Electrical Standard Specification

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1 SECTION ONE: GENERAL REQUIREMENTS

1.1 Scope of the Specification

This general specification relates to the design, supply, installation, setting to work, testing and commissioning of all necessary materials and equipment to fully complete the electrical and associated services installation.

The Contractor shall undertake to carry out all works to achieve the highest possible standards of workmanship, the clauses contained within this section should be read in conjunction with the particular electrical specification, any stated, clauses contained within the particular electrical specification shall be deemed to override this specification.

Where discrepancies occur, the Contractor shall draw these to the attention of the Engineer, in writing, prior to installation. The Engineer will within 7 days from receipt of this written document instruct the Contractor on the methodology to be applied.

The Engineer's decision on this matter will be final and binding.

1.2 Method Statement

The Contractor shall submit a written statement on the method by which he plans to carry out the works, this shall be in the form of a bar chart with associated information, it shall relate to all other trade works which are both within and external to this contract. Prior to the submission of this statement the Contractor should liaise closely with other parties to ensure that he is fully briefed and aware of all site and installation requirements.

The Contractor shall also indicate any residual risks that the Client should be aware of.

All Risk Assessments shall be carried out in accordance with the HSE Guidelines and the Construction Design and Management Regulations 2009.

1.3 Maintenance of Services

The Contractor shall allow for the provision, erection, connection and subsequent removal of any cables or fittings necessary or required to maintain existing services to and within the site, in the event of disconnection being made necessary, due to, or by means of the works. In areas where stripping out, remodelling or removal of equipment is called for, the Contractor shall ensure that all existing points and equipment served from that area are maintained in permanent safe working condition. All points that are affected by such modifications shall, where necessary, be rewired and the Contractor shall allow for this contingency, including any temporary connections where necessary until the permanent installation is carried out. All such rewiring shall be carried out in materials and manner specified for the new work in that area. In connection with the installation of new switchgear, and alteration of existing supplies and services, the Contractor must allow for any working out of normal hours which may become necessary.

1.4 Stripping Out, Making Safe and Redundant Materials

The Contractor where necessary, shall disconnect, and place on one side, all items of equipment including lighting fittings, switch accessories, heating and distribution equipment, cables, etc., from all areas shown to be stripped out or remodelled, in whole or in part. In all such areas all wiring shall be disconnected from any source of supply and shall be made "dead" throughout its entire length. All redundant surface conduit and accessories shall be removed with all cabling.

All equipment, apparatus, fittings and accessories so removed shall remain the property of the Client and shall be carefully set to one side, suitably protected from all weathers and potential damage, and allowance made for all items to be returned on the receipt of instructions from the Engineer. Once this instruction has been received by the Contractor, the equipment and materials will become the property of the Contractor. No item whatsoever shall be removed from site until such instruction has been given. All materials for which no further use is envisaged shall be removed from site, and disposed of, all at the Contractor's expense.

The Contractor shall be responsible for ensuring correct phasing of all supplies in all areas due to be re-wired, remodelled and/or affected by alterations, and where temporary connections may be necessary to maintain systems, and for fixing permanent labels indicating the level of the voltage where deemed necessary by the Engineer.

1.5 Materials

All materials shall be of the best quality of their respective kinds called for in the Specification and the Contractor shall not substitute any materials for those specified or indicated in the Technical Schedules without the written authority of the Engineer being obtained.

All Materials shall be in accordance with the guidelines contained in the edition of the publication "*Good Practice in Selection of Construction Materials*" (2011: British Council for Offices) current at the date of specification

1.6 Carrying out the Works

The Contractor shall confer at all times with the Engineer and other Contractors to ensure that the works are integrated with those of all other trades.

The Contractor shall include in his tender provision for designing, installing, testing and connecting ready for use the installation forming the basis of this contract in sections as may be necessary to suit the construction of the building or buildings or parts thereof.

Compliance with the above requirements may mean the works forming the Contract cannot be carried out continuously and due allowance for this shall be made in the Tender.

1.7 Opening Up for Inspection

The Contractor shall afford every facility to the Engineer for the examination or measurement of any works which are intended to be covered up or buried. The Contractor shall give due notice when such works are ready for examination and the Engineer shall carry out such works that are ready for examination and/or measuring without unreasonable delay.

1.8 Cleaning Up on Completion

The Contractor shall clear away all dirt, rubbish, packaging, drums, and superfluous materials resulting from execution of the Contract as they accumulate and on completion of the Contract shall leave the installations clean, tidy and ready for use.

1.9 British Standards

Where a British Standard Specification or British Standard Code of Practice issued by the British Standards Institution is current at the date of Tender and appropriate to the case, the Contractor shall ensure that all goods and materials supplied or used and all workmanship shall be in accordance with that standard.

All accessories, equipment and materials used to complete the works shall be in full compliance with the appropriate British Standards Specifications and the installation shall be carried out fully in accordance with the latest revision and/or amendment thereto.

1.10 Regulations

The whole of the work shall be carried out to the entire satisfaction of the Engineer and in accordance with the following:

i) The British Standard BS 7671 Requirements for Electrical Installations (Institution of Electrical Engineers, Wiring Regulations).

ii) The rules, regulations and requirements of the local area Electricity Plc.

iii) The rules, regulations and requirements of the Fire Precautions Act, including any Fire Insurance Company Rules.

iv) The rules, regulations and requirements of the National Joint Council for the Electrical Contracting Industry.

v) The Health and Safety at Work Act 1974 and all amendments.

vi) The Electricity Supply Regulations, current edition.

vii) All Building Regulations and Local By-Laws, current edition.

viii) Noise Control. The Contractors attention is drawn to the provisions of Section 60 and 61 of the Control of Pollution Act 1974 with reference to the control of noises in relation to any demolition or construction works and to the issue of prior consent and the Contractor will be held responsible for complying with such requirements, restrictions or consents, etc., and is allowed in his tender for any costs or expenses arising from such compliance.

The Contractors attention is drawn to BS Codes of Practice BS 7375 and amendments relating to "Distribution of Electricity on Construction and Building Sites, together with BS 4363 Distribution Units".

1.11 Supply Authority

This refers to the organisation from whom the client purchases electrical energy.

Details of the Supply Authority's address and the full details of the electrical supply being provided shall be stated in the contractor's proposals which shall include the following:

1) Voltage
2) Number of Phases
3) Frequency
4) Type of System Earthing (TNC-S, etc)
5) Prospective Short Circuit Fault Current
6) The External Impedance at the Consumers Terminals

1.12 Drawings

The drawings to be read in conjunction with this Specification are listed in the particular electrical specification. Should additional information be required concerning details, building layout or mechanical services, further drawings may be obtained from the main contractor. The Contract Drawings and other such drawings as may be presented to the Contractor during the progress of the works shall be considered as illustrating the Specification.

Should any discrepancy arise between drawings and the Specification, the Contractor shall execute the work in accordance with the decision of the Engineer.

If necessary deviations from the drawings arise, the Contractor shall submit details of the proposed modifications and obtain the approval of the Engineer before such modifications shall be executed.

The Contractor shall arrange to keep on site a full set of drawings, which must be kept up to date, showing the progress of the work.

The Contractor shall keep a concise record, as work proceeds, of any part of the installation which is not in accordance with the original drawings.

Upon completion of the works the Contractor shall prepare and submit "As Fitted" Drawings in accordance with Clause 1.18.

1.13 Labels, Charts and Engraving

All distribution boards, switchgear, control equipment, switches, etc., shall be fully labelled for identification.

At the main distribution or intake position shall be fixed a distribution diagram showing connections installed complete with switch and fuse ratings and sizes and types of cables to each area served. This diagram shall be mounted on hardboard and be framed and glazed and screwed to the wall adjacent to the main switchpanel.

Labelling shall correspond with the schematic diagrams, details given on the relevant drawings, in this Specification and/or as instructed on site.

All switch and distribution equipment shall be provided with white/black/white laminated "Traffolyte" labels engraved to show 5mm black lettering on white ground, adequately describing the function of the unit. For items connected to one or more phases of the supply, the label shall indicate the phase or phases to which the item is connected.

All DP&N and TP&N distribution boards and multi-phase bus bar chambers shall in addition be labelled "DANGER 400 VOLTS" (or line to line voltage application) in 10mm BLACK lettering on yellow ground.

Precise details of circuits controlled by each MCB, or fuse-way shall be provided on a TYPED circuit chart which shall be covered with a sheet of clear Perspex and the whole shall be secured to the inside of the distribution board cover. Where space prohibits internal fixing of circuit charts they shall be framed, glazed and screwed to the wall or framework immediately adjacent to the equipment.

Under no circumstances will pencil or ink charts, "adhesive tape" labels or the use of the chart provided by the manufacturer within the equipment be permitted.

Each distribution board shall be provided with a typed circuit chart having the following information:

i) Size of cable feeding the board.

ii) Circuit from which the feed to the board is obtained.

iii) Fuse-ways or circuit breaker reference numbers.

iv) Equipment supplied by each fuse-way or circuit breaker.

v) The capacity and reference number of each HBC fuse or circuit breaker.

vi) Size of cable feeding each sub-circuit or final circuit.

The chart shall comprise a white card covered with a transparent non-flammable PVC or similar sheet and be secured to the inside of the board cover. Chart details and fixing must be approved by the Engineer before fitting takes place.

An identity label shall be affixed to each piece of apparatus, e.g. distribution boards, control gear, switchgear, etc., these shall be permanent non-flammable traffolyte, or equal, labels engraved in 5mm black letters, filled black on a white background. Labels shall be attached to the covers of apparatus by means of brass screws.

1.14 Treatment for Shock Notice

The Contractor shall supply and install adjacent to each service intake panel a metal "Treatment for Shock" notice as per the Electrical Times Limited, approved pattern.

1.15 Rubber Matting – Protection from Electric Shock

Rubber insulating mats shall be provided by the Sub-Contractor and shall run along the entire length of each switchboard and section board. Rubber insulating mats shall be robust non perforated pattern, possessing good insulating properties and such of dimensions to ensure that the operatives are physically unable to make contact with a non insulating floor with either or both feet. All mats shall conform to BS.921.

1.16 Wall Charts

System diagrammatics are to be provided, mounted within all plant rooms and switchrooms. These drawings shall cross reference all equipment with the maintenance and operating instructions.

The charts are to be mounted in a clear acrylic sheet fronted, stained timber frame with screw fixings to a suitable walled area.

1.17 Working Drawings

The Contractor shall allow for the provision of detailed and dimensional working drawings for both builders' works and Engineering requirements and these shall be forwarded to the Engineer for approval within 14 days of the contract start date or the receipt of an official order.

The Contractor should provide full working drawing of all works associated with this project together with any calculations which may be required by the Engineer.

The working drawings shall be at a scale no greater that 1:100 and shall detail all matters and finishes which affect the installation.

1.18 "As Fitted" Drawings

The Contractor shall keep records and details of all amendments made to the specification and drawings issued for the purpose of this contract. This information shall be translated into a format that will allow the preparation of "as fitted" drawings for presentation to the Engineer, together with the user instruction manuals deemed necessary for this contract.

The handover of these drawings will be prior to the official contract completion date and time.

Phased Handover

"As fitted" drawings relating to the works undertaken during the phased work packages shall be handed over prior to the handover meeting.
The drawings shall show the exact position of all circuit and wiring details, components specified/shown on original drawings, together with any additions that have been authorised. The drawings shall also be amended to account for omissions authorised. The routes of all cables, trunking, ducts and pipework runs shall be clearly indicated, so as to provide a comprehensive record of the whole of the electrical/mechanical installation works.

The "as fitted" drawings shall be presented in the following formats, as indicated in the specific technical section of this specification.

a) One set of paper prints to the same scale, quality and competency as those provided for contractual purposes.(For checking Purposes)

Three sets of paper prints of the above, to be included within relevant sections of the maintenance manual, if practicable.

b) Two sets of electronic drawings files formatted onto a CD and compatible with auto-cad version 2010. These files shall include all drawings produced as "as fitted" record in negative format as "as fixed" record in negative format (a) above.

1.19 Temporary Supplies

The Contractor shall allow for any temporary electrical supplies which may be necessary to maintain the operational effectiveness of existing services during the works.

The Contractor shall produce a fully detailed method statement; clearly and unambiguously identifying each element of the work package and how power supply disruption will be avoided.

1.20 Services Interruption

All works requiring the disconnection of the electrical supply will be carried out outside normal working hours, during a continuous Sunday working programme with a maximum disconnection period of eight hours in any one day.

Under no circumstances must any electrical supply be switched off without the prior written consent of the Engineer. The Contractor must notify the Engineer in writing at least 10 working days before any planned supply interruption and must state clearly the length of the proposed interruption.

Note: No power supply may be switched off without prior written consent to the Engineer or the contract administrator.

The Contractor will include in his costs for all temporary electrical supplies required during each phase of the works together with their subsequent removal on completion.

1.21 Testing and Inspection

The Contractor shall, as when instructed by the Engineer, demonstrate the ability of any component in the installation to fulfil the function for which it has been designed and/or supplied.

Before commencing any wiring the Contractor shall carry out the tests as detailed in BS 7671 Wiring Regulations.

In addition a full load test for 1 hour shall be carried out.

The above test shall also be carried out at any time during the progress of the works as required by the Engineer. Responsibility for the imperfections in materials or equipment which become evident after erection and testing will rest solely with the Contractor.

All defects revealed by the tests or inspections shall be rectified immediately, and all tests repeated until the systems are deemed satisfactory by the Engineer, all at the Contractors expense.

The records of all tests shall be properly kept and recorded by the Contractor, and at completion of all test periods, duplicate copies of the results shall be forwarded to the Engineer.

At practical completion of the works and tests, the Contractor shall complete and forward to the Engineer, in duplicate Completion and Inspection Certificates as prescribed by BS 7671. Wiring Regulations. The Contract will not be certified as complete until receipts of the above Certificates are satisfactorily completed.

NOTE: The Contractor shall provide "detailed" test record sheets showing all relevant test and circuit data, instrument reference and the signature of the testing operative and witness, one of whom shall be a fully competent technical supervisor.

This clause shall also apply to phased handover requirements.

1.22 Earthing Arrangement and Protective Conductors

The whole of the electrical installation and all other equipment connected thereto shall be earthed to conform to BS 7671 Wiring Regulations, and in addition, to the requirement of the Supply Authority.

A protective conductor sized accordingly shall be connected to the extraneous conductive parts in accordance with the Regulation 411.3.1.1, where such services enter the premises, and to be connected to the consumer's earth terminal on the Main Distribution Panel. Protective bonding conductors shall be protected where liable to damage and at every point within 2.500m of finished floor level, by means of steel conduit. Clamps complying with BS 952 shall be used and fitted in readily accessible positions, type EC15/EC16 as necessary.

In cases where the pipework is in excess of 50mm, the Contractor shall provide copper tape secure by means of a Furse Limited bond type BN120.

The whole of the electrical installation and all other associated equipment connected thereto shall be earthed in conformity with BS 7671. Wiring Regulations, the Local Authority Regulations and shall also comply with the following clauses.

A) MATERIALS

All separate earth and bonding conductors shall be of high conductivity annealed copper type, size and with protective covering specified, and manufactured to the appropriate British Standard. All conductors shall be one manufacture, and supplied direct to site in a drum with the manufacturers seals and labels intact. These seals and labels shall be handed to the Engineer on request. Earth plates and rods shall be manufactured by B.I.C.C. Limited or approved equal.

B) INSTALLATION

The main switchgear and frame upon which it is mounted shall be bonded to the sheath of incoming supply cable, or earth termination point by means of a 25mm x 4mm copper tape and approved clamps.

Identical bonding shall be carried out to be the framework of the building – and repeated at all sub-main distribution positions, both in the same and individual buildings – and also to the incoming gas and water services.

Where flexible conduits are installed the circuit protective conductor shall be run inside the conduit.

The Contractor shall also carry out bonding of services throughout, i.e. cylinders, sinks, baths and all other equipment which may be supplied and fixed by others. The bonding shall be carried out using 6 sq.mm green/yellow PVC insulated cable via a flex outlet plate adjacent to the local distribution board.

N.B. This shall be upgraded to 16 sq.mm on all main cross bonding and all P.M.E. and earthed neutral supply systems.

At no time shall the resistance of any, or all, earth "paths" exceed 0.5 ohm. In addition, the impedance of any conduit system between any point and its local distribution board shall not exceed 0.1 ohm.

Where any situation arises that metallic enclosures are not fitted with purpose made earth terminals, the Contractor shall terminate the C.P.C. via M4 brass screws and washers, the enclosure being drilled and tapped to receive the screws.

1.23 Demonstration to the Client

The Contractor shall allow two full days' seminars to the client's representatives on the operation and maintenance of all systems covered by this contract. This shall include specialist representatives from equipment and system suppliers giving full briefing on the application and day to day running of the equipment.

1.24 Builderswork Requirements

All major builders' works will be carried out by the Main Contractor. The Electrical Contractor shall undertake to produce a detailed and accurate schedule of his requirements for this item.

This schedule shall be provided within 14 days of the placing of official order and prior to site attendance.

1.25 Radio and TV Suppression

All electrical equipment to be supplied and installed under this contract, such as motors, thermostats, etc., shall be provided with radio and television suppressions to comply with BS EN 55014 and subsequent amendments. In addition, the requirements of EEC Directive 89/336/EEC for EMC shall be complied with. The Contractor shall be responsible for fitting suppressors to all such equipment supplied under this contract which is not so fitted.

2 SECTION TWO : TECHNICAL REQUIREMENTS

2.01 Cables, Conductors and Flexible Cords

Every cable installed, including IT control wiring shall be BASEC approved with low smoke and flame halogen free insulation and shall comply with the appropriate British Standard Specification (and subsequent amendment) as follows:

i) Non Armoured PVC insulated cables to BS 7211.

ii) Vulcanised rubber, butyl rubber, eg. Rubber or silicone rubber insulated cables to appropriate British Standard.

iii) Cu/XLPE/SWA/LSF cables to BS 6724.

iv) Mineral insulated copper sheathed cables to BS 6387:1994.

v) Flexible cables and flexible cords insulated with PVC, vulcanised rubber, butyl rubber, e.g. rubber, silicon rubber of glass fibre to BS EN 50525-1/2/3.

vi) HV cable in accordance with BS 6222-2 and IEC 287 – Red.

All cables shall be new and unused.

Unless otherwise stated all conductors shall be stranded copper with no conductor size smaller than 1.5mm sq. for cables 24/.20mm for flexible cords. Where multicore cables are used reduced neutral conductors shall not be permitted.

Cables of distinctive colour shall be used up to final distribution boards, being Brown, Black or Grey, relative to phase connection. From final distribution board onwards red cable only shall be used for all live feeds excepting in 3 and 4 core composite cables where the phase colouring shall be maintained. Neutrals shall be blue throughout.

Cable colours on extra low voltage circuits shall be readily distinguished from those on low voltage circuits.

All cable conductors shall comprise of stranded copper wires. Solid core cables shall not be permitted. All cables shall have low smoke and fume oversheath.

Other than at fittings and accessories, joints will not be permitted in any cable run. Connections between flexible cords and other cables shall be made by means of proprietary connectors fixed in a BS conduit box, or via flex outlet spur boxes or as otherwise specified.

All cable cores shall be identified by numbers of colours. Control and other ancillary circuits shall have their conductors identified at the terminations via Critchley interlocking ferrules.

2.02 Wiring and Cabling Systems

(a) GENERAL

All cabling runs, both internal and external, shall be approved by the Engineer, on site, before any installation commences.

The tie wrapping of cables with a CSA greater than 10mm sq. will not be permitted, beta strip and pin to be used up to and including 4C 70mm sq. Larger cables shall be cleated.

No joint or connector boxes will be permitted in any cable run under any circumstances, and all cables shall be installed in one continuous length between accessories, equipment, plant or buildings.

Joints will only be permitted in runs of mains cables due to the limitation of maximum possible manufactured lengths. In the event of this situation arising, the Contractor shall notify the Engineer in writing prior to any installation commencing in order that the location and type of any requiring the joint elsewhere than at the end of the longest length of cable available in order that such joints may be, at all times accessible for inspection.

All cables shall be installed in such a manner as to prevent damage to the sheathing and/or armouring, or any displacement of the conductors. Any cable length so damaged shall be removed from site and replaced by a completely new length.

On all armoured cables an identification band shall be fitted, below the armour clamp and along its length giving details of type and size of cable and materials. Spacing of identification bands shall not exceed 5 metre intervals.

All main and sub-main cables, where run vertical on the outside of buildings, shall be protected by rolled, galvanised steel channel, with welded fixing lugs, to a height of 2.500mm above the finished ground level.

Where cables pass through walls, floors, etc., they shall be protected within a length of PVC steam pipe the end of which shall be sealed with a cold plastic compound. The pipe shall be of a diameter at least 25mm greater than the overall diameter of the cable.

In all instances, where cables enter buildings or ducts, they shall be drawn into 150mm diameter salt glazed earthenware self-aligning pipes. These pipes shall run from an agreed position inside the buildings to a point at least 900mm clear of the building line and its foundations, and at a depth of not less than 500mm. The ends of the pipes shall be sealed with nylon ropes and cold plastic compound. In the buildings, the pipes shall raise to floor level with a slow bend.

Where mains cables are installed with ducts, or along the surface of walls, they shall be supported by heavy nylon cleats of size to suit the overall diameter and shall be spaced consistent with the requirements of BS 7671. Wiring Regulations and the cable manufacturers recommendations. The cleats shall be manufactured by Messrs. Cablok Limited or equal and approved and supported from walls, ceilings, beams, etc., by the

necessary length of aluminium channel, supplied by the manufacturers of the cleats.

Where the cables are buried directly into the ground, they shall be at a depth of not less than 600mm, laid on a bed of 75mm of sand and covered with a further 75mm of sand and by interlocking protection tiles of an approved pattern. Suitable PVC identification tape shall be installed along the continuous length of the cable.

Where cables are run on cable tray they shall be arranged such that all single core cables comprising a circuit shall be adjacent or "tiered" on one another, and all the larger sizes of cables are run, where particular, together. All the cables shall be laid in such a manner that, where they leave the tray, they do not cross or interweave with the cables remaining on the tray. The larger sizes of cables shall, as far as possible, be run on the outside of the trays, and where these cables have to cross runs of the smaller ones, they shall cross beneath the other cables to prevent damage to the similar or smaller ones.

All cables less than 70 mm sq. shall be secured on trays shall be fastened to the tray by means of "Betastrip" which shall pass over and under the cables and be fixed at each end by means of M6 brass nuts, bolts and washers

All armoured cables shall be terminated generally as described hereafter and in accordance with the manufacturer's recommendations. Unless specified otherwise, lead sheaths and armouring shall be used as earth continuity conductors, and at each termination the cable sheath and armouring and joint box shall be effectively bonded to the associated equipment, so that the continuity path resistance is, in no place, greater than a corresponding length of earth conductor, i.e. sheath or armour only, in parallel, dependent on type of cable.

In addition each termination shall have connected to its earth connection one PVC insulated copper cable which shall also be terminated at the earth terminal of the item of equipment, the size of the cable shall comply with BS 7671 Wiring Regulations

For all lengths of cables of any type under this Contract, copies of the manufacturers test certificates shall be forwarded to the Engineer, as and when called for.

All cables shall be kept at least 150mm clear of any pipes carrying hot water.

All cables shall be of an adequate voltage grade to suit projects' conditions.

(b) P.I.L.C.S.W.A. & SHEATHED CABLES

These shall be mass impregnated, non-drained type. They shall comprise round or shaped conductors of equal sectional area, composed of strands of high conductivity plain annealed copper wire, insulated with strong, long fibred paper, uniform in texture, free of metal particles and deleterious substances.

The cores shall be laid up together (each core being differently numbered on the outer layer for identification) and wormed circular, the whole being

overall lapped with paper tapes, vacuum dried, impregnated with special non-drain compound, sheathed with lead with two compound paper tapes, jute bedded, armoured with a single layer of galvanised steel wire, served and preservative compounded overall.

The cables shall terminate in cast iron sweating boxes with plumbing glands, armoured clamps and screwed filling plugs. For bolting to trunking, or mounting directly to switchgear, terminal boxes of the same manufacture as the switchgear specified for the Contract shall be used.

All cores shall be sweated solid at the centre of the chamber to form moisture and oil barrier and taken direct to the terminal of the apparatus, terminating in a correct size sweating socket. Where cables change from paper insulated to V.R.I. tails, etc., the change shall only take place in the sealing boxes with tails of the same copper cross section, and they shall be amply protected with bitumen compound.

All wiped joints shall be carried out in a manner approved by the Engineer, by a qualified cable jointer, and the Contractor shall arrange for any person so employed to demonstrate his ability to the Engineer, or his appointed representative, when called upon to do so.

The Engineer shall be notified in writing prior to the commencement of any jointing.

(c) PVC INSULATED AND SHEATHED STEEL WIRE ARMOURED, PVC SHEATHED

These shall be polyvinyl chloride insulated type, comprising shaped conductors of equal sectional area, stranded high conductivity annealed copper wire, insulated with PVC compound.

The cores shall be laid up to form a circular cable using jute fillers and each core shall be identified by numbers; the whole to be bedded with polyvinyl chloride compound, armoured with a single layer of galvanised steel wires, and the whole sheathed overall with PVC.

Cables shall be terminated in Hawke or equal and approved terminating and sealing glands, complete with PVC shroud to cover the gland. These glands shall in all circumstances be securely clamped to the control panel, item of switchgear, etc., by the appropriate size of brass locknuts, earthed tag and washers. Each gland shall be fitted with a watertight sealing attachment to provide a watertight seal on the inner sheath. Where the sizes of cable does not permit the PVC shroud to be slid straight onto the tapered portion of the shroud and shall be cut to fit tightly around the cable, and the gland made off before the shroud is pushed up over the gland. The end of the shroud on the cable shall then be taped up with three or four turns of self-adhesive, coloured PVC tape of the same colour as the cable sheathing.

All glands shall be made-off in strict accordance with the manufacturer's instructions for fixing.

In every instance, the cores of the cables shall pass through the gland and enter the terminals of the equipment direct. Where "bolt-on" terminations are provided in the various components, the cores of the cables shall terminate in the correct size of cable lug, i.e. of the same rating as the cable, which shall be securely sweated on the cable.

The type of cleat and method of attachment to the structure shall be subject to approval beforehand by the Engineer. Cleats shall be spaced at intervals recommended by the manufacturers as being adequate to prevent sag and strain.

The radius of any bend shall be in accordance with the cable manufacturer's recommendations.

An identification band, as previously described, shall be fitted at intervals along the continuous length.

(d) ALUMINIUM ARMOURED PVC INSULATED CABLES WITH ALUMINIUM CONDUCTORS

These shall comprise shaped conductors of equal sectional area composed of solid drawn aluminium, insulated with polyvinyl chloride compound. The cores shall be laid up and covered with clear PVC tape, and armoured with a layer of hard drawn aluminium strip, and the whole covered with an extruded polyvinyl chloride sheath.

Fixings and suspensions shall be as detailed in (c) above.

The cables shall be terminated in an approved gland fitted with a tapered cone, which firmly clamps the armour strip securely to the apparatus, and earthing. Manufacturer's instructions shall be strictly adhered to with no permitted exception.

Conductors up to 100 Amp capacity may be fitted with the purpose made swage terminals made off in accordance with the manufacturer's instructions. All other conductors shall be fitted with the correct size of crimped lug and terminated as described in (c).

Connections or contact areas between aluminium and other metals shall be smeared with Demo paste, or equal or prevent electrolytic action taking place.

All aluminium conductor cables, and all necessary accessories for these cables shall be manufactured by BICC or equal and approved.

(e) MINERAL INSULATED METAL SHEATHED CABLES

These shall be single or multi-core as required, and the whole shall be installed only with the tools recommended by, and in accordance with, the instructions and recommendations of the manufacturer.

Only tradesmen skilled in the use of M.I.M.S. cables shall be used on the installation, and at the Engineers request the tradesmen shall demonstrate their skill, on site, by "making-off" a trial seal or seals to the Engineers satisfaction.

Unless otherwise specified, all M.I.M.S. cable shall be light duty grade and in all instances shall be sheathed overall with PVC coverings.

The minimum size of cable that may be used shall be 1.5 sq mm.

All joints shall be made at main switches, distribution boards, switches, lighting point boxes, socket outlets and fixed apparatus only. No joints shall be made in cables at any other points.

All cable ends shall be sealed using the purpose made item manufactured and supplied by the manufacturer, of the correct size and type, for that particular cable.

Where seals are used without a gland, the seal shall be that supplied by the manufacturer, with a permanently fixed earth tail which shall be connected to an earth terminal inside the accessory or apparatus.

Cable tails shall normally be insulated with black Neoprene sleeving, but where necessary in hot situations the sleeving shall be RED silicone rubber. Hot situations shall be defined as connections within bulkhead fittings, similar unventilated lighting fittings and connections to heating apparatus which is directly and mechanically coupled to heating systems.

All tails shall be marked with self adhesive identification sleeves as follows:

Brown, Black & Grey for phase and Blue for neutral conductors on main and sub- main cables.

Brown for line, Brown for switch and Blue for neutral on sub-circuit wiring.

Numbers to tally with terminal numbers to which the conductors are connected for control circuit wiring.

Where cables enter boxes and equipment the following methods of termination shall be used:

(1) The universal type shall be used in all situations other than those specified below, and on no occasion shall any other gland be used for main and sub-main cables.

Where the entry to the equipment is already tapped, the gland shall be screwed direct into the equipment utilising, where necessary, solid brass reducing sockets.

Where entry to the equipment is a clearance hole, the gland shall be fixed to the equipment by use of a male brass bush & coupling assembly to ensure that the interior space within the accessory box is not reduced by the protruding exposed threads of the gland.

(2) The earthing screw gland may be used where a tapped entry box is concealed space, always provided that such situation is dry and that both earth screws are tightened.

Internally all cables shall wherever possible be concealed behind plaster finish walls, in particular cavities, in ceiling spaces, cast in situ concrete roofs etc., and where provided, the maximum use shall be made of floor, vertical and ceiling ducts. All runs shall be straight and parallel with the sides of the building and all rises and ropes shall be vertical.

Only on the underside of roofs having no ceiling cavity shall the cables be run on the surface.

Cables shall be fixed, in various locations, as follows:

(i) On the surface unplastered and ceilings in damp situations – heavy gauge copper saddles.

(ii) On finished surfaces – heavy gauge copper saddles.

(iii) Concealed cables – standard copper clips and saddles.

(iv) Ceiling voids – catenaries or cable tray.

Cables shall be fixed at spacings not exceeding the following:

In floor screeds and in situ concrete	– 150mm
In other concealed positions	– 900mm
On surface work	– 250mm

Lighting installations shall be carried out in the loop-in principle. Cables shall terminate at the ceiling points in either standard circular malleable iron screwed conduit boxes, or looping-in boxes, in non demountable ceilings and where cast in situ concrete is used; or in flex outlet boxes in demountable ceiling areas.

Link boxes shall be provided at each end of underground runs so that the cable can be completely disconnected from the rest of the installation. These boxes shall be made up of proprietary connectors securely fixed in a grey iron 60mm x 60mm x 50mm adaptable box with weather proof cover.

In addition to the standard test called for, the Contractors shall test – at a pressure of 500 volts, every seal and length of cable when it is installed, and 24 hours after installation.

Where cables are laid in screed, they shall be tested whilst the finish is still "green".

No termination whatsoever shall be made unless the insulation resistance is infinity.

Where run on the surface cable shall be dressed to remove all irregularities and to follow the contour of the surface so as to provide a neat inconspicuous installation.

Where M.I.M.S. cables are required to terminate at motor terminal boxes, or any other equipment where some form of movement is required, or where the termination may be subject to vibration they shall be formed into a loop adjacent to the termination. The radius of the loops shall be sufficient to permit tensioning and other similar adjustment.

Where M.I.M.S. cables are installed, a suitable surge suppression device shall be connected at the terminals of any inductive loads, i.e. fluorescent luminaires, motors, etc.

Where used on fire alarm circuits all cables shall be PVC covered irrespective of location.

The whole of the installation shall be carried out with tools recommended by, and in accordance with the instruction of, the appropriate manufacturer, unless otherwise specified. Cables shall be terminated with approved medium temperature type seals of the screw-on pots, complete with the correct sized gland, and the tails shall be insulated with P.T.F.E.

sleeving of the appropriate colour. Glands shall be tightened to form a permanent and effective earth continuity connection, and when connected into clearance holes shall be fitted with a compression washer and lock nut. All glands shall be complete with PVC shrouds.

FP200/FIRETUFF CABLE

All wiring shall be carried out on loop-in basis with connections made only at accessory or equipment positions. No joint boxes shall be permitted in any length of cable under any circumstances.

When stripping the cable, care shall be exercised to avoid damaging the silicon rubber installation, and to this end the required length of "tail" shall be obtained by stripping back in one operation only. This shall be achieved by scoring round the PVC sheath with cable stripping tool taking care not to cut through the aluminium foil. The cable shall then be gently flexed at the point of scoring until the sheath yields, and then the sheath shall be pulled off gently twisting it at the same time in the direction of lay of the cable cores.

Before splaying out the cores for termination, the Contractor shall fit the correct size of plastic ferrule, slid over the cores and fitting to the end of the sheath. On 7, 12 and 19 core cables a ferrule shall not be used; instead the Contractor shall fit a length of heat-shrink tubing over the core/foil interface. Conductors shall not be "set" as they leave the ferrule; but shall be run straight and gently set so that pressure is not exerted on the cores as they leave the cable termination.

In addition, all cores shall be sleeved for their entire exposed lengths in accessories with varnished rayon sleeving.

All cables shall be run direct from the reel which shall be mounted on a spindle device to prevent the cable from kinking. Cables shall only be dressed by hand and all bends shall be of radius such that the bend is not less than 6 times the cable diameter.

Cables shall be fixed using white PVC coated single hole P clips and such fixings shall be provided every 300mm for horizontal runs and 400mm for vertical runs. Where multiple runs of cable occur, they shall be fixed in total by means of white coated perforated metal strip forming a common fixing band. The strip shall be securely fixed at each end, and spacings shall not exceed those given for single cables.

Where the cables are concealed within the building fabric, e.g. wall chases, floor screeds etc., they shall be protected throughout their buried length be steel conduit or rolled steel channel.

No attempt shall be made to separately earth the PVC/aluminium sheath of cable. Full earthing facilities will automatically exist with the proper connection and termination of the bare copper earth core within the cable.

ACCESSORY BOXES

All accessory boxes used with FP200 cable installation shall be white plastic type for all except where the mounting of potentially hot sources is required, e.g. enclosed tungsten filament lamps. In these instances, the equipment shall be mounted in a metal box adjacent to the cable

termination box, and final connection shall be by means of an extension from the cable termination box.

TERMINATIONS

Entry into all boxes and other equipment shall be by means of nylon compression gland, and shrouded entry adapters for circular boxes.

In damp or external situations, type AZ glands to BS 6121-1 with seals shall be used to prevent ingress of moisture.

Care shall be taken to ensure that sheath and ferrule does not enter accessory boxes, but stops immediately at the end of the gland. This will ensure unnecessary bending and cramping of cable will be avoided.

IDENTIFICATION

All cores within control cabinets, distribution boards, etc., shall be fully identified as to their circuit use (e.g. live, neutral, phase, zone, bell etc.,) by means of crimped-on cable markers having black lettering on white ground. These shall be applied over the core sheathing in such a manner as to be readily seen as soon as the cabinet door, or similar, is opened.

In addition, the fixings shall be provided immediately adjacent to each ceiling rose, switch to socket box, etc.

Where cables enter or leave boxes, the cable sheath shall be protected by rubber packed grommets for surface installations.

Bends in cable shall be in accordance with BS 7671 Wiring Regulations.

PVC INSULATED AND SHEATHED CABLES

Cables shall be of the sizes and types as indicated in this specification and associated drawings.

Wiring to each electrical point shall terminate within a brushed metal box complete with fixed connectors where applicable, e.g. lighting points.

The circuit protective conductor of the cable shall terminate in the earth terminal of the accessory of equipment in the point or switch box for lighting fittings.

Where cables run under floors and in roof spaces, they shall if run at right angles to the joists be passed through holes drilled in the neutral axes of the joists where possible but in no case shall the hole be less than 50mm from the top of any joists.

Where cables are run parallel to the joists in roof spaces or in floors they shall be clipped to the sides of the joists not less than 50mm from the top or bottom of the joists.

The cables shall be supported with PVC moulded clips, saddles, or PVC tape to the Engineers approval fixed at adequate intervals to prevent any strain on the cables. Saddles and tape shall be secured by suitable brass screws. Moulded clips will only be permitted when fixing to timberwork.

The spacing of the clips, saddles or tape shall be in accordance with BS 7671 Wiring Regulations

All cables shall be single or multi-core, with earth continuity conductor, 600/1000 volt grade flat formation PVC insulated, PVC sheathed. All line cables shall be brown, neutral cables blue and switch wires brown or identified by self-coloured white sleeve. All single poles shall be connected in the live cables.

All wiring shall be carried out on the looping in principle and shall be arranged so that joints in the cables are made only at switches, light points and sockets, etc.

No more than three cables will be permitted at any lighting point.

No joint or connector boxes shall be used under any circumstances.

All cables shall be run directly off reels and not taken from loose coils. No bends in a cable shall have an inside radius of less than four times the width of the cable.

All cables shall be manufactured to the appropriate BS specifications/EEC standard.

FIXING

Cables to be fixed on timber shall, where run parallel with joists, etc., be fixed to the side of such timber by means of moulded PVC clips, and where run at right angles to such joists shall be fixed by the above method to supporting battens. All fixings shall be intervals not exceeding 100mm.

Where cables are sunk in floor screeds, they shall be protected by round, welded screwed steel conduit, the free ends of which shall be fitted with brass bushes; and the ends at metal accessory boxes or other metal items, shall terminate direct into the box or item and shall be fitted with a suitable brass brush.

Where cables are sunk in plastered walls, they shall be protected throughout their buried length by round, welded, steel conduit. These shall be run in chases, the depth of which shall be sufficient to give at least 12mm of cover.

Where flush cables are to enter surface mounted equipment, they shall be terminated at the rear of the accessory in a suitable conduit or adaptable box and "tails" only shall pass through the equipment. Where surface cables enter a surface pattern metal accessory, the cable shall be protected with the appropriate length of steel conduit, the free end of which shall be fitted with brass bush above ceiling/floor level.

All cables shall be prevented by spacing, insulation or other means from coming into contact with water and gas pipes, telephone and communication system cables, and shall preferably by installed below hot water pipes.

Where cables pass through walls they shall be protected by steel conduit, the conduit shall extend clear of the wall and be fitted with a brass ring bush at each end.

Where cables are subject to damage or abuse they shall be protected up to a height of 2,000mm by steel conduit suitably bushed unless otherwise specified, e.g. wood or plastic/metal capping.

On installations where wiring is concealed in the ceiling spaces and drops to accessories are on the surface, these shall be protected by heavy gauge steel or high impact PVC conduit from within the ceiling end within the ceiling cavity.

Where cables are run in the ground the Contractor shall mark out the cable routes in conjunction with the Main Contractor who will excavate the trenches and grade and level the ground ready for the installation of the cables. The Main Contractor shall also provide and install earthenware duct or Hepduct where required under roads and crossings and these shall be laid with a minimum cover of 600mm.

A heavy gauge polythene marker tape shall be laid above the cables at a depth of 230mm below the finished ground level. This shall be of the "Heptape" manufacture or equal and be provided and laid by the Contractor.

The Contractor shall install cables to the following minimum depths laid on an 80mm bed of soft sand without dragging and then covered with a further 80mm of soft sand.

H.V Cables	1000mm
LV and ELV Cables	600mm

The following spacing between cables and other services shall apply:

LV to ELV Cables Gas and Water Mains	300mm
LV to ELV Cables	500mm
LV and ELC Cables to Gas and Water Mains	250mm
HV, LV and ELV Cables to POC Telephone Cables & IT Systems	450mm

Cables shall not be laid in ashes, organic refuse or other such materials likely to cause damage. When such conditions are encountered the method of laying the cables shall be agreed with the Engineer.

Each cable shall be identified throughout its length by means of durable marker labels bound to the cable at intervals not exceeding 3700mm for external installations and 6000mm for internal installations, at changes in direction and at each end, with Critchley type identification discs.

The discs shall be marked "Danger", with the voltage rating together with the cable identification size.

To be in accordance with Regulations (522.6).

Final circuit wiring shall not be run in the same conduit trunking as mains or sub-mains wiring. Phase and neutral conductors forming the same circuit shall always be drawn into the same trunking or conduit.

All cables shall be run directly off cable reels and not taken from loose coils.

Cables rising to or from cubicle panels, fuseboards, etc., shall be concealed within partitions and enter the rear of the fuseboards, etc., or if installed on the surface shall be protected by vertical trunking or conduits which shall protrude at least 80mm into the floor or ceiling space. The ends of conduits shall be suitably bushed and the ends of trunking drilled to receive grommets for the entry of PVC sheathed cables.

All circuits shall be provided with a CPC sized in accordance with Regulation 543. This shall also apply in the case where existing conduits are re-used.

2.03 Trunking

Trunking shall be of the sheet steel pattern, having overall dimensions as detailed in the specification and on the drawings and shall be in accordance with the capacity as laid down in BS 7671 Wiring Regulations.

The trunking shall be of minimum 10 gauge sheet steel, and complete with all accessories, fittings, earthing straps, insulated pin racks, cable retaining clips, etc., and removable screw fixing front cover lid arranged in convenient sections.

In any run of trunking, the cable factor shall be in accordance with BS 7671 Wiring Regulations.

Each group of final-circuit cables shall be taped together at intervals not exceeding 900mm with self adhesive tape or insulated clips.

All trunking shall be securely fixed every 300mm by means of two roundhead screws (No.8) and the correct rawplugs. In damp situations the trunking shall be spaced from the wall by means of short tube collars.

Where trunking runs across tie bars, beams, etc., long sleeve couplings shall be used. Where passing through ceilings and walls, it shall be fitted with suitable fire barrier and protected from water and mechanical damage by an outer steel sleeve.

Where trunking enters distribution boards suitable flange boxes shall be installed. In addition, the calculated dimensions of the trunking to achieve the 35% spare capacity requirements must be further increased by a factor of 1.5 for a minimum of 15 metres at the termination to a distribution board or switchpanel.

All conduits shall be connected to trunking by means of flanged couplings and male brass bushes.

All sections and accessories shall be bonded together by means of purpose made copper strips.

The Contractor shall not alter the section, area or form of the trunking in any manner other than to cut to length required. All bends, sets and changes of direction, coupling to differing sizes of trunking, and connections to switchgear, control panels and other accessories, plant and equipment shall be carried out solely by the use of the purpose made trunking accessory to be obtained from the trunking manufacturer.

All entries cut into trunking must be painted with aluminium paint (I.C.I. Ltd No. 127-22) and the whole of the trunking painted immediately after erection.

All edges of trunking shall be sheathed with U-section PVC which shall be securely glued into position.

All sections of trunking, etc., shall be bonded together with brass or copper tapes so as to provide an effective and permanent protective conductor connection. Care shall be taken to ensure that the paint finish of the trunking section does not reduce the effect of the bonding. Cable supports shall be fitted throughout the trunking at intervals not exceeding 2.0m or 1.0m if the lid is on the underside.

Purpose-made expansion joint units shall be installed at structural expansion points and be fitted with separate earth continuity conductors.

For multi-compartment trunking, proprietary crossover bridges shall be installed at points where cables entering the trunking have to cross compartments accommodating segregated services. In cases where bridges are not available, the conduit containing the cables shall be extended to the appropriate compartment.

Fire resisting barriers shall be fitted where the trunking passes through floor slabs or wall. The trunking cover shall be fitted permanently at these points and shall extend to 80mm on each side of walls or below ceiling level and 300mm above floor level.

Where a trunking carries cables serving more than one circuit, each individual circuit shall be grouped together and bound with PVC tape.

The following types shall comply generally with the foregoing and with the additions detailed hereunder:

BUSBAR TRUNKING

The covers shall be provided to prevent unauthorised access.

SHAPED SKIRTING AND BENCH TRUNKING

An earth terminal shall be provided at all positions, with a positive earthing connection fixed within the trunking.

LIGHTING TRUNKING – SURFACE

This shall be fixed direct to the ceiling or suspended as specified. Sufficient supports of the manufacturers recommended type shall be fitted to carry the weight involved and provision shall be made for fixing the lighting fittings; switch units, etc., by means of the manufacturer's accessories. The lid of the trunking shall be underneath and shall completely seal the trunking between fittings.

FLUSH TRUNKING, OTHER THAN FLOOR TRUNKING

This shall be fixed in purpose-made positions or built in situ by the Main Contractor as specified. The Contractor shall be responsible for the proper alignment.

FLOOR TRUNKING

This shall be installed in the structural slab to the levels indicated for the finished floor. The Contractor shall provide, in conjunction with the Main Contractor, the necessary protection to prevent damage and distortion of the trunking and the ingress of foreign matter during the laying of the screed and floor. All trunking shall be cleaned out before wiring commences.

Trunking covers shall be positioned numbered on the underside so as to match with corresponding numbers marked inside the trunking.

2.04 Non-Metallic Conduit and Trunking

The trunking and conduit installation shall be carried out utilising rigid PVC and trunking as manufactured by Messrs Egatube Ltd or equal and approved. The following general specification for the installation of PVC conduit and trunking shall be strictly adhered to:

1. NON-METALLIC CONDUITS

STANDARDS

(i) All non-metallic conduits shall be high impact PVC complying to BS 4607 Part 2, type AH. The minimum size to be used on this contract is 20mm external diameter.

(a) Light gauge conduit may be used for protected precast and in situ concrete work where builder's traffic is minimal or protected surface wiring.

(b) Heavy gauge conduit should be used where a danger of physical maltreatment exists.

JOINTS

(ii) Conduits will be joined and terminated utilising the appropriate rigid PVC components as detailed below or standard conduit entry electrical equipment. Jointing will conform with one of the following techniques:

1. Permanent Adhesive – the solvent cement supplied by the conduit manufacturers will be used to produce a flexible sealed joint where allowance is necessary for longitudinal movement (e.g. expansion couplers).

2. Flexible Adhesive – A non hardening adhesive supplied by the conduit manufacturers will be used to produce a flexible sealed joint where allowance is necessary for longitudinal movement (e.g. expansion couplers).

3. Screwed Joints – Standard electrical dies may be used with threaded fittings.

BENDS

(iii) Bends and sets in conduit will be made in accordance with the manufacturer's instructions. The radius of the bend shall not be less than 2.5 times the outside diameter of the conduit or such greater radius which will facilitate easy drawing-in of cables.

TEMPERATURE

(iv) PVC conduits may not be used in situations where ambient temperatures are likely to exceed 70 deg C. (158 deg F.) or where the normal working temperature of conduits and fittings will exceed 60 deg C. (140 deg F.) Conduits should not be installed adjacent to steam or hot water pipes.

EXPANSION

(v) Adequate allowance should be made for longitudinal expansion and contraction of the conduits under normal working temperatures variations as follows:

(a) Expansion couplers should be used on straight runs exceeding 5.0m with a loose flexible type joint (No.2 before) at the long spout of the coupler.

(b) Saddles as supplied by the manufacturers shall include a sliding support tolerance for longitudinal expansion.

(c) Special consideration may need to be given to the fixing of accessories where they may prevent natural conduit movements. Oversize or slotted fixing holes may be necessary or the introduction of expansion couplers.

SUPPORT

(vi) Conduits should be saddled at not more than 900mm intervals. Where working temperatures tend to be high this should be reduced to 600mm.

CONDUIT BOXES AND FITTINGS

(i) All conduit boxes shall be circular pattern of rigid PVC with push fit or screwed spouts, conforming to sheet 62 BS 4607-2. Boxes not supporting a fitting or accessory shall be fitted with a PVC lid held in position by means of 2BA round headed screws.

SUPPORT

(ii) Circular boxes shall be provided at all outlet points, unless otherwise specified, and lighting fittings, ceiling switches and other accessories will be screwed to the two internal lugs of the boxes. Care

must always be taken considering the use of totally enclosed fittings with PVC circular boxes where the temperature within the box is likely to rise above 60 deg C. (140 deg F.) Special steel insert clips should be used in conjunction with circular boxes where this problem can arise, and also in situations where heavy pendants are used.

LOOPING IN

(iii) Looping-in boxes of circular PVC pattern to sheet 63 BS 4607-2 may be used in such work, as dictated by the structure of the building. Conduit entry shall be made by means of PVC socket adapters and PVC bushes bell-mouth buses and adapters.

ADAPTABLE BOXES AND SWITCHGEAR

ADAPTABLE BOXES

(i) These shall be of moulded or fabricated PVC of square or oblong shape complete with PVC lids secured by M4 brass of the same size shall be interchangeable. No adaptable box smaller than 75mm x 50mm or larger than 300mm x 300mm shall be employed. Boxes shall be of adequate depth in relation to the size of conduit entering them.

TERMINATION

(ii) Conduit shall be terminated at adaptable boxes, fuseboard switches, socket or other equipment not possessing push-in or threaded spout by means of an appropriate size adapters. All cemented joint to be made to depth of the conduit being used.

EARTH CONTINUITY

CONDUCTOR

(i) Earth continuity shall be provided by a separate insulated conductor contained within the rated in accordance with circuit loadings and appropriate regulations.

TERMINALS

(ii) An earthing terminal shall be provided at every switch outlet position for connection of earthing continuity conductors, as required.

2.05 Underfloor Duct

This shall be installed as for floor trunking. Fittings and accessories shall be those specifically designed for use with the duct and be installed to the manufacturer's instructions. Purpose-made units shall be used for the connection of conduits and skirting and vertical trunking to the duct.

2.06 Cable Tray Supports

In general the tray shall be of galvanised finish but for corrosive atmospheres it shall be polythene or PVC coated. Bends and tees shall be purpose-made to match the cable tray.

Brackets shall be painted or galvanised as required by the location and be of adequate strength to support the cable tray and weight of cables(s) to it. The spacing of the brackets and other tray supports shall not exceed 1.0m between the first and last support for each length of tray being within 150mm of the end of the tray.

The brackets shall give sufficient clearance behind the tray for cabling fixings to be made and when supporting cable trays in "tier" formation, they shall give clear access to all trays. The fixing of trays to brackets and supports shall be made using cadmium plated steel mushroom headed nuts and bolts with shakeproof washers.

Cable tray runs shall be broken at structural expansion joints, at these points the cable trays shall be bridged with a flexible protection conductor which shall be capable of absorbing, without strain, all movement of the joints. Earthing continuity shall be maintained between non-insulated tray and supports, but insulated tray shall be earth-free.

Cable shall be secured using purpose-made clips fixed with brass or cadmium plated bolts or by approved proprietary fixings. Where the cables pass through holes they shall be fitted with a protective sheathing.

Where cables are installed on tray they shall be heavy duty type return flange.

All cable trays shall be of sufficient width to accommodate all cables necessary to be run there-on, and bends and changes of direction shall be so formed that the recommended bending radius of cables is not exceeded by the cable tray, and the cables are at all times supported by the tray.

The supports and fixings for the tray shall not exceed the maximum spacing recommended by the manufacturer, consistent with the weight of cabling that the tray is to carry, and all times a margin of 25% shall be maintained below the maximum carrying capacity.

Wherever cable tray may run vertically "on-edge" the tray shall be spaced from the wall surface by the use of tube collars for a minimum distance of 40mm.

All lengths of cable tray shall be securely bonded together with 25mm x 4mm copper strip links and nuts, bolts and washers. All supports, brackets, etc., shall be bonded together and to the tray, by 4 sq.mm bare, stranded galvanised wire. This wire shall be bolted, or clamped using approved pattern clips to all the supports, etc., and where installed in metal framed buildings, be cross-bonded to the framework of the building. The supports earth bond and the tray earth tape shall be run back to the nearest distribution positions and shall be bolted to the sheet casing of the distribution equipment.

2.07 Steel Conduit

All conduits and cable trunking installed shall be of approved manufacture and shall comply with the appropriate British Standards (and subsequent amendments) as follows:

(i)	Steel Conduits Imperial	BS 31
(ii)	Steel Conduits Metric	BS EN 61386
(iii)	Steel Flexible Conduits	BS EN 61386
(iv)	Non-Metallic Conduits	BS 4607-2
(v)	Non-Ferrous Conduits	BS EN 13599
(vi)	Cable Trunking	BS EN 13599
		BS EN 13599

Only heavy gauge welded mild steel conduit shall be used throughout the works, and shall be screwed, enamelled or galvanised as required, made in full conformity with BS 4568 and amendments, and of a size not less than 20mm.

The inside surfaces and ends of the erected conduit and all fittings shall be smooth and free from burns or other defects.

Provision shall be made for counteracting condensation as directed by the Engineer.

All conduit fittings and accessories including screwed couplers, ordinary clips, saddles, pipe hooks, screwed reducers, stopping plugs, locknuts and male and female bushes shall be manufactured in accordance with BS 4568.

All screwed couplers, screwed and reducers and locknuts shall be made of malleable iron and all stopping plugs, male and female bushes made of brass. Round locknuts only shall be used on surface work.

Sunk conduits shall be fixed by means of mild steel pipe hooks driven into dry hardwood plugs, not more than 90mm apart.

Conduits laid in top of roof or floor blocks to points, shall be fixed by means of corrugated steel saddles fixed by hardened steel pins driven by a percussion tool. On pre-stressed beams, fixings must not be driven into the joints, beams or planks unless specific permission is granted by the Engineer.

Conduits, when fixed direct to the steelwork, shall be fixed to the rods of open web horizontal beams, tees or angles, by tie rod saddles.

Conduits fixed on the surface of walls or ceilings shall be fixed by heavy distance saddles fixed not more than 900mm apart secured by means of one 30mm brass countersunk screw, driven screw, driven into a fibre, white metal or similar plug of the correct size.

Where bends and sets occur the conduit is to be securely fixed at a distance of 230mm either side of such diversion.

Conduits down angle iron stanchions, and other similar places, shall be fixed by spacer bar saddles clipped to special fabricated mild steel slips of 25mm x 2mm strips not more than 900mm apart. Stanchions must

not be drilled unless the special permission of the Engineer is first obtained.

Conduits in all other concealed positions shall be fixed by black enamelled corrugated mild steel saddles each secured by means of two black enamelled round head screws and fixed, not more than 900mm apart, to the fabric of the building.

All joints shall be made tight by painting threads just before jointing with special aluminium paint by ICI Ltd No. 127-22.

All conduit fittings and equipment shall be erected prior to any cables being drawn in.

Where two or more lines of conduit run parallel with each other, the distance between them shall not be less than 12mm and where conduits cross, a space of 25mm shall be left at the crossing. All conduits must be run vertically; diagonal runs will not be permitted on walls or in demountable ceiling voids.

Conduit shall be fixed to adaptable boxes, fuseboards, iron clad switches, by means of smooth bore male brass bushes and couplers.

No elbows or tees either solid or inspection shall be used.

An adequate number of easy bends and approved pattern circular junction boxes are to be used for the drawing-in of cables after the conduit system has been erected.

Not more than 2 right angle bends shall be used between boxes.

For concealed installation where junction boxes for draw-in purposes are required. These shall be located in store rooms, ceiling spaces and similar areas. Positions for these boxes shall be agreed with the Engineer before the commencement of the installation.

Where bends are purpose-made on site they shall have a radius of not less than 80mm and the tube at no point shall be flattened or damaged.

All tube ends shall be reamed before fixing and all runs shall be adequately ventilated and drained and well spaced from gas and water pipes.

The whole of the conduit system together with the casing of the main switchgear and other apparatus and fittings shall be electrically and mechanically continuous throughout.

Each conduit termination at boxes, switchgear, distribution board, trunking, etc., shall be made with a flanged coupling and effectively tightened male brass brush or alternatively shall be tightly screwed into a spout forming part of the box, etc.

Ceiling break joint rings shall be fitted where necessary.

Conduit shall run in a neat and inconspicuous manner and with horizontal and vertical lengths labelled and plumbed respectively and securely fixed. Where long threads are used for connecting lengths of

conduit, they shall have a locknut tightened onto the socket to ensure protective conductive continuity.

In situations where conduits are fixed directly to the underside of a roof deck that is to be completely covered externally with a weatherproof material the conduit and conduit accessories shall be fixed by means of toggle bolts to facilitate the removal of the conduit after completion of the weatherproofing.

Conduit on the surface of walls and ceilings shall be securely fixed with distance saddles and where conduit is hidden spacer bar saddles shall be used, both types of saddles being located at intervals in accordance with table 11C.

In addition conduit shall be secured within 450mm of each side of a bend or point of emergency from floor or ceiling.

When distance saddles are used "raised back" pattern accessories shall be used where necessary.

Multi-way saddles shall be used where two or more conduits run parallel and crossover shall be avoided by the use of adaptable boxes. Where lengths of conduit are joined they shall be screwed tightly together with no appreciable gap left between ends inside the coupling.

All galvanised conduit and accessories shall be fixed by means of cadmium plated screws.

All conduit outlets installed to concrete or other "in-situ" construction must be plugged with extreme care to prevent the ingress of foreign matter causing the conduit to be blocked during building construction. The Contractor will be held responsible for any additional building costs resulting from the blockage of conduits due to neglect or lack of attendance.

Where steel conduits are installed, the contractor shall ensure that the installation is planned and sequenced to ensure that the use of 'Running Couplers' can be avoided where ever possible. If 'Running Couplers' are required, the use of these shall be kept to an absolute minimum. If the Engineer deems that an excessive/surplus number of these have been used, the relevant conduit sections shall be removed, rectified and re-installed without these items, this remedial work to be carried out without delay and at the Contractors expense, all exposed threads shall be treated with rust inhibiting primer paint and a final coat of black or galvanised paint according to the type of conduit.

All rusty and damaged conduits, together with the exposed portion of screw threads, shall be treated with rust inhibiting primer paint and a final coat of black or galvanised paint according to the type of conduit affected.

ADAPTABLE BOXES

Malleable cast-iron adaptable boxes shall be provided and fixed at inspection positions where two or more conduits cross. These boxes shall be 150mm x 150mm deep inside measurement, and shall be provided with malleable cast-iron sunk lids secured by four M4 brass rounded head screws. Where the boxes are fully recessed, they shall be

provided with 16 swg mild steel lids, overlapping the boxes 6mm all round. Boxes shall be fixed by means of 2No. 10 countersunk head screws, and the holes in the back of the box must be countersunk to receive the screws.

No more than three conduits, up to 30mm will be allowed per side on the above adaptable boxes. Where more than three conduits per side occur, larger boxes shall be used. Deeper boxes shall be provided for conduits larger than 30mm diameter.

All boxes must be positioned in conjunction with the Engineer.

CIRCULAR INSPECTION BOXES

Small standard circular malleable iron conduit boxes with heavy cast-iron lids and brass fixing screws shall be provided and fixed at all junctions and the necessary angles and bends of conduit.

For surface work boxes of the raised back pattern shall be used.

Solid or inspection elbows, bends, or tees must not be used. Corners shall be turned by easy sets or bends made cold without altering the section or opening the seams of the conduit. No bend shall have an inside radius of less than three times the external diameter of the conduit. All bends must be machine made.

No more than two right angle bends, or equivalent sets, must be made in conduits run between inspection bosses and on straight runs, inspection boxes must be inserted after each second conduit length.

CEILING BOXES

Circular boxes, or the equivalent BSS looping bosses shall be provided and securely fixed for all ceiling points in non-demountable ceilings and in all situations where a conduit installation is specified.

Where boxes finish behind surface level, the necessary extension rings shall be fitted.

Ceiling boxes in suspended ceilings shall be supported by a length of 5mm MS rod, threaded at each end. One end of the rod shall be secured to the ceiling box by means of two 2BA nuts and flat washers, the other and passing through the roof and floor block and being secured by two M4 nuts and flat washers to 75mm x 75mm x 2mm MS plate resting on top of the roof and floor slab.

The mild steel rod and plate shall be painted with bitumastic paint before erection.

FLEXIBLE CONDUIT

Flexible conduit shall be installed for connections to vibrating and adjustable equipment and at points where structural expansion occurs. Connection to the rigid conduit system shall be by means of a solid type female adapter which shall be fixed in accordance with the manufacturers instructions.

Flexible conduits shall be of adequate length to avoid strain and shall be Kopex type LSI/PVC or equal and approved and terminate via the manufacturers couplings. Within boiler houses, flexible conduits shall be heat resistant.

All insulated protective conductors, no smaller than 2.5mm sq. shall be run inside the flexible conduit and bonded to the metalwork at each end with set screws and brass washers. The cable shall comply with / or shall be sized in accordance with BS 7671, I.E.E. Wiring Regulations.

FLAMEPROOF CONDUIT

This shall be heavy gauge solid drawn and screwed, used in conjunction with flameproof equipment and installed generally as for steel conduit, and in accordance with British Standard Specification.

At the boundary point between "safe" and "dangerous" areas, flameproof sealing boxes shall be installed. In areas where moisture is likely to be present, galvanised conduit and fittings shall be used.

FIXING OF CONDUIT AND ACCESSORY BOXES

The Contractor shall pay particular attention to the method of fixing switch, socket, conduit and accessory boxes so that when completed they are in the exact position relative to the finished wall surface and are perfectly square in all directions. Boxes shall be fixed by at least two screws such that the heads do not protrude into the box. In partition walls, all boxes shall be screwed to timber battens within the cavity. Under no circumstances shall "clip" fastenings, which in any manner rely upon the partition material for fixings, be used.

Where accessories are "grouped" they shall be arranged in a neat and symmetrical layout. Where sockets, switches, thermostats or controls and bells, indicators or other accessories are shown to be mounted adjacent, they shall be installed in such a manner as to be vertically in line.

2.08 Switch and Distribution Equipment

Sizes of sub-main cables, switches, isolators, circuit breakers and distribution boards shall be as set out in the Schedules on the drawings and in the relevant clauses of this specification.

All equipment will normally be mounted on brick walls or on formed "blocking" in section walls at heights to be agreed on site. Where sub-main switch and distribution equipment is positioned, the whole shall be pre-mounted on an angle iron frame covered with sheet steel. The panel shall be arranged to bolt to the wall in at least four positions and where necessary shall have legs to the floor to support the panel.

At wall mounted distribution positions (except fair faced brick walls) an adaptable conduit box shall be flush mounted behind the distribution board into which all cables shall enter, "tails" only passing through to the distribution board which shall be mounted over the box. On fair faced brick walls and partitions of insufficient cavity depth, all cables running to the distribution board shall be enclosed in sheet steel trunking.

At all positions sheet steel trunking shall be used to "frame" the equipment to avoid conduit and cable runs being exposed and to contain all interconnections.

Cables rising or dropping to ceiling or floor cavities shall be contained in trunking which in all cases shall enter the voids.

Where cubicle type panel switchboards are positioned they shall be securely fixed to the floor by means of rawbolts and, where deemed necessary, shall be tied back to the wall in an approved manner.

The arrangement of wiring to all ways and neutral bars of distribution boards etc. shall be such that all connections for all circuits are in the correct sequence. The correct size of circuit breaker or fuse, corresponding to the size of sub-circuit conductors and/or apparatus to be controlled, shall be fitted to each way.

Three spare HRC fuse cartridges or MCB of every size and type used on the installation shall be supplied by the Contractor at the completion of the works.

Where on a distribution board spare ways are indicated on the schedules, these spare ways shall be complete with fuse bridges and fuses or a circuit breaker of that rating shown. Where no indication of rating is shown on the distribution schedule, then that spare way shall be blanked off with the manufacturers purpose-made blanking-off plate and the distribution chart left blank for that circuit.

The Contractor shall include for all glands, termination and spreader boxes necessary for the proper installation of the cables to be supplied and fitted to all equipment. All such termination equipment shall be manufactured by the specified switchgear manufacturer.

Where it is impractical to run cable conductors direct to switches, etc., within panels or distribution boards, then copper "tails" connected to the cable cores electrically and mechanically in an adaptable box in an approved manner may be substituted at the discretion of the Engineer. Prior approval to this method shall be obtained before carrying out such work and the Contractor shall include for all costs associated with such alternative.

All inter-connections shall be made with solid copper links.

Immediately prior to the completion of the contract, ALL switch and distribution equipment shall be cleaned out internally and cleaned down externally. Any damage to the manufacturers paint finish shall be made good by the Contractor using the switch or distribution equipment manufacturers matching paint.

Unless indicated elsewhere within the corresponding Particular Specification, all low voltage switchpanel installations shall comply fully with FBA BSEN 60439 Part I form 4, type 2 full compartmentation.

- Spare fuse compartment to be fitted complete with one full set of BS 88 fuse links for each rating of device installed.

- Transient over voltage protection to be incorporated by an integral "Furse" over-voltage protector unit ref: ES 415.

- Secondary barriers to be provided to bus-bar sections.
- A 600mm x 600mm white traffolyte plaque to be engraved with black lettering, showing full flow diagram and operating instructions for equipment, detail of which to be approved by the Engineer.
- Manufactured from 2mm zinc coated plate steel, painted throughout with minimum 50 micron polyester epoxy powder paint.
- Protected to a minimum of IP32.
- Compartment doors to have protected ventilation slots in top rear of compartment to allow ventilation.
- Solid copper bus-bar to BS EN 13601.
- All bus-bar connections to be maintenance free.
- On site tests to be completed in the presence of Engineer.
- Full functioning witness tests in the presence of Engineer.
- Connection from bus-bar to device to be of solid copper Asta certified 63 KA conditions to characteristics of device.
- All outgoing circuits to be capable of retro-fitting.
- Provision of protected control cables to pass through all vertical sections.
- Front access top and bottom cabling facility.
- Capable of sectional site erection.
- Off loaded, manoeuvred into position, erected and tested as a continuous operation.
- Electronic metering, class 1 accuracy measuring:

  Amps/phase
  Voltage
  Frequency
  KW, KVA, KVA1
  KWH

2.09 Distribution Boards

At each distribution board the Contractor shall supply and fit an engraved white traffolyte label with 5mm black lettering as:-

Example:

DB/1
Location: Main Switchroom
16 Way TP&N
Supply Cable: 4C 35mm Cu/XLPE/SWA/LSF
Supplied From: Energy Centre TX1
Fault Energy: **To be measured by Contractor**
External Impedance: **To be measured by Contractor**

Furthermore, where single phase distribution boards are installed the Contractor shall include the appropriate phase i.e. "brown phase" or '' L1''

Note: Installed circuit lengths are to be measured by the Electrical Contractor and inserted into the "max length" column of the distribution board schedules and included within maintenance manuals.

Distribution board schedules to be completed, including reconnecting existing circuits, a copy to be included within the relevant section of the maintenance manuals.

In addition, each final circuit conductor, for new and refurbished areas shall be fitted with Critchley "Z" type identification ferrules, clearly stating its designation, i.e. at distribution boards, phase, neutral and CPC shall be labelled R1, etc.

This clause also refers to mechanical services wiring.

2.10 Lighting Installation

LUMINAIRES

All luminaires listed in the lighting schedule shall comply with BS EN 60598 and BS 4533 and be supplied and installed complete with lamps. Where a choice of colour of either metalwork or glasswork is available for the luminaires and none is specified, the colour will be specified at a later date.

All fluorescent luminaires shall be complete with a fused terminal block. The fused terminal block shall include a suitable size fuse, protective terminal cover and terminals, sized to suit installed cables specified elsewhere.

If different colour finishes alter the price of the luminaires the standard finish shall be the basis on which the tender is made unless otherwise specified.

When tubes are inserted in luminaires the tube details shall face downwards.

Installed luminaires shall not be used for temporary lighting without the Services Engineer's approval.

All diffusers, louvers and glassware for luminaires shall be cleaned, immediately prior to handover.

LIGHTING POINTS

(i) Wiring

The minimum size of cable for lighting circuits shall be 1.5sq.mm.

Circuit wiring in lighting trunking shall be looped into P.V.C flexible terminal blocks suitable for the temperature at which they will operate.

Circuit wiring in conduit shall terminate in insulated connecting blocks with brass screw connections in the conduit boxes to which the luminaires are connected. The connecting block shall be suitable for the temperature at which they will operate.

Wiring to all luminaires shall be non- hygroscopic and heat resistance.

Where continuous lines of surface mounted luminaires are specified, through wiring will be permitted provided that the proposed method of erection, lining up and connection of the luminaires is acceptable. If this is not the case, then a separate loop-in conduit or M.I.M.S system shall be made to each luminaire. Continuous runs shall be mounted true and in a straight line with no gap between adjacent luminaires. If through wiring is permitted this shall be fixed clear of the control gear in the luminaires and where this is not possible high temperature wiring shall be used. All holes through luminaires for through wiring shall be bushed and an insulated 1.5 sq.mm earth wired shall be run between all the luminaires in the run.

Wiring to the lampholders of tungsten filament luminaires which are not equipped with cool wiring devices or suspended from ceiling roses shall be silicone-rubber-insulated and braided or glass fibre insulated capable of withstanding a temperature of 140°C.

Flexible pendant drops shall be white circular heat-resisting P.V.C insulated and sheathed cable of conductor cross sectional area not less than 0.75 sq. mm, unless otherwise specified.

(ii) Erection of luminaires

Decorative luminaires shall be suspended by the manufacturer's pendant sets which shall include a separate suspension wire integral with the flexible cable.

Luminaires shall be mounted at the heights given in the Schedules or drawings.

Fluorescent luminaires shall have fixing and cable entry arrangements on two centres to suit the luminaires. The fixing arrangement shall be suitable for use with conduit boxes.

For luminaires in suspended ceiling the cabling or conduit system shall terminate in a BS box above the ceiling. From the conduit box to the luminaire either of the following methods of wiring may be used.

a) An internal threaded dome cover with a cable gland for flexible cord shall be fixed to the BS box and a flexible cord shall be run from the dome cover to the fitting.

b) A three terminal ceiling rose with socket and plug attachment shall be fitted to the box and a flexible cord run to the luminaire. The flexible cord shall be secured to the luminaire by use of a suitably sized compression gland.

Flexible cords shall be 3-core 0.75 sq.mm in 5amp circuits, 1.0 sq. mm in 10 amp circuits, and 1.5 sq.mm in 15 amp circuits. The third core of the flexible cord shall be used for earth continuity and shall be securely fixed to the conduit box and luminaire.

For surface mounted luminaires the cabling or conduit system shall terminate in a BS box to which the luminaire is fitted.

Suspended fluorescent and industrial-type tungsten luminaires shall be suspended by rigid conduit from ball-and –socket dome covers or drop rods. Such dome covers shall be fitted with flexible copper connectors between the ball and the socket.

Where suspended fluorescent luminaires are specified they shall be suspended 450mm below the ceiling subject to a minimum mounting height of 2400mm.

Approved angle blocks shall be provided for luminaires suspended from or mounted on sloping surfaces.

Break-joint ring of approved colour shall be provided wherever the diameter of the ceiling rose or plate from which a luminaire is suspended or the diameter of the gallery or the width of the spine of a surface mounted luminaire does not exceed the diameter of the aperture in the ceiling for the associated conduit box by at least 10mm. If this requirement causes a break-joint ring to be provided for any luminaire, then break-joint rings shall be used for all other similar luminaires in the same room or area.

Fluorescent luminaires which are to be mounted end to end in continuous rows shall be provided with all necessary jointing pieces for the battens and diffusers or reflectors. The manufacturer shall be informed of the precise quantities required at the time of ordering to avoid delay. Battens for which special jointing pieces are not provided shall be butted together and connected by means of smooth bore bushes and locknuts tightened up to ensure that no gap appears between adjacent battens. End caps shall be fitted only at the ends of rows.

All luminaires shall be carefully stored before erection and, prior to handover, any damaged paintwork made good and the complete luminaires cleaned.

Where luminaires are installed in a suspended ceiling, these are to be independently supported from the building structure unless the Contractor obtains written confirmation that the ceiling has been specifically designed to carry & support the additional weight of the luminaires.

M.I.M.S CABLES AT LIGHTING POINTS

Lighting points shall not be used as M.I.M.S cable junction boxes for the through-connection of switch wires. Not more that three connectors shall be permitted at any lighting point.

Strap wires for two-way or intermediate switching shall be connected directly between switches and not through lighting points.

From each ganged switching position, cables to lighting points shall be limited to single and twin core cables or a multi-core cable shall be taken to a separate junction box from which separate cables shall be run to a point in each switched group of lights. Such a junction box shall be used

in a concealed installation only if it can be fixed in a concealed but accessible position, e.g behind a demountable ceiling panel.

The junction box used for this purpose shall be completer with lid and porcelain multiple connector blocks with sufficient ways to suit the number of connections necessary. The connector block shall be fixed to the base of the box using M4 bolts and nuts. All terminals in this connector block shall be adequately marked for identification.

CEILING ROSES

Ceiling roses shall comply with BS 67 and be approved manufacture. They shall be coloured white having a moulded plastic base suitable for direct mounting onto a conduit box , and here terminals plus earth terminal., the 'live' terminal being shrouded.

Plug-in ceiling roses shall be coloured white having a moulded plastic base suitable for direct mounting onto a conduit box and a 2 amp 3 pin socket, plug and locking cover. The base shall have three terminals plus earth terminal, the 'live' terminal being shrouded.

LAMPHOLDERS

Lampholders shall comply with BS EN 61184 and be effectively earthed where of metal.

Where lampholders are screwed direct to conduit systems they shall be brass, unless they are installed in a bathroom or toilet when they shall be insulated.

Lampholders used in conjunction with P.V.C sheathed cables shall be provided with a cable grip.

Batten lampholders shall be suitable for direct mounting on circular conduit boxes.

Unless otherwise specified lampholders for emergency lighting systems shall be SBC positioned in such a way as to place the lamp specified in its normal position.

LAMPS

The sizes, types and colours of lamps are shown on the Schedules or Drawings.

Lamps for use at a voltage other than 230v shall be fitted with caps which prevent them from being used in 230v lampholders.

LOCAL LIGHTING SWITCHES

Lighting switches shall be manufactured in accordance with BS 3676 and shall be of the type and rating shown in the Scheduled or Drawings. The mounting height to the of the switch shall be fully in line with the current DDA requirements unless otherwise specified, and where the structure and furnishings permit, the distance from the edge of the architrave to the near edge of the switch shall be 150mm.

Where several switches on one phase are shown at one position, a ganged box shall be used. Different phases shall not be ganged in one box unless each phase is segregated in a separate compartment which is covered by a separate internal warning plate.

Where possible the arrangement of switches in ganged boxes shall be similar in plan to the lighting points which they control. Switches not so arranged shall be labelled in an approved manner to indicate the circuits controlled.

Recessed switches shall be mounted in sheet steel or malleable cast iron boxes of minimum depth 37mm fitted with adjustable grids to allow for variations in the thickness of plaster.

The face plates of recessed switches shall be fixed square and flush with the wall. Fixed rings shall not be the only means of securing the face plates.

The swing of all doors shall be checked on site before marking out any chases for switch positions.

Surface mounted switches connected to surface conduits shall be fitted to either malleable cast iron or pressed steel boxes with cover plates giving protection to the dollies.

Watertight switches shall be in malleable cast iron with spout nipple entries.

Lighting switches installed in ducts shall be of the weatherproof type.

Ceiling switches shall be fixed to circular BS boxes using break-joints rings. The switches shall be white or ivory coloured, and fitted with silent interiors.

In rooms where flammable gases are used, switches and controls for electrical plant on perimeter walls shall be of the flush pattern fitted with brass plated of the finish specified in flush steel or malleable cast iron boxes.

Any requirement in such rooms for sparkless switches will be particularly specified, and where they are required they shall be of the same pattern of dolly, switchplate, box and finish as the other switches in the same area or room.

The installation of earth connections for lighting switches shall be as detailed in the Earthing and Bonding Section of the Specification.

2.11 Emergency Lighting

EMERGENCY LIGHTING TEST SWITCHES

Emergency lighting test switches shall be manufactured in accordance with BS EN 60669-1 and shall be of the secret key gridswitch type complete with neon indicator which shall be illuminated when the keyswitch is in the 'Test' position.

The cover plate shall be engraved 'Emergency Lighting Test Switch' in red letters approximately 3mm high.

The mounting height to the bottom of the switch shall be fully in line with the current DDA requirements unless otherwise specified, and where the structure and furnishings permit, the distance from the edge of the architrave to the near edge of the switch shall be 150mm.

Different phases shall not be ganged in one box unless each phase is segregated in a separate compartment which is covered by a separate internal warning plate.

Where possible the emergency lighting test switch shall form part of the switchplate for the general lighting. Where this is not possible, the emergency lighting test switches shall be located adjacent to the general lighting switches. The arrangement of the test switches shall be similar in plan to the lighting points which they control. Switches not so arranged shall be labelled in an approved manner to indicate the circuits controlled.

Recessed switches shall be mounted in sheet steel or malleable cast iron boxes of minimum depth 37mm fitted with adjustable grids to allow for variations in the thickness of plaster.

The face plates of recessed switches shall be fixed square and flush with the wall. Fixed rings shall not be the only means of securing the face plates.

The swing of all doors shall be checked on site before marking out any chases for switch positions.

Surface mounted switches connected to surface conduits shall be fitted to either malleable cast iron pressed steel boxes.

EMERGENCY LIGHTING

The following statutory documents apply to emergency lighting:-

1. Health and Safety at Work Act 1974.
2. Fire Precautions Act 1971
3. Fire Certificates (Special Premises) Regulations 1976
4. Cinematographic Act 1952
5. Cinematographic (Safety) Regulations 1955 No. 1129
6. Manchester Act (Where necessary)

Other special conditions will apply relating to Local Fire Officer and Local Authority requirements, and the like and these will be detailed in the Specification where applicable. The equipment shall comply with the following British Standards:-

BS EN 60598 and BS 4533	Electrical Luminaires. Automatic change-over contactors for emergency lighting systems.
BS EN 61558	Safety isolating transformers for industrial and domestic purposes.

BS 9720	Specification for custom built transformers (to be read in conjunction with BS 9000 and BS 9005).
BS EN ISO 3451-1	Methods testing plastics.
BS EN 13032	Photometric data for luminaires.
BS EN 61184	Specification for lampholders and starter holders.
BS EN 61347	Ballasts for operation of tubular fluorescent lamps.
BS EN 60081	Tubular fluorescent lamps.
BS 5266, BS EN 50172	Code of Practice for emergency lighting of premises.
ICEL 1004	Conversion units for emergency luminaires.

The installation of all equipment and wiring shall comply with all other relevant sections of this Specification.

For the purpose of this section of the specification, the definitions of all plant, equipment and materials, included on the drawings and in this specification, shall be as those defined in BS 5266 and BS EN 1838.

On completion of the installation of the emergency lighting system, or part thereof, an inspection and test certificate shall be given in accordance with Appendix A of BS 5266-1 and BS EN 1838. The Services Engineer shall be advised at least two weeks before the tests are being undertaken to enable the various authorities to witness the tests.

EMERGENCY LIGHTING LUMINAIRE CONVERSIONS

Unless specified elsewhere within the drawings or specification all general lighting luminaires which are required to have either integral or remote emergency conversion packs fitted, shall be fitted with such conversions by the specified manufacturer at the works prior to delivery.

Luminaires which have been converted to emergency version by any organisation other than the original manufacturer of the luminaire will not be accepted without the express written consent of the Services Engineer being given prior to the conversion taking place.

2.12 Fire Alarm System

The equipment and installation shall comply with other relevant sections of this specification and drawings and with the following British Standards.

BS 5839 - Fire detection and alarm systems in buildings
(Code of Practice for installation and servicing)

BS 6266 - Fire protection for all electronic data processing installations

BS 60849 - Sound Systems for emergency purposes.

The system shall be based on the drawings issued with the specification and shall be of system types as listed in the particular specification and as defined by BS 5839.

SYSTEM OPERATION

The fire alarm system shall have a 2 stage operation.

a) ALERT
b) FIRE

Upon an alert signal being activated, if this signal is not manually muted within a pre-set period (adjustable 0-5 minutes) the full "fire" stage shall be activated automatically.

In the event of a device operating the fire alarm control panel shall be programmed to initiate various functions or operate devices wither on the same loop, another loop, alarm output contacts, or auxiliary switches which may be required to :-

a) Cause automatic fire doors to close.
b) Shut down fuel oil valves, gas sully, fans and
c) Operate route indicators, warning signs, and the like

Input devices are indicated on the drawings, compromising a mixture of some or all of the following devices:-

a) Manual call points
b) Smoke point type detectors
c) Beam type smoke detectors
d) Heat detectors
e) Interface units
f) Flame detectors

Refer to drawing and the particular specification for details of the above requirements.

ADDRESSABLE DEVICES

Each device shall be compatible with the main fire alarm control panel.

All devices shall be allocated a unique number (address) to identify it on the loop.

All such addresses shall be provided by the setting of dual rotary switches in the devices.

All devices shall be suitable for connection to the type of cabling specified elsewhere for the Fire Alarm System.

<u>Manual Call Points.</u>

All manual call points shall use safety glass, and shall provide a means of identifying the call point operated.

Automatic Smoke Detectors

These shall be of the optical or ionisation type and shall incorporate two (2) LED indicators which pulse when the device is being interrogated. When activated both LED's shall illuminate permanently.

Where smoke detectors are concealed (in ceiling voids. Lift shafts, normally locked rooms, and the like). Remote indication of the activated device shall be provided by means of an LED indicator positioned in a visible location as near to the device as practical.

The detector shall be supplied in two parts to enable the bases to be fixed when the cabling is being installed.

Duct Smoke Detectors

These shall be as smoke detectors but shall be mounted on the outside of the air handling ducts with sampling tubes projecting inside. Where duct smoke detectors are concealed (in ceiling voids or service shafts), remote indication of the activated device shall be provided by means of an LED indicator positioned in a visible location as near to the device, as practical.

Interface Devices

These shall be programmable relays connect4ed onto the address loop.

Their function shall be to :-

a) Send a signal to an item of plant from the fore alarm control panel.
b) To receive a signal from an item of plant to the fire alarm control panel.

Each interface device shall function without an external supply, except where the relay output has to supply a DC or AC voltage to activate an item of plant. This independent supply shall be fault monitored by the control system via the interface unit. In the event of failure, the fire alarm control panel shall indicate a fault on the system.

Beam Smoke Detector/Receiver Units

The detector unit shall have the facility of automatic resetting, after operation.

The receiver unit shall have a LED indication for when the device has operated.

The detector units, and their associate DC power supply, shall be monitored via an interface unit onto the address loop and shall be monitored for both fire and fault conditions. In the event of a fault condition, the fire alarm control panel shall indicate a fault on the system.

Vesda (HSSD)

With regards to the Vesda (HSSD) systems, reference should be made to the corresponding section of the detailed Particular Specification with regards to this item where relevant for the project.

Xenon Lights

Xenon flashing beacons (coloured RED) shall be connected to the detection loops via an interface unit.

Loop Isolators

Loop isolators shall be installed on each loop at a maximum spacing of 1 isolator per 20 devices. If the address loop is short circuited, the isolators shall operate automatically, and isolate the faulty section of cable.

The devices shall also send a fault signal to the main fire alarm control panel, indicating which device has operated in order that the fault can be rectified

Loop isolators shall be installed in locations which are fully accessible after all Services have been installed.

MOUNTING HEIGHTS

The mounting height of equipment shall be in accordance with Part M of the building regulations unless otherwise detailed on the drawings:-

Alarm contacts	1.3m above floor level to centre
Alarm bells	2.2m above floor level to centre
Control and Indicator panels	1.7m above floor level measured to the centre of the panel

Smoke & Heat Detectors 1m minimum from self-contained type emergency lighting and fluorescent luminaires and 400mm minimum from walls. .

All Xenon indicators must be located in positions where they will be clearly visible throughout the area to which they relate, multiple devices should be used in larger or congested areas'

SOUNDERS

The requirements of the fire alarm sounder are:-

a) That is should be clearly audible to everyone who must be alerted in the vent of fire.
b) That is shall be immediately identified as a fire alarm and not confused with any other audible signal.

Audibility tests shall be carried out by the installers prior to the date of Practical Completion and the Services Engineer shall be advised of the date for the test, in writing, giving at least 3 weeks notice. The test shall be witnessed by the relevant statutory authorities.

FIRE ALARM CONTROL PANEL

Except in premises where the location of the fire can be determined without delay, the fire alarm system shall include a fire alarm control panel. The sitting of the panel is shown on the layout drawing.

Unless otherwise stated, the fire alarm control panel shall be suitable for fully flush mounting.

The control panel shall be of the fully addressable analogue type, with facilities for the number of loops shown on the drawings, each loop shall cater for a minimum of 160 devices and maximum of 198.

The system shall have provision to expand on a network basis.

The main fire alarm control panel shall be provided with the following minimum facilities:-

System Healthy Indicator
Alert Condition Indictor
Evacuation Condition Indicator
Vacuum Fluorescent Display
Printer
Key Pad
Pre Alarm Indicator
Detector condition monitoring
Supply Fault Indicator
Device Fault Indicator
"Zone" indication
Common Fault Indicator
Sounders muted Indicator
Local Sounder muted Indicator
Detector disabled Indicator
Fire Brigade Isolate Indicator and switch
Zone Test, Zone Isolate and Cancel facilities

In addition the following contacts/inputs/output shall be provided.

(i) P.A alarm input
(ii) Fireman's Indicator panel located at Main Entrance
(iii) 6 no. spare inputs (programmable)
(iv) 6 no. spare outputs (programmable)

Each loop shall be monitored by a separate microprocessor, each microprocessor being under the supervision of a central processor for the whole system.

All system generating software shall be held in a non-volatile memory protected against loss in the event of a total system failure by means of a dedicated memory back up battery offering at least 100 hours retention.

The use of blown or pre-programmed EPROMS and the like shall not be acceptable for site specific data.

Programming of the control panel shall initially be carried out by the manufacturer but the system must be such that reprogramming can be carried out by the Client's representative at a later date if required.

The programming shall be in 2 areas:

(i) Limited access menu
(ii) Main access menu

The limited access menu will allow the Client's staff to operate:

(i) Printer outputs of all statuses, and the like
(ii) Isolate Devices
(iii) Restore Devices
(iv) Isolate Zones
(v) Restore Zones
(vi) Isolate (Electrically) loops
(vii) Restore (Electrically) loops
(viii) Set Panel Date and Time
(ix) Reset System

The main menu will be accessible to authorised personnel only and will allow the following operations:

(i) Configuration of all input/output devices, detectors, and the like to zones, operation of devices, assigning devices to text, and the like.
(ii) Configuration of auxiliary contact including addition/deletions. Operation of limited menu including pass words.
(iii) Full test programmes, monitoring current levels and the like

The system shall continuously monitor itself. In the event of a failure, a fault warning should be given which should automatically reset after the system has been restarted. The fault shall be recorded. The manufacturer shall allow for a buzzer to be mounted on/within the main fire alarm control panel which shall be capable of being manually muted. If a second device is activated the buzzer shall recommence operation. When this signal is muted a warning light shall be illuminated to indicate that the sound has been muted.

The manufacturer shall be required to provide full details of all functions of the control panel to the Service Engineer for their approval before manufacturer can comment.

In the event:-

(i) A faulty section of wiring
(ii) A faulty smoke or heat detector
(iii) A faulty manual call point
(iv) A faulty interface unit

The system shall automatically disconnect the damaged section/device, and continue to operate the remainder of the system.

When indicated on the drawings, a repeater panel shall be provided. It shall have the same functions and displays as the main fire alarm control panel.

FIREMANS INDICATOR PANEL

A recessed fireman's indicator panel shall be located in a position indicated on the drawings.

Unless otherwise stated, the fireman's indicator panel shall be suitable for fully flush mounting.

This repeater panel shall indicate via a minimum of two lamps/circuits the following:-

(i) Systems Healthy (Green)
(ii) Systems Fault (Orange)
(iii) Alarm Zone 1 (Red)
¨
¨
n) Alarm Zone 'N' (Red)

A lamp test switch shall also be included to enable all lamps to be tested periodically.

Cable entry to the panel shall be either top, bottom or rear. The final entry details shall be determined by the installer.

All access to the above panel shall be from the front only via a lockable door.

WIRING

The following general principles shall be followed in the layout of fire alarm wiring:-

1. There shall be no wires shared between sounder and call point/detector circuits.
2. There shall be no tee-offs from sounder or call point/detector circuits.
3. Joints in cables shall be reduced to a minimum and generally only 2 core cables shall be used to avoid the joints and connectors behind detectors, and the like Where 4 core cables are proposed their use mist be approved by the Services Engineer, in writing, prior to the installation works commencing.
4. Each sounder, call point and detector shall be identified by a unique number. These identifying numbers shall be shown on each item of equipment and shall have a correspondingly numbered label attached to it is installed on site.
5. In the case of a zone situated at a distance from the main fire alarm control panel, the exclusive zone cable shall be brought into a zone connector box and the multi-core cable installed between this connector box and the main fire alarm control panel.

POWER SUPPLIES

Power supplies for fire alarm systems shall combine the minimum maintenance requirements with high reliability factor.

The fire alarm system shall be supplied from batteries which are capable, when fully charged, of supplying the full alarm load for a period of one hour, and the system inert load for a period of 24 hours. The batteries shall be float charged at the 20 hours recharge rate on a constant voltage type charger having continuous output rating capable of supplying the full alarm load plus the battery charging current. The main

supply to the charge shall be obtained from a clearly labelled switchfuse or unswitched spur unit connected directly to the main switchboard or distribution board for the building.

The system shall be a floating rechargeable battery, to provide a standby period of not less than 72 hours in the monitoring mode and followed by ½ hour output in the alarm condition.

AUTOMATIC DOOR HOLDERS

Where electrically operated door holders are installed, these shall be designed to release the doors in the event of a fire alarm. Door holders shall be of the fail safe type such that the door is held open by a continuously energised solenoid and is released when the solenoid is de-energised, either by operation of the fire alarm system or by failure of the electricity supply to the unit.

PLANT SHUTDOWN

Where emergency shutdown of plant is required, the following shall apply:

Where mechanical ventilation is installed, means shall be provided whereby the supply air including any recirculated air can be shut off in any zone when an alarm is raised. This will be operated by relays activated by the fire alarm system which will shut down the supply fan to the zone. If it is necessary to keep this fan running in order to supply other zones then it will be necessary to install dampers in the supply ductwork which will enable sections to be shut off automatically by the fire alarm system. These dampers shall be held in the open position by a solenoid energised from a clearly labelled separate way on the nearest distribution board.

Details of the above requirements are to be shown on the design drawings.

LABELS/DIAGRAMS

All manual controls shall be clearly labelled to indicate their functions.

On or adjacent to all control and repeater panels, the manufacturer shall provide diagrammatic representations of the building indicating: - zones, circulation areas, escape routes, and any other information that is detailed elsewhere in the specification.

All information shall be permanently marked on the plans.

The manufacturer shall submit full details of proposed diagrams to the Service Engineer for comment prior to manufacture commencing.

The contractor shall be responsible for the design of the 'Cause and effects' schedule and liaison with the relevant parties.

SPARES AND ADDITIONAL EQUIPMENT

The fire alarm manufacturer shall provide a full list of recommended spares and any other equipment required to operate the system for a minimum of 10 years.

The list shall include any equipment required to programme the system.

MAINTENANCE

The fire alarm system manufacturer shall provide full details of his proposed maintenance and servicing agreements for this fire alarm system at the time of Tender. The details shall include, but not limited to, frequency of visits, call out times and the like for the perusal of the Services Engineer.

These items shall be costed as a separate item and shall not form part of the Tender Sum.

INSEPECTION, TESTING AND COMMISSIONING

The fire alarm system manufacturer shall carry out testing as specified by the relevant sections of the British Standards listed elsewhere in the Section of the Specification.

The complete installation once installed shall be fully inspected and tested to the satisfactions of the Service Engineer to prove the following:

(i) All manual call points initiate an alarm
(ii) All smoke and heat detectors initiate an alarm
(iii) All alarms initiated are in the correct zone
(iv) Information given of the display is correct
(v) All actions of the fire alarm are correct
(vi) Visual alarms can be seen adequately
(vii) Interfacing with Public address system demonstrated
(viii) The standby battery duration is achieved.

Following successful commissioning of the system, a commissioning certificate in accordance with BS 5839 shall be issued by the installer.

OPERATION AND MAINTENANCE MANUALS

Operating and Maintenance manuals shall be provided as detailed elsewhere in the Specification. However, the following items shall be included with particular reference to the fire alarm system.

1) An account of the scope of the system installed, comprising:

- A full technical description of the system installed, written to ensure that the Client's staff fully understand the scope and facilities provided.
- A technical description of the mode of operation of the system.

2) A record of the precise components and layout of the installation, comprising:

- A copy of all record drawings, together with a list of all drawings included.
- Diagrammatic drawings of each system indicating principle items of equipment, and the like.

3) Schedules of equipment, detectors and the like by system, stating their locations within the building, duties and performance figures, together with anticipated life expectancies.

4) Manufacturer's literature including detailed drawings, electrical circuit details, and printed operating and maintenance instructions for all items of plant and equipments.

5) A copy of all test certificates used in the installation, including but not limited to) electrical circuit tests, type tests, works tests, start and commissioning test.

6) A copy of all manufacturers guarantees.

7) A description of the method of operation for the system comprising:

- Full details of operation for the limited access menu
- Full details of operation for the main access menu
- Scheduled details of all settings, and actual values programmed during commissioning.

8) An account of how the systems should be maintained, comprising:

- Detailed recommendations as to the preventive maintenance frequency and procedures, including related health and safety procedures, which should be adopted by the Client to ensure the most efficient operation of the system.
- A list of recommended "running spares" required which may involve the Client in extended deliveries when replacements are required at some future date.
- Procedures for fault finding
- Emergency procedures.

INSPECTION, TEST AND APPROVAL CERTIFICATES

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

INSPECTION, TESTING AND COMMISSIONING

The whole of the fire alarm system installation shall be inspected, tested and commissioned in accordance with clause 26 of BS5839-1 and as further described.

The fire alarm system installer shall employ the fire alarm equipment manufacturer to commission the entire system.

Commissioning shall be carried out in accordance with BS 5839-1, and BS EN 60849 which shall include:

a) An audibility test of the alarm devices. Audibility level reading shall be taken in each room using an instrument complying with BS EN 60651 with slow response and a weighting. And sound pressure levels found to be lower than that required by BS 5839 shall be reported, in writing, to the Services Engineer.

b) All trigger devices i.e. Manual call point heat detectors and smoke detectors shall be tested for correct operation.

c) A mains failure test shall be carried out to verify the standby battery system complies with the previous clause titled 'Power Supplies'.

2.13 Plug Tops; Fuses; Spare Glasses, etc

Plug tops where required shall be supplied unfused and the following proportion of cartridge fuses shall be supplied for the full number of plug tops:

30%	3 amp
30%	10 amp
30%	13 amp

At "hand-over" date, the Contractor shall pass to the Engineer the full number of plug tops and fuse cartridges.

The Contractor shall supply and hand-over to the Engineer, at completion of the works, six spare fire alarm contact glasses and three opening keys, as necessary for the Contract.

2.14 Alignment of Accessories and Fixing Heights

The Contractor shall pay very particular attention to the method of fixing switch boxes and socket outlet boxes and shall ascertain a definite datum line from which all measurements can be taken and also the thickness of walls, depths of finished plaster and final finish of all wall surfaces.

Accessory mounting heights are to be in accordance with Building Regulations Part 'M'

The following heights above floor level shall be assumed unless specified differently elsewhere, all positions to be agreed on site:

(a)	Lighting switches, fire alarm contacts, control switches, push buttons	In line with DDA requirements
(b)	Bracket lighting points	1.9m centre to back plate
(c)	Clocks, fire alarm and other bells	2.2m to centre
(d)	Wall mounted socket outlets	In line with DDA requirements
(e)	Distribution boards	2.0m to top of the boards

2.15 Accessory Boxes

All equipment supplied under this contract and by others specified to be surface mounted shall be fixed in totally plain boxes, i.e. not equipped with knockouts or any form of entry position.

All boxes shall be drilled on site to provide the necessary number of conduit/cable entries required and shall be fixed with the necessary size of screws or bolts utilising all fixing holes provided.

2.16 Drawing and Positions of Points

All particulars given on the drawings are intended to be as accurate as possible, but the Contractor shall be responsible for the verification thereof and for taking off and calculating all and any other requirements which he may require.

Everything to be done is usual and necessary for the proper execution of the works comprehending what may be reasonably implied from the drawings and specification, although some may not be specifically mentioned or detailed.

The concept drawings accompanying this specification are to show design intent and the general arrangement of various items of works specified and installed in the contract and do not necessarily show the exact bends and routes of cables, etc. but the Contractor shall include for any and every appliance and fitting necessary for the proper execution of the works.

It should be noted that symbols representing the installation equipment (i.e. sockets, switches, etc) are, for practical drawing purposes, not to scale. The Contractor shall therefore obtain confirmation of all installation equipment prior to commencement of any work. It shall be the Contractor's responsibility to inspect the General Building Contractors detail and working drawings to enable him to finally position all equipment in the correct juxta relationship with the building elements of furniture, walls, windows, work tops, etc., and all other items of equipment supplied and/or installed by others.

All, or any part, of the installation carried out without prior agreement on site with the Architect, his Engineer and the General Building Contractor, shall be liable to rejection and the whole shall be re-executed all at the Contractor's expense.

The Contractor shall prepare detailed working drawings. Copies of these drawings must first be submitted to the Engineer for approval before any work is put in hand.

The contractor will provide detailed design drawings, one set of which must be carefully kept on site and the same shall at all times be available for inspection and use by the Architect and his Engineer. The Contractor shall record, on these drawings, each and every variation made during the progresses of the works. These records shall be made neatly in permanent colour immediately the variation is carried out and shall form a basis for the compilation of the "as fitted" drawings.

Working Drawings

The Contractor shall allow for the provision of detailed and dimensional working drawings for both builders and Engineering requirements and these shall be forwarded to the Engineer for approval.

The Contractor shall provide full working drawings of all works associated with this project together with any calculations which may be required by the Engineer.

2.17 Equipment Isolation

All items of electrical equipment supplied under this contract and others shall have ready means of isolation for it, immediately adjacent to the equipment. This isolation shall take the form laid down in the specific clauses of this specification, but where not as detailed, and all rotating machinery, pumps, motors, etc., the isolation shall comprise single pole and neutral sheet steel enclosed isolators of the manufacture and type generally specified for the Contract.

2.18 Segregation of Services

Every extra low voltage wiring system, e.g. signalling, intercommunication, clocks, fire alarms, shall be contained within its own conduit, trunking and/or cable. When it is required that ELV cables shall be run in trunking, the cables shall be 600/1000 volt grade and segregated in separate compartments.

Segregation shall otherwise be in accordance with the IEE Regulations.

All conduits and trunking used for telephone and communication systems shall be entirely separate to all others and separately earthed.

2.19 Three Phase Circuits

All circuits to individual fixed items of equipment operating on two or more phases of the supply shall be contained within one armoured cable, PVC, insulated cables in conduit or mineral insulated metal covered cables.

Under no circumstances shall single PVC/PVC insulated, twin and earth PVC/PVC insulated or multi-core rough rubber or PVC cables be used.

2.20 Completion Certificate

Following the inspection and testing of the installation and any corrective action found necessary, the Contractor shall issue a completion certificate, as prescribed in the Institution of Electrical Engineers Regulations Appendix 6, together with inspection certificate.

2.21 Final Circuit Wiring

Final circuit wiring shall be by the supply and installation of LSF insulated stranded copper cables installed in steel trunking and conduit. At each distribution board, the Contractor shall identify each final circuit conductor with its circuit reference; this shall be for phase, neutral and CPC conductors. Critchley "Z" type identification markers shall be used, each conductors shall be identified, i.e. phase, neutral and CPC shall be labelled R1, etc.

Typed distribution board schedules shall be fitted and an engraved traffolyte label fixed to the front facia of each distribution board, this label shall state the distribution board designation, number of ways, size and type of sub-mains, rating and type of the "up-stream" protective device at the point of isolation.

The Contractor shall test each individual circuit in accordance with current regulations. The result of these tests shall be recorded on NICEIC type data sheets and included within the maintenance manuals within a separate section reserved for "test and commissioning data".

The Contractor shall measure and record the value of fault energy (KA) at each distribution board together with external earth impedance (ohms). The results of these tests shall be recorded on test and data sheets, distribution board schedules and engraved upon a traffolyte label which shall be secured to each relevant item of equipment stating the above results together with the date of the test.

Generally the small power accessories shall consist of 240V-13A twin switched socket outlets, protected by 30mA/30mA RCBO, unswitched and switched fused connection units and isolators shall be wired as radial or ring circuits and installed under this contract.

The ratings of cables and protective conductor shall be as required to comply with BS 7671.

All single core PVC insulated cables installed in conduit or trunking are to be LSF 450/750V grade ref: 6491B. All 2.5mm sq. single and multicore cables are to be 7/0.67mm.

To conform with BS 7671, the 17th edition of the IEE Regulations, the Contractor shall ensure that where single core cables are installed in conduit or trunking, a grouping factor of not less than .0.6 is attained. This is particularly relevant where cables leave distribution boards.

2.22 Commissioning

The Contractor shall attend all commissioning meetings and submit procedures both for the electrical Engineering services and for specialist systems that may be supplied and installed by others under the General Contract, e.g. lifts, fire, security and communication systems, heating and ventilating installations, etc.

Full labour and test equipment shall be provided such that the condition and state of all electrical supplies and equipment, throughout the installation, and up to the point of termination on specialist suppliers and installers sections, may be proved.

The Contractor shall be responsible for obtaining the attendance of the manufacturer's representative and/or Engineer to commission and put into operation all items of specialist equipment supplied and/or installed under this contract.

The Contractor shall fully include for all such attendances within this tender for the Electrical Engineering services.

2.23 Lightning Protection

GENERAL

Unless otherwise indicated within the corresponding section of the particular specification, the lightning protection system shall consist of air terminations including roof conductors, down conductors, bonds to exposed permanent metal parts of the building, testing points, earth terminations and earth electrodes.

The installations shall comply with BS EN 62305, BS EN 623 and BS 7430.

The Contractor shall submit a copy of the "Risk Assessment" and plan indicating the proposed layout for review by the Engineer.

MATERIALS

Air terminations, roof conductors and down conductors shall be of copper, copper alloy or aluminium except that aluminium shall not be used below ground level.

Earth electrodes shall be hard drawn copper rods of not less than 15mm diameter in 1250mm lengths with internal screw joints. Earth rods shall have a triangular type clamp fixed to the head and hardened steel tip fixed to the foot. The length of each earth rod shall be such as to achieve the necessary earth resistance, but a minimum length of 2500mm shall be used.

Test clamps shall be plate type phosphor bronze, naval brass, gunmetal or hard drawn copper.

Inspection chambers shall be as manufactured by BICC Ltd in pre-cast concrete with a heavy cover permanently marked 'earthing electrode'. The covers shall be arranged so that they are flush with the ground finish.

AIR TERMINATIONS AND ROOF CONDUCTORS

a) General

An air termination may consist of a vertical conductor, a single horizontal conductor or a system of horizontal conductors.

Roof conductors shall be fixed with saddles of similar material at intervals not exceeding 1.2m sufficient clearance being provided around the conductor to allow for movement due to expansion and contraction.

b) Chimneys

Where a chimney has a metal capping this shall form the air termination and be bonded to the down conductor.

Metal chimneys do not require an air termination or down conductor, but an earth electrode shall be provided and connected to the base of the chimney.

c) Buildings

Roof conductors of 25mm x 3mm strip shall be fixed along the ridges or around the roof perimeter and be interconnected with other conductors run across the roof as necessary so that no part of the roof is more than 9m from a conductor. Where there is a higher part of the roof such as a tank or plant room this shall be fitted with a perimeter conductor joined to the main roof system. Low buildings which are within the protective cone of higher conductors need not be protected.

d) Exposed Metal Parts of Structure.

All metallic projections such as radio and television aerial masts, chimneys, ducts, vent pipes and railings on or above the main surface of the roof shall be bonded to the air terminations network. Where dissimilar metals are involved the joint shall be made completely waterproof by covering with P.V.C tape.

DOWN CONDUCTORS

Down conductors shall be of 25mm x 3mm strip, shall follow the most direct route between air termination and earth terminations and where practicable shall run vertically down the outside of the building. Where an external route cannot be followed the conductor may be housed in a non-metallic non-combustible internal duct provided the duct does not contain an unarmoured or non-metal sheathed service cable. Down conductors shall be securely fixed by saddles or similar material at intervals not exceeding 1m.

The number of down conductors shall be as indicated on the design drawings. Each down conductor shall have a test joint in a convenient position and no connection other than to an earth electrode shall be made below the test joint. When only one down conductor is provided the connection to the earth electrode may be used for the test point when it is conveniently accessible.

JOINTS AND BONDS

The lightning protective system shall have as few joints as possible. Joints and bonds shall be mechanically and electrically effective.

EARTH TERMINATIONS AND ELECTRODES

Each down conductor shall have an earth system connected to the lower side of the test joint. The test joint shall be fixed to the building structure at between 40mm and 180mm above finished ground level.

Each electrode terminal connection shall be fitted within an inspection chamber. A permanent label indelibly marked with the words 'Safety

Electrical Earth – Do Not Remove', shall be permanently fixed to each connection.

Where an earth electrode system is provided locally for the electrical installation is shall also be used for the lightning protection system where this is practicable and the down lead or one of the down leads shall be located to enable this to be achieved. All adjacent underground services having exposed metal in the form of sheathing, armouring or piping shall be bonded as directly as possible to the earth termination.

Connections to earth electrodes shall be made with suitable purpose made bronze connectors and 19/1.178mm stranded copper conductor protected against corrosion by wrapping with P.V.C tape. Buried parts shall be at least 600mm deep and protected with cable tiles. Where multiple earth electrodes are required to achieve the required resistance, they shall be spaced apart at a distance equal to the length of the rods and shall be driven vertically.

Where the nature of the ground is such that it is impracticable to drive rods e.g. where the ground is impervious rock very close to the surface, copper strip electrodes shall be used, the length and number of strip shall be such as to obtain the necessary earth resistance.

2.24 Earthing and Bonding

Earthing and bonding shall comply with BS 7430 and BS EN 7671.

At all main switchgear positions an earth conductor consisting of copper strip having a minimum cross sectional area of 100sq.mm shall be provided and all equipment including the metal sheath and armouring of cables, the metal cases of all switches and distribution fuseboards and metal frames shall be directly bonded to it.

Where copper strip is fixed to the building structure it shall be by means of purposes made brass or bronze saddles, using purpose made plugs and clamps. Fixings requiring the drilling of holes through the strip will not be accepted.

Joints in copper tape shall be tinned before assembly riveted with a minimum of two copper rivets and sweated solid.

Where holes are drilled in the earth tape for connection to items of plant the effective cross sectional area of the connection shall not be less than that required to comply with the BS EN 7671.

Bolt, nuts and washers for any fixing of the earth tape shall be brass of the high tensile grade or where liable to corrosion they shall be bronze.
Any special earthing requirements shall be specified in the Schedules or drawings.

SUB-STATION EARTHING

A main earth bar of hard drawn high conductivity copper shall be mounted on the sub-station wall by means of busbar supports.

The size of each bare earth bar copper tape used in the sub-station shall be the same and determined form the prospective fault current in accordance with the following table:-

Fault Current not exceeding	Minimum Size
14 kA	25mm x 5mm
30 kA	40mm x 5mm
33 kA	50mm x 7mm

The connection between the transformer neutral and the low voltage switchboard neutral bus-bar shall be insulated.

The position on the L.V switchboard neutral conductor at which the earth connections will be made will depend on the system of earth leakage protection adopted – i.e. as to whether it will be on the mains or load side of the neutral current transformer and it will be specified on the design drawings or in the Schedules.

EARTH ELECTRODES

Unless otherwise specified earth electrodes shall be copper bond type earth electrodes where the pure electrolytic copper (99.9) is bonded onto a low carbon steel core.

The earth rods shall be of proprietary manufacture 15mm minimum diameter driven into the ground to a minimum depth of 2.4m providing the ground conditions are suitable, made up of sections 1.2m long with internal screw and socket joints and fitted with a hardened steel tip and driving cap.

A minimum of two earth electrodes shall be provided for each main earthing system and the conductor brought back to the main earth busbar for each electrode.

Connections to the earth electrodes are to be readily accessible for periodic inspection and shall be protected against mechanical damage and corrosion. The actual connection to the rod shall be by means of a purposes made clamp and shall be made below ground level in a concrete inspection pit having a removable cover.

Where a connection is made to an earth electrode, a permanent label indelibly marked with the words "Safety Electrical Earth – DO NOT REMOVE", shall be supplied and fixed thereto.

Where an earth electrode system is installed, soil resistivity or other tests shall be carried out to ensure that the required earth loop impedance figures are attained. Earth loop impedance figures shall be in accordance with BS EN 7671.

Reading to be submitted to Services Engineer before installation made live.

EARTHING OF INSTALLION SUPPLIED AT LOW OR EXTRA LOW VOLTAGE

Unless otherwise specified the earthing lead shall be bonded to the sheath and/or armouring of the Supply Authority's cable.

EARTH CONTINUNITY

Earth continuity conductors shall be of the sizes specified or, if no size is particularly specified in accordance with BS 7671. All such conductors other than tapes shall be insulated with green/yellow P.V.C Earth clamps shall comply with BS 951.

Earth tapes which are fixed to the walls shall be clamped onto stand-off brackets to afford clearance of 5mm. Connections to the earth tape shall be clamped or riveted and soldered.

The metal sheaths and/or armouring of paper and P.V.C-insulated cables shall be bonded to the metal parts of the equipment to which they are connected.

In cases of circuits protected by fuse-links of rating not greater than 32 amps, electrical continuity may be obtained between the conduits or sheaths of M.I.M.S cables and the equipments to which they are connected providing:-

a) The surfaces of equipment are cleaned free from paint or other non-conducting material and cleaned surfaces coated with petroleum jelly.

b) Conduit entry into the equipment shall be by the use of spouted boxes or by means of a smooth bore male brass bush and compression washers between the coupling and the box.

c) Cable glands are screwed into spouted boxes or fixed by locknuts with compression.

Earth couplings shall be connected by means of an insulated copper wire coloured green/yellow which shall be connected by means of a 5mm brass screw secured to the equipment. In surface conduit installations in which a high degree of neatness is required, plain couplings with compression washers may be authorised.

In lightning switches, socket outlets and all equipment outlets the copper earth wire from the couplings shall pass through a hole in the box and terminate at a 4mm brass screw tapped or bolted into the box.

Insulated earth connections shall be provided between the terminal in the box or other enclosure and the terminal on the lighting switch, socket outlet or other equipment.

Surfaces of all equipment to which earthing connections are made shall be cleaned free from paint and other non-conducting material.

The supply and fixing of all earthing and bonding materials, whether or not shown in detail on the drawings, which may be required for the proper and effective earthing and bonding of any equipment, shall be considered to be included in the material and labour covered by the supply and installation of the equipment unless this work is specifically detailed elsewhere in the Schedules.

EARTHING OF LIGHTING POINTS

Metal parts of lighting fitting which are required by BS 7671 to be earthed shall be connected to the lighting point earthing terminal by

means of a green/yellow insulated conductor of cross section not less that that of the line conductor supplying the fitting.

In an installation wired in conduit or in M.I.M.S cables, the earthing terminal shall be a 4 mm screw brass pillar terminal tapped into the base of the conduit box at each lighting point.

In trunking installations the earthing terminal shall be provided by means of the third way in a three-way connector block used at each lighting point. The earthing terminal shall be connected to the trunking by means of a green/yellow P.V.C insulated 1.0sq.mm cable fixed by a brass nut, bolt and washers.

EARTHING OF SOCKET OUTLETS

The earthing terminal in the box or other enclosure associated with a socket outlet which is required to be connected in accordance with BS 7671 to the socket outlet earthing terminal, shall be a 4mm screw brass pillar terminal tapped into the box or other enclosure.

BONDING

The bonding connections required by BS 7671 to be made to other services such as gas and water as near as practicable to the point of entry shall be made by means of a solid copper conductor of minimum cross section in accordance with BS 7671. These bonds shall be installed as inconspicuously and neatly as possible. The connections shall be visible after installation.

Frames of motors, generators, metal cases of switchgear and all metal-clad or enclosed apparatus, metal sheathing and armouring of cable and conduits shall be electrically continuous and connected to the main earth system. The electrical continuity of the earthing system shall be such that the electrical impedance between the main switch and any other part of the works shall not exceed 1 ohm.

All earth tapes and conductors run underground or through walls shall be either P.V.C taped or served with corrosion resisting compound. Where tapes are run underground they shall be laid in sand and their presence indicated by marker tapes laid directly above the cables after the trench has been backfilled, the tapes being approximately 300mm below the surface level. The tapes shall be manufactured from high grade polythene 150mm coloured yellow with the words " Electric Cable Below" printed along its length.

Equipotential earth bonding of extraneous conductive parts as detailed in BS 7671 shall be carried out at:-

The point of entry for the Building and all separate remote buildings, including:-

(i) Mains water pipes
(ii) Mains gas pipes
(iii) Other service pipes and ducting
(iv) Rising mains for central heating and air conditioning.

Supplementary bonding shall be provided to comply with BS 7671 and sized in accordance with Clause 547-03 of BS 7671.

The bonds shall be green and yellow P.V.C. insulated, and in concealed parts of the installation shall be concealed as far as is practicable in voids, partition walls or buried direct in plastered walls. Generally, bonding lugs will not be available on extraneous conductive parts and allowance shall be made for purpose-made clamps or clips, drilling or utilising fixing or connecting bolts with the permission of the installer of the service or equipment.

The following shall be used as guidance to requirements:-

1. Bond between the hot and cold water pipes and metallic waste at each basin, sink, bath or shower, and to the basin, sink, bath or shower tray if metal.

2. Bond from the connection to 1. to any radiator, metal rail, W.C water pipe or other conductive part in a bathroom or shower room.

3. Bond from each radiator to its connecting pipework if the pipework does not provide a sound metal to metal contact.

4. Bond from the exposed conductive parts of the electrical system in each space to the heating water and gases pipework in the space unless test indicated adequate earth continuity of the pipework back to a main bonding point.

5. Bond between any fixed conductive part, "exposed" or "extraneous" within 2 m of each other unless test show adequate continuity, This does not include metal windows.

6. In every space with a metal frame tiled ceiling bond at one point on the frame to the exposed conductive parts of the lighting installation. In corridors bond at least once every thirty meters.

7. In every space bond from the exposed conductive parts of the lighting installation at one point to each ventilation duct system entering that space unless test show adequate continuity of the ductwork back to a main bonding point. (Bonding across any ductwork flexible connections to grilles on diffusers is included under 'Mechanical Services')

8. In metal frame partitions bond at one point in every electrically continuous section of the frame to the exposed conductive parts of any mains voltage electrical system within that partition. Bond also from the metal partition to any medical gas pipe system entering the partition.

9. Bond together all metal pipes, ducts, trunking, tray plate, and the like at the top, and at the bottom, of each service riser, except 'all electric' risers and connect to the nearest electrical earth terminal.

10. Bond across the flexible ductwork at each end of each air handling unit or axial fan.

11. Bond across the flexible coupling from the motor to the impeller casing on each pump.

12. Bond at one point across any system of antivibration mountings which separates metallically any rotating plant from its frame.

13. Bond together and to the control panel, every metal pipe, duct or trunking in each plant room, near the point where they enter or leave the plant room.

14. On metal tanks bond from the tank to each metal pipe connecting to the tank unless the connections form a sound metal to metal contact and bond across metal pipework entering and leaving a plastic tank.

15. Bond metal framed panels below cill levels which do not form an integral part of a heating unit.

Radiators shall be bonded on one side across the valve to pipework utilising a pre-drilled earth connection hole at the rear of the radiator (when provided), colour coded P.V.C. earth cable and a copper earth strap, installed in a concealed manner at the rear of the radiator.

It shall not be required to install supplementary bonding leads, but an earth continuity impedance test shall be carried out, readings recorded and submitted to the Services Engineer for each bathroom, kitchen and shower room and all other rooms where radiators, fan coil units, and the like are installed.

Supplementary bonding connections shall not be made to terminate inside socket outlets or spur units due to the possibility of accidental contact being made with live terminals, all earth bonding shall be made external to such fittings.

EXTENSIONS AND ALTERATIONS TO EXTISING INSTALLATIONS

Existing installations which are being extended shall be checked to ensure that the existing earth continuity conductors and earthing leads comply with BS 7671. it is not sufficient merely to connect to the nearest earth continuity conductor of the existing installation. If the existing earthing system is found not to comply with BS 7671 application shall be made for instructions.

Where a connections is made to another earth continuity conductor or earthing lead, a permanent liable indelibly marked with the works " SAFETY ELECTRICAL EARTH - DO NOT REMOVE" shall be supplied and affixed thereto.

2.25 As Fitted" Drawings and Maintenance Manuals

Three copies of the final manual shall be prepared. The contents shall be set out in logical sequence. Each section of the manual shall be fully indexed and the whole contained in a good quality black "twinlock" binder reference 3CB or equal and approved with gold embossed lettering stating, for example:

RECORD AND MAINTENANCE MANUALS
FOR
ELECTRICAL INSTALLATION
AT
PROJECT TITLE

Initially, two sets of the manual, including drawings, shall be presented to the Supervising Officer. One copy will be returned with comments

and one retained. The corrected Manual and the corrected pages of the retained copy Manual shall be handed to the Supervising Officer including all required drawings.

(a) Introduction

To include general preamble, list of abbreviations, schedule of record drawings and service identification.

(b) General Description of Systems

To give a full description of systems and associated equipment with schematic sketches of systems to enhance the explanatory notes. To be compiled in conjunction with manufacturers information.

The section shall have sub-sections covering all equipment and systems.

(c) Design and Performance

To show full details of plant design parameters, etc., to have sub-sections covering general design conditions and design criteria.

(d) Technical Data

Technical details and performance for each item of equipment taken from manufacturer's information.

(e) Controls

Full description of control systems complied in conjunction with the Control Specialist.

(f) General Operating and Maintenance Notes

General notes covering the measuring techniques and equipment to check the equipment performance on periodic basis. To have sub-sections covering regulations of systems, measurement, safety precautions, planned maintenance and equipment log.

(g) Procedure for Operating and Maintenance

A general section, covering procedure, routing operating and operational notes.

Under a main procedure section, sub-sections covering normal operation, initial setting up, routine inspection and operation of systems.

Under a sub-procedure section, sub-sections covering replacement and adjusting of main spares, lens, amplifiers, etc.

(h) Emergency Procedures

General section and sub-section covering emergency procedures and first aid.

(i) Fault Tracing

General section and sub-section covering fault tracing charts for quick analysis and control systems.

(j) Maintenance

General section and sub-sections covering schedules, inspection, fault finding, adjustment, replacement, overhaul frequencies and cleanliness.

The section shall include maintenance sheets for all systems.

(k) Commissioning Report

The commissioning report detailed earlier shall be incorporated in the final document.

(l) Spares

List of spares based on manufacturers recommendations and subject to the special conditions of the contract.

List of holding spares (as handed over with plant).

(m) Manufacturer's Literature

Provide a composite set of manufacturer's literature, covering general information and detailed instructions, to include:

Catalogues and Leaflets detailing Equipment installed.
Operating and Maintenance Instructions.
Testing Procedures.
Performance Charts, Curves, Rating Data.
Wiring Drawings for Equipment – incorporating any site modifications.

With full manufacturer's references including:

Equipment Serial Numbers.
Customer Order Reference Numbers.
Reference for Ordering Spares.

Plant Component Drawings where appropriate.

The "As Fitted" drawings information shall be submitted on AutoCAD (Latest Version) format CD.

2.26 Variations

The Contractor shall allow for the foregoing in preparing his tender and programming his works and will be deemed to have visited site prior to tendering. No claims for additional costs or extension to the contract period will be considered arising from lack of knowledge, or the implementation of the requirements of the Specification.

No costs for variation will be allowed unless prior authorisation has been given (in writing) by the Engineer.

2.27 Schedule of Rates

The Electrical Contractor shall provide, within 14 days of being asked to do so by the Engineer, a fully priced and detailed Bill of Quantities and Schedule of Rates showing how his tender was built up. A request from the Engineer for such information is not to be interpreted by the Contractor as an indication that his offer has been accepted or is about to be accepted. The Bill of Quantities and Schedule of Rates shall be fully priced to include the installed cost of each item, tradesmen's hourly rates and all establishment charges and fixing profits.

DAYWORKS SCHEDULE

In the event of variations to the Contract which cannot be measured and priced in accordance with the Materials with Prices Schedule, I/We undertake to carry out the works so authorised and charge in accordance with the following:-

Technician Electrician	……..	per hour, plus ……..….%
Approved Electrician	…….	per hour, plus …….…… %
Electrician	……	per hour, plus ……..…...%
Trainee Electrician	…….	per hour, plus ……..……..%
Labourer	…….	per hour, plus ……..……..%
Apprentice	……..	per hour, plus ……..……%

Net Cost of Material	£	plus ……..……..%
Fares, Allowances & Transport	£	plus ……..……..%

SIGNED …….

F**OR AND ON BEHALF OF** ……..….

……

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DATE ……