblies and shall be of the type and rating as specified in the following section.

8. Matching plugs shall be provided for half the number of outlets and supplied with fuses.

9. Plugs shall be fitted with the correct rate fuse for the appliance to which it is connected complying with BS 1362.

10. Socket outlets shall be completed with boxes not less than 35mm deep and the box shall have a suitably mounted brass protective conductor terminal.

11. Cover plates shall be of similar manufacture and type to match the switches. They should be overlapping for concealed installation and flush to the side of the box for surface installations.

12. The earth pin sockets shall be connected to the box earth terminal with a green/yellow insulated protective conductor. Cover screws are not acceptable for earth continuity.

13. Indicating pattern outlets shall be used for appliances with a heating.

14. In Class 4 Protection Areas where installed in exterior locations, or in areas of continual dampness, outlets shall be watertight with watertight

caps and approved gaskets. Suitable caps shall also be supplied for each outlet.

40 ACCESSORIES & MOUNTING HEIGHTS

1. In every case the exact nature type, size, rating etc., will be detailed in the Particular Specifications, drawing or schedule. If the make of accessory is not indicated in the Particular Specification the Contractor must obtain the Engineer's approval for the type he proposes to use before starting work.
2. Each accessory box shall be securely fixed independent of the conduit or cable fixing. Accessory boxes for surface fixing shall be secured by at least two screws. Flush accessories shall be contained in boxes which shall, unless a proprietary type of box is specified which relies on other than screws for fixing, be securely fixed with two screws.
3. Accessories shall be fitted at the heights stipulated and shall be correctly aligned vertically or horizontally in line where fixed adjacent to each other on the same wall.
4. Care shall also be taken to fit flush boxes in exact positions relative to the wall finishes.
5. Mounting Heights: - Unless specified otherwise in the Particular Specification or on the associated drawings, the following mounting heights above finished floor level and measured to the underside of the accessory box shall be used:-

Lighting Switches	1350mm
Low level socket outlets spur units, TV outlets etc.	400mm
Over-bench mounted switches socket outlets etc. above top of bench	150mm
Clocks	Generally 2100mm to the centre line of the clock
Isolating switches and switch fuses	1350mm
Bells and sounders	Generally 2100mm to the centre line of the bells
Fire Alarm Pushes	1350mm
Thermostats	1600mm to the centre line of the stat unless otherwise stated
Wall lights	Generally 2000mm to the centre line of the fitting
Cooker Control	Generally 1350mm to lower edge of unit and to the side of the cooker

6. In general, lighting switches shall be positioned approximately 200mm from the nearside edge of any doorway.

41 FIXINGS

1. Lightweight equipment and conduit saddles fixed to the building structure shall be by means of proprietary fibre or plastic plugs. Alternative fixing devices may be used subject to the approval of the Engineer. Woodscrews shall be used in the following environments, (dry) steel, (damp) brass, (corrosive) cadmium plated steel.
2. The Contractor will be responsible for the fixing of all equipment and accessories which shall include the supply and installation of all Rawlplugs and other plugs, bolts and rawlbolts, screws, suspensions, brackets, clamps, saddles, spacers, etc., and any other fixing whether or not specified, which may be required for the proper and effective fixing of material or equipment. The use of wooden plugs for fixing purposes will not be permitted.
3. Fixing to the brickwork shall be made in the brick and not in the bond. If it is not possible to make all the fixings in the brickwork, then the equipment shall be positioned to enable the upper fixings to be made in the brickwork.
4. The Contractor will supply and fix all timber grounds and noggins required for the electrical installation.
5. Fixings by means of hardened steel pins driven in by percussion tool (HILTI or similar) or by gun fixing techniques will only be allowed where specifically agreed in writing by the Engineer.
6. Fixings to steelwork, etc., by means of special preformed spring clips or brackets will only be carried out after approval has been obtained from The Engineer steelwork must not be drilled.
7. Where goods or materials are supplied by Nominated Suppliers, the Contractor shall include for receiving, unloading, storing, providing adequate protection from the elements, unpacking, hoisting as necessary, assembling, positioning and fixing.
8. The Contractor will allow in his tender for the fixing of any wall mounted starters and control gear, etc., which may be supplied by the equipment manufacturer separate from the machines.
9. Heavy equipment shall not be fixed by plugs or shot bolts without the written approval of the Engineer, approved purpose-made clamp brackets and bolts or patent fixing bolts shall be used. Where heavy equipment is to be located on lightweight construction walls, the Contractor shall submit to the Engineer, for approval, details of the proposed support and fixings.
10. Structural steelwork shall not be drilled for any purpose without the written approval of the Engineer. In general, all fixing to steelwork shall be by means of patent clamp brackets or hook bolts. Approval shall be obtained from The Engineer for any other type of fixing.

42 PAINTING

1. Painting work connected with the Electrical Contract is to be carried out by the Contractor, except where otherwise detailed in this Specification.
2. The Contractor shall touch up all damaged paintwork to walls, ceilings containment, fittings and the like. The redecoration shall match the existing as far as practicable.
3. All new containment shall be painted to match the surrounding building finishes. PVC trunking shall be left unpainted.
4. Prior to handing over the installation, the Contractor is to remove all oil, dirt and other foreign matter from the conduits, equipment or plant. Failing to do so will render the Contractor liable for the cost of redecoration, should this become necessary.
5. Where painting is to be carried out by the Electrical Contractor due care will be taken not to mark the surrounding finishes, the paint will be applied in a professional manner. All iron and steel materials, including conduits, switchgear, brackets and accessories which show signs of rust will be wire brushed clean and painted with one coat of Jenolite rust remover and neutraliser, one coat of grey chemical sealer and one coat of red oxide paint prior to erection.
6. The Contractor will allow for painting the intake panel framework, trunking and all equipment mounted thereon, including all remote switchgear and controls with two coats of "NO RUST" aluminium finish paint as Soligmum Ltd or approved equal, and one coat of paint, colour as similar to the existing installations.

43 LABEL & CIRCUIT LISTS

1. The Contractor shall supply and fix all the labels and circuit's lists.
2. Labels shall be provided to all switchgear, control gear and distribution boards mounted within electrical intake cupboards/positions.
3. The labels shall be engraved traffolyte or some suitable agreed plastic laminator or rear engraved perspex. Unless specifically stated later in this specification labels shall have black lettering on a white background for warning or mandatory instructions. The labels shall be clearly marked having lettering not less than 10mm in height for title and not less than 5mm in height for explanation.
4. The labels shall be fixed in position by bright chrome or nickel plated machined self tapping screws with domed head. The outline size of the labels shall be consistent throughout the installation to permit interchangeability. Stick-on plastic labels shall not be used.
5. Each label will denote the function of the equipment served. Three phase equipment will also be labelled to denote the voltage. Labels will be as described above except lettering shall be red in colour.

6. In commercial intake positions the labels will denote the identification number/letter of equipment, current rating, polarity, circuit being served and description of circuit.

7. Labels to distribution boards shall denote the identification number/letter, number of ways, current rating, polarity, description of circuits being fed, location of supply cable.

8. Labels shall also be provided to all remote isolators, starters and push button units to indicate the equipment being installed.

9. Additional labels shall be provided as specified elsewhere in this Specification.

10. All labels and final titles shall be approved by The Engineer prior to engraving.

11. A notice of durable quality shall be fixed in a prominent position on the main switch gear. The notice shall read:-

12. 'IMPORTANT' This installation shall be periodically inspected and tested and a report on its condition obtained as prescribed in the current edition of the IEE Regulations.

13. The general main circuit breakers and/or switch fuses shall have a label indicating current rating; number of poles; function (which may include type of equipment) and a reference if called for e.g. 200amp; TPN; Lighting Main Switch Reference L1.

14. Section and distribution boards shall have similar labels but indicating numbers of ways; current rating (mixed if applicable); number of poles; area of premises it serves; function and detail of control plus any reference that may be called for e.g. 8 way 15 amp TPN; Office Lighting, Distribution Board reference L1 controlled from circuit 1, L1, L2, L3 of Section Lighting Board reference LS1 located Electrical Room.

15. In addition to the above main labelling, each section or distribution board shall be fitted with a circuit list taking the form of a heavy white card with circuit details typed or printed thereon in a clear and legible manner, the card shall be protected by a transparent plastic cover. The circuit list is to be located on the rear of the door/lid of the board and held in position by mechanically fixed clips, not by adhesive or tape.

16. A comprehensive typed Circuit List will be provided for each distribution board, consumers control unit installed. The Circuit List will detail a full description of the circuits which are being served, inclusive of fuseway number and M.C.B./fuse rating.

17. The List will consist of a white covered card enclosed within a transparent non-flammable PVC or approved sheet cover, secured to the equipment by means of 4 No. brass screw fittings.

18. Where it is not possible to install the Circuit Lists within the distribution board, a hardwood glazed frame will be mounted beside the board enclosing the List.

19. Instructions for the treatment of personal suffering from electric shock in the form described by health and safety shall be mounted and framed

under glazed hardwood frame, or in another manner approved by The Engineer and wall mounted in each Electrical switchroom area or enclosure into which one person may stand to inspect equipment.

44 TEMPORARY WIRING

Temporary wiring shall be installed in accordance with the IEE Wiring Regulations and to the instructions of the Engineer. Correctly rated and protected cable shall be used and where the ambient temperature is likely to exceed 35°C then Heat Resisting Oil and Flame Retardant (HOFR) insulated cable shall be used. In addition if the cable is likely to be subjected to mechanical damage it shall be protected by steel conduit, steel trunking or other method to be approved by the Engineer.

45 FIRE, GAS, WATER DETECTION & ALARM INSTALLATION

1. Comply with the requirements of BS 5839: Part 1: 2002.
2. A fire alarm system is required to be installed as part of fire certificate required by the Fire Precautions Act or the workplace regulations after an audit of a fire risk assessment.
3. Liaison with the local authorities as follows:
    - Building control officers
    - Fire authorities
    - Statuary and insurance requirements
4. The system installed shall compatible with the existing fire alarm system, or category agreed by the Purchaser.
5. Shall fulfil the Protection requirements below:
    a) Objective for Property Protection: To summon the fire brigade in the early stages of a fire.
        (i) Type P1: Property protection, automatic detection installed throughout the protected building.
        (ii) Type P2: Property protection, automatic detection in designated areas.
    b) Objective for Life Protection: To protect people from loss of life or injury.
        (i) Type M: Manual system (call points).
        (ii) Type L5: Life safety generally when specific fire engineering solutions or where PI insurance is required.
        (iii) Type L4: Life safety system, same as a manual system plus smoke detection on escape route.

(iv) Type L3: Life safety system, same as a manual system plus smoke detection on escape route and heat or smoke detection in adjacent rooms.

(v) Type L2: Life safety system, same as L3 but detection in fire hazard/risk of ignition i.e. kitchens, sleeping areas and other specified areas.

(vi) Type L1: Life safety system, similar to P1 but the audibility is more critical.

6. The control panel shall be equipped with a serial communications link as an interface port for connection to the site building management system.

7. The detection devices shall be wired upon a single 2 core bus cable that loops back to panel.

8. The detection loop cables shall be 300/500volt comply with BS 7629-1 as Pirelli FP200 Gold (1.5mm^2 conductor csa) or equal and approved.

9. The automatic detection devices shall comprise mainly analogue type with addressable base units.

10. The detection loop shall also include addressable interface modules able to send and receive signals to and from other monitoring and alarm systems and relay data back to the fire alarm control panel. As a minimum each device shall be enabled to connect 3 inputs and 3 outputs. Where more are required then the Contractor shall provide additional inputs and outputs. The input channels shall be as per conventional alarm circuits able to monitor for alarm and fault conditions. The outputs shall be volt free relay contacts programmable to switch in response to the various alarm or fault conditions.

11. All devices connected to the detection loop shall have unique addresses and no devices are to be installed as spurs to the loop.

12. The sounder circuit cables shall be 300/500volt comply with BS 7629-1 as Pirelli FP200 Gold (1.5mm^2 conductor csa) or equal and approved.

13. Sounder devices shall be combined electronic siren and strobe light units throughout.

14. The manual call points shall be surface mounting break glass units with an addressable module in each.

15. Call points should be fitted in conspicuous and easily accessible points on escape routes, mounted at 1.4 metres +/- 0.2m above floor level.

16. Call points should be located at the exits to the open air and all storey exits on each floor.

17. Distances to call points should not be more than 45 metres to operate, and 25 metres in any special hazards or high-risk areas.

18. One sounder should be located near the control panel or entrance on a separate circuit. Addressable systems should be wired from the control to a sounder protected by a short circuit isolator.

19. All the sounders should sound similar to avoid confusion.

20. A minimum of 65 dB is required in general areas or 5 dB above any background noise which persists for more than 30 seconds.
21. Were high noise levels exist, visual indication such as strobes may be required.
22. Where people in sleeping is to be woken then 75 dB is required at the bedhead.
23. A loss of 30 dB per door should be allowed for, to guarantee 75 dB at the bedhead a sounder per bedroom.
24. Special requirements are needed where there are people with impaired hearing.
25. Spacing for smoke detector under a flat ceiling has a radius of 7.5 metres.
26. Spacing for heat detectors have a radius of 5.3 metres.
27. A detector radius should reach every part of the room.
28. Detectors should be located a minimum 500mm away from walls.
29. There should be a 500mm clear space below and around the detector.
30. Detectors should be located at least 1 metre from air conditioning units.
31. Obstructions from floor to ceiling is more than 300mm ignore, less than 300mm then treat as a dividing wall.
32. In a pitched ceiling or in a roof void the spacing of the detector can be increased for 1% for every degree of the pitch angle up to a maximum of 25%. For this increase to be implemented detection should start at the apex.
33. Fire detection should be provided in the void greater than 800mm.
34. Fire detection should be provided if a fire or smoke can spread especially between rooms or compartments before detection.
35. End of line fault monitoring units shall be included and these shall be housed in separate, accessible and visible end of line enclosures and identified with labels and located adjacent the last sounder.
36. The Contractor shall provide a complete network of galvanised cable trays (not shown upon the tender drawings) dedicated to carry fire alarm and gas alarm cables only. The cable trays shall be sized as appropriate to carry the cables to be installed.
37. Where cables drop to break glass units or drop to low level then the cables shall be installed in 20 mm diameter galvanised steel conduits to offer the cable(s) protection.
38. The floor area of a single zone should not exceed 2,000m^2.
39. Two faults should not remove protection from an area greater than 10,000m2 (for addressable systems).
40. If the total floor area of the building is 300m^2 or less then it may be regarded as a single zone.

41. If the total floor exceeds 300m^2 then all zones should be restricted to a single floor level.

42. As an exception to the above stairwells, lift shafts or other vertical shafts (non stop risers) within a single fire compartment should be considered as one or more separate zones.

43. The maximum distance travelled within a zone to locate the fire should not exceed 60mtrs.

44. The equipment should be generally accessible on the ground floor next to the entrance to the building to enable the occupier and the fire brigade to quickly identify the zone in fire.

45. A plan of the building should be displayed close to the control panel showing entrances, escape routes and zones.

46. Operating instructions and logbook should be available.

47. The power supply for the control panel should be exclusive to the fire alarm system.

48. This should be secured from unauthorised use and labelled FIRE ALARM DO NOT SWITCH OFF.

49. Upon a mains failure the batteries should continue to power the system for a minimum of 24 hours plus 30 minutes alarm duration after that.

50. For unoccupied premises the battery backup should be up to 72 hour plus the 30 minute alarm duration. For over 72 hours the system should be monitored by a central station.

51. All cables for the fire alarm system should be fire proof including the mains supply. The standard cable should be a soft skinned type cable and the enhanced should be an MICC type cable.

52. The call point/detector/sounder circuit cables shall be 300/500volt comply with BS 7629-1 as Pirelli FP200 Gold (1.5mm^2 conductor csa) or equal and approved as minimum..

53. Upon completion the fire alarm shall be fully inspected and tested and Fire Alarm Installation certificate issued as part of the O&M Manuals. The record drawings issued as part of the O&M Manuals shall include the entire device and address information as installed and verified.

54. Test Certificate shall be provided as follows:

    a) Installation Certificate

    b) Commissioning Certificate

    c) Verification Certificate

    d) Acceptance Certificate

    e) Alteration Certificate

46 ELECTROMAGNETIC COMPATIBILITY (EMC)

The Contractor must observe the requirements for Electromagnetic Compatibility and include whatever measures are necessary to ensure that the installation (including a part thereof) neither gives rise to nor is susceptible to electromagnetic emissions which adversely affect the performance of the installations and in the former case other installations in the vicinity.

All control equipment shall be selected by the Contractor under this contract, to be designed and installed such that their operation does not produce an unacceptable level of radio interface. The limits of interface given in BS EN 55014-1:2006 shall not be exceeded.

47 INSPECTION AND TESTING - LV

1. The whole of the installation shall be inspected and tested on completion in the presence of the Contract Administrator in the manner described in the I.E.E. Regulations. The Contractor will provide the necessary labour, material and instruments for carrying out these tests and shall give the Contract Administrator seven days notice of the date it is proposed to carry out the test.
2. The following inspections shall be carried out during the whole of the Contract:
    a) General work standard and site inspection
    b) Equipment free from rust, damage and dirt
    c) Visual inspection of electrical equipment.
    d) Electrical information/literature on any equipment labelling and Circuit Charts being installed including
3. Prior to any wiring being commenced earth continuity tests shall be carried out to trunking, cable tray and conduit installation to ensure that the resistance figures are acceptable. These figures shall be submitted to the Contract Administrator for acceptance.
4. Visual checks are to be made of overload settings of all starters which should be set in relation to the full load rating of the motors they control.
5. The Contractor will also allow for testing the installation whilst work is in progress, or as instructed by the Contract Administrator, and in particular the following tests must be carried out:
    a) In the case of concealed sections of the installation these will be inspected and tested before being concealed.

b) Where cables are run behind 'pinned' ceilings or buried underground, tests must be carried out immediately after the ceiling is fixed and before decorations commence

c) Inspection and testing of conduits and trunking as previously specified.

d) Testing of MICC cables as previously specified

6. When the Supply Authority Board requires a Certificate of Tests as a condition of accepting an installation or part thereof for final connection to the supply, the Contractor will furnish such test certificates direct to the Board and forward a copy to the Contract Administrator.

7. The following sequence of events shall be carried out:-

8. Setting the plant to work

9. Inspection of the plant under operating conditions

10. Electrical tests on motors and generators and for ensuring the correct phase rotation of the three phase output from standby generation plant with that of the mains.

11. Demonstration to the Engineer of the proper operation of the plant and the control and safety devices under any fault condition.

12. During the execution of the works by the Contractor and on completion (and if considered necessary at the end of the defects liability period) the work shall be inspected by the Contract Administrator for compliance with the Specification

13. The tests executed in the presence of the Contract Administrator as detailed in the I.E.E. Wiring Regulations are as follows:-

a) Insulation

b) Polarity

c) Earth conductor continuity

d) Earth bonding

e) Line-earth loop impedance

f) Earth electrode resistance

g) Ring circuit continuity

14. At the discretion of the Contract Administrator a full load test (1 hour). During this test allow for taking voltage and current readings at the final sub-circuit, sub-main and main intake positions

15. The Contractor will submit the results of the tests to the Contract Administrator within seven days of the date of testing.

48 HANDOVER:

The Contractor shall, prior to completion:-

1. Supply all test certificates of plant items from manufacturer.
2. Supply all test certificates covering the works during installation and any special tests certified by the Insurance Company.
3. Supply schedule of circuits installed.
4. Supply "as-installed" drawings.
5. Supply operating and maintenance instructions for the proper working of the whole installation, service by service.
6. Supply of adequate instructions on safety precautions under fault conditions.
7. Supply a list of names, addresses and telephone numbers of all contracting firms and manufacturing firms responsible for the installation or supply of equipment items comprising the Contract Works.
8. Supply spares as indicated and/or makers recommended list of spares
9. Make sure all plant items clearly show actual manufacturers nameplate giving plant details, reference numbers, duty and date of manufacture.
10. Attend to the general finishing of installation.
11. Agree with Contract Administrator a list of defects.
12. Supply accessory, plant and equipment keys in duplicate.

49 BS APPENDIX

BS 148:1998	Specification for unused and reclaimed mineral insulating oils for transformers and switchgear
BS 159:1992	Specification for high-voltage busbars and busbar connections
BS 2692-2:1956	Fuses for voltages exceeding 1000 V a.c. Part 2 Expulsion fuses
BS 3288-4:1989	Insulator and conductor fittings for overhead power lines. Part 4 Locking devices for ball and socket couplings of string insulator units: dimensions and tests
BS 3693:1992	Recommendations for design of scales and indexes on analogue indicating instruments
BS 381C:1996	Specification for colours for identification, coding and special purposes
BS 4678-1:1971	Cable trunking. Part 1 Steel surface trunking. Current, but obsolescent
BS 4678-2:1973	Cable trunking. Part 2 Steel underfloor (duct) trunking
BS 4678-4:1982	Cable trunking. Part 4 Specification for cable trunking made of insulating material
BS 4800:1989	Schedule of paint colours for building purposes
BS 5207:1975	Specification for sulphur hexafluoride for electrical equipment
BS 5266-1:1999	Emergency lighting. Part 1 Code of practice for the emergency lighting of premises other than cinemas and certain other specified premises used for entertainment
BS 5266-2:1998	Emergency lighting. Part 2 Code of practice for electrical low mounted way guidance systems for emergency use
BS 5266-3:1981	Emergency lighting. Part 3 Specification for small power relays (electromagnetic) for emergency lighting applications up to and including 32 A
BS 5306-1:1976	Fire extinguishing installations and equipment on premises. Part 1 Hydrant systems, hose reels and foam

	inlets
BS 5306-2:1990	Fire extinguishing installations and equipment on premises. Part 2 Specification for sprinkler systems
BS 5306-3:2000	Fire extinguishing installations and equipment on premises. Part 3 Maintenance of portable fire extinguishers. Code of practice
BS 5372:1997	Specification for dimensions of cable terminations for multi-core extruded solid dielectric insulated distribution cables of rated voltages 600/1000 V and 1900/3300 V having copper or aluminium conductors
BS 5685-1:1979	Electricity meters. Part 1 Specification for Class 0.5, 1 and 2 single-phase and polyphase, single rate and multi-rate watt-hour meters. Current but obsolescent
BS 5685-2:1986	Electricity meters. Part 2 Specification for single-phase coin operated prepayment flat rate and two-part tariff watt-hour meters of Class 2 and fixed charge collectors of Class 2
BS 5685-3:1986	Electricity meters. Part 3 Specification for meters having Class 1 electro-mechanical maximum demand indicators Current but obsolescent
BS 5685-5:1987	Electricity meters. Part 5 Specification for input and output switching or logic arrangements for multi-rate registers for electricity meters
BS 5685-8:1991	Electricity meters. Part 8 Specification for impulse operated multiple registers for use with induction electricity meters
BS 5839-1:2002	Fire detection and alarm systems for buildings. Part 1 Code of practice for system design, installation, commissioning and maintenance
BS 6266:2002	Code of practice for fire protection for electronic equipment installations
BS 6436:1984	Specification for ground mounted distribution transformers for cable box or unit substation connection
BS 6651:1999	Code of practice for protection of structures against lightning

BS EN 7430:2011	Code of practice for earthing
BS 7729:1994	Specification for instrument transformers. Three-phase voltage transformers for voltage levels having U_m up to 52 kV
BS 7806:1995	Dry-type power transformers
BS 7821-1:1995	Three phase oil-immersed distribution transformers, 50 Hz, from 50 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. Part 1 General requirements and requirements for transformers with highest voltage for equipment not exceeding 24 kV
BS 7821-2.1:1995	Three phase oil-immersed distribution transformers, 50 Hz, from 50 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. Part 2.1 Distribution transformers with cable boxes on the high voltage and/or low voltage side. General requirements
BS 7821-2.2:1998	Three phase oil-immersed distribution transformers, 50 Hz, from 50 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. Part 2.2 Distribution transformers with cable boxes on the high voltage and/or low voltage side. Cable boxes of type 1 for use on distribution transformers meeting the requirements of BS 7821-2.1
BS 7821-2.3:1998	Three phase oil-immersed distribution transformers, 50 Hz, from 50 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. Part 2.3 Distribution transformers with cable boxes on the high voltage and/or low voltage side. Cable boxes type 2 for use on distribution transformers meeting the requirements of BS 7821-2.1
BS 7821-3:1995	Three phase oil-immersed distribution transformers, 50 Hz, from 50 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. Part 3 Supplementary requirements for transformers with highest voltage for equipment equal to 36 kV
BS 7821-4:1995	Three phase oil-immersed distribution transformers, 50 Hz, from 50 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. Part 4 Determination of the power rating of a transformer loaded with non-sinusoidal currents
BS 7821-6:2002	Three phase oil-immersed distribution transformers, 50 Hz, from 50 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. Part 6 Requirements

	and tests concerning pressurized corrugated tanks
BS 7844-1:1996	Three-phase dry-type distribution transformers 50 Hz, from 100 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. Part 1 General requirements and requirements for transformers with highest voltage for equipment not exceeding 24 kV
BS 7844-3:1998	Three-phase dry-type distribution transformers 50 Hz, from 100 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. Part 3 Determination of the power rating of a transformer loaded with non-sinusoidal current
BS 88-2.2:1988	Cartridge fuses for voltages up to and including 1000 V a.c. and 1500 V d.c. Part 2.2 Specification for fuses for use by authorized persons (mainly for industrial application). Additional requirements for fuses with fuse-links for bolted connections
BS 88-4:1988	Cartridge fuses for voltages up to and including 1000 V a.c. and 1500 V d.c. Part 4 Specification of supplementary requirements for fuse-links for the protection of semiconductor devices
BS 88-5:1988	Cartridge fuses for voltages up to and including 1000 V a.c. and 1500 V d.c. Part 5 Specification of supplementary requirements for fuse-links for use in a.c. electricity supply networks
BS 88-6:1988	Cartridge fuses for voltages up to and including 1000 V a.c. and 1500 V d.c. Part 6 Specification of supplementary requirements for fuses of compact dimensions for use in 240/415 V a.c. industrial and commercial electrical installations
BS EN 13601:2002	Copper and copper alloys. Copper rod, bar and wire for general electrical purposes
BS EN 50085-1:1999	Cable trunking and cable ducting systems for electrical installations. Part 1 General requirements
BS EN 50085-2-3:2001	Cable trunking and cable ducting systems for electrical installations. Part 2-3 Particular requirements for slotted cable trunking systems intended for installation in cabinets
BS EN 60044-1:1999	Instrument transformers. Part 1 Current transformers
BS EN 60044-2:1999	Instrument transformers. Part 2 Inductive voltage transformers

BS EN 60044-3:2003	Instrument transformers. Part 3 Combined transformers
BS EN 60051-1:1999	Direct acting indicating analogue electrical measuring instruments and their accessories. Part 1 Definitions and general requirements common to all parts
BS EN 60073:2002	Basic and safety principles for man-machine interface, marking and identification. Coding principles for indicators and actuators
BS EN 60076-10:2001	Power transformers. Part 10 Determination of sound levels
BS EN 60076-1:1997	Power transformers. Part 1 General
BS EN 60076-2:1997	Power transformers. Part 2 Temperature rise
BS EN 60076-3:2001	Power transformers. Part 3 Insulation levels, dielectric tests and external clearances in air
BS EN 60076-4:2002	Power transformers. Part 4 Guide to the lightning impulse and switching impulse testing. Power transformers and reactors
BS EN 60076-5:2001	Power transformers. Part 5 Ability to withstand short circuit
BS EN 60129:1994	Specification for alternating current disconnectors and earthing switches. Replaced by BS EN 62271-102:2002 but remains current.
BS EN 60265-1:1998	Specification for high-voltage switches. Part 1 Switches for rated voltages above 1 kV and less than 52 kV
BS EN 60265-2:1994	Specification for high-voltage switches. Part 2 Specification for high-voltage switches. High-voltage switches for rated voltages of 52 kV and above
BS EN 60269-1:1999	Low-voltage fuses. Part 1 General requirements
BS EN 60269-2:1995	Low-voltage fuses. Part 2 Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)
BS EN 60269-3:1995	Low-voltage fuses. Part 3 Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)
BS EN 60269-4-1:2002	Low-voltage fuses. Part 4-1 Supplementary requirements for fuse-links for the protection of semiconductor

	devices. Sections I to III: Examples of types of standardized fuse-links
BS EN 60282-1:2002	High-voltage fuses. Part 1 Current-limiting fuses
BS EN 60298:1996	A.C. metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
BS EN 60420:1993	Specification for high-voltage alternating current switch-fuse combinations
BS EN 60529:1992	Specification for degrees of protection provided by enclosures (IP code)
BS EN 60644:1993	Specification for high voltage fuse-links for motor circuit applications
BS EN 60694:1997	Common specifications for high-voltage switchgear and control gear standards
BS EN 60947-5-1:1998	Specification for low-voltage switchgear and control gear. Part 5-1 Control circuit devices and switching elements. Electromechanical control circuit devices
BS EN 61268:1996	Alternating current static var-hour meters for reactive energy (classes 2 and 3)
BS EN 61330:1996	High-voltage/low-voltage prefabricated substations
BS EN 61810-1:1999	Electromechanical non-specified time all-or-nothing relays. Part 1 General requirements
BS EN 61810-5:1999	Electromechanical non-specified time all-or-nothing relays. Part 5 Insulation co-ordination
BS EN 62271-100:2001	High-voltage switchgear and control gear. Part 100 High-voltage alternating-current circuit-breakers
BS EN 62271-102:2002	High-voltage switchgear and control gear. Part 102 High-voltage alternating current disconnectors and earthing switches
BS EN 7844-2:1996	Three-phase dry-type distribution transformers 50 Hz, from 100 to 2500 kVA with highest voltage for equipment not exceeding 36 kV. Part 2 Supplementary requirements for transformers with highest voltage for equipment equal to 36 kV
BS IEC 60076-8:1997	Power transformers. Part 8 Application guide