Lancaster West Estates Neighbourhood Team

Royal Borough of Kensington & Chelsea

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Performance Specification for the FIRS System

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1A PRELIMINARIES

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1.0 PRELIMINARIES

1.1 GENERAL CONDITIONS & PRELIMINARIES OF THE MAIN CONTRACT

Main Contract Conditions and Preliminaries can be obtained from the Contract Administrator.

1.2 GENERAL CONDITIONS OF CONTRACT

Details of the Main Contract conditions and Preliminaries may be obtained from the Contract Administrator during the Tender period.

1.2.1 Designation

The designation 'Contract Administrator/Project Manager/Architect' or 'Consultant Engineer' stated within this Specification shall be deemed to read 'Engineer'.

1.2.2 Drawings and Specification

The Specification and drawings shall form part of the Main Contract documentation and, therefore, shall be read in conjunction with the said document.

The Engineering Services (herein after called the "Services") shall be executed in accordance with the Specification, contract drawings and such further instructions as may be issued from time to time by the Contract Administrator/Project Manager/Architect in the most substantial and workmanlike manner according to the true intent and meaning of the Specification and no advantage shall be taken of the outline drawings and Specification and shall be completed to the full satisfaction of the Contract Administrator/Project Manager/Architect.

The Contractor shall include for all relevant items shown upon the drawings whether or not such items are referred to in the specification but not shown upon the drawings to provide a complete and fully functional installation.

Positions of plant shown upon the drawings shall be used for the purposes of tendering, but they may be reasonably varied by the Contract Administrator/Engineer without extra cost unless such alterations are made after the plant is installed.

The Contractor shall be held to have carefully examined the site, Specification and the drawings and shall be held to concur as a practical manufacturer and tradesman in the methods and styles of construction to be adopted and the sufficiency of the material proposed to be used in the execution of the "Services".

Should anything be omitted from the said Specification or drawings which is fitting and usually considered necessary to be done for the due and proper completion of the "Services", the Contractor shall execute the same as if it has been particularly specified or shown upon the drawings and shall supply whatever may be necessary to complete the whole "Services" without any claim for payment for such omissions.

Should there be any item or items in the Specification or upon the drawings which the Contractor has any doubt as to the true intent and meaning thereof, he shall satisfy themself by enquiring of the Contract Administrator/Project Manager/Architect before submitting his tender. The Contract Administrator/Project Manager/Architect's decision shall be final. After formal acceptance of the tender, the Contract Administrator/Project Manager/Architect's interpretation thereof shall be binding on the Contractor.

In the event of any discrepancies in the scale approved to any plan or drawing and the figured dimensions thereon, the figured dimensions shall be taken and held to be correct.

1.2.3 Costs to Comply with Specification

Costs for the total of Services shall be based on the specified fittings, articles and materials.

No alternative scheme shall be considered, and Contractors shall conform strictly to the Specification and associated drawings.

1.2.4 Schedule of Rates

The Contractor shall, within 14 days of being so requested by the Contract Administrator/Project Manager/Architect, furnish a schedule of rates showing in detail, the quantities, prices and extensions used in the calculations of his price and he shall accept responsibility for the accuracy of any quantity and extensions contained therein which shall balance with the total cost of this.

This Schedule shall form part of the Contract Documents.

1.2.5 Contractor to Inform Themselves Fully

The Contractor shall be responsible for all measurements and for the completion of quantities required and no allowance shall be made for any alleged ignorance or insufficient knowledge, inaccurate measurements, or error on his part.

The drawings prepared in connection with the "Services" indicate diagrammatically the position of the various runs, points and equipment etc., but the actual runs and positions of equipment etc., shall be fully determined on site and the Contractor is required to obtain all information in respect of dimensions, door hangings, architectural features, furniture etc., from the Contract Administrator/Project Manager/Architect's drawings and by enquiry of the Contract Administrator/Project Manager/Architect.

1.2.6 Inspection, Testing and Rejection

The "Services" shall be carried out in accordance with the instructions which shall be given from time to time by the Contract Administrator/Project Manager/Architect's Representative and to his satisfaction in all things.

The Contract Administrator/Project Manager/Architect shall have full power to inspect and test at the sole cost and charge of the Contractor, the work or materials during manufacture or construction or at any place where any materials are being made or obtained therewith. All other operations of the Contractor or any authorised Sub-Contractor, manufacturer or tradesman shall be open to the inspection of the Contract Administrator/Project Manager/Architect at all times. The Contract Administrator/Project Manager/Architect shall have full power either before or after delivery or erection to reject any of the work which he may consider defective either in material manufacture or workmanship and to order removal of same and his directions on such subjects are to be final and shall be promptly attended to by the Contractor at his own expense. Should compliance with such instructions be refused or neglected for three days, the Contract Administrator/Project Manager/Architect shall have power to have the rejected work taken down and removed without being answerable or accountable for any loss or damage which may arise or happen to the same and any consequential expense shall be paid to the Employer.

Except where otherwise specified, the Contractor shall provide free of charge such assistance, labour, materials, electricity, fuel, stores, apparatus, and instruments as may be requisite and as may be reasonably demanded to carry out the tests efficiently.

1.2.7 Tests Upon Completion

The Contractor shall give the Contract Administrator/Project Manager/Architect twenty-one days' notice in writing of the date after which the Contractor shall be ready to carry out the tests on completion hereinafter specified. Unless otherwise agreed, the tests shall take place within ten days after the said date on such day or days as the Contract Administrator/Project Manager/Architect shall in writing notify the Contractor.

If the Contractor fails to make such tests within the time aforesaid, the Contract Administrator/Project Manager/Architect may proceed to make tests and all tests so made by the Contract Administrator/Project Manager/Architect shall be at the risk and expense of the Contractor.

The Contractor shall be required to provide all necessary testing equipment and instruments and to test the installation in the presence of and to the satisfaction of the Contract Administrator/Project Manager/Architect and to carry out such rectification to the plant and further tests as the Contract Administrator/Project Manager/Architect may direct and shall leave the installation in perfect working order as specified. All such tests shall be carried out free of charge to the Employer.

To facilitate progress of the "Services" it may be necessary to test sections of the "Services" separately and no extra charge to the Employer shall be allowed.

If any portion of the "Services" fails to pass the tests of the said portion, tests shall, if required by the Contract Administrator/Project Manager/Architect, be repeated within a reasonable time upon the same terms and conditions and all costs arising from the repetition of the tests shall be met by the Contractor.

1.2.8 Setting Out Of Works

The Contractor shall take out all his own dimensions for all plant and materials to be supplied and fixed and shall be entirely responsible for their accuracy. All measurements are to be taken from actual buildings and plant and not from drawings and Specification.

1.2.9 Builders Work

All excavation, back filling, cutting away, making good and all incidental builders work shall form part of the main contract. No cutting away shall be allowed without the sanction of the Contract Administrator/Project Manager/Architect. The Contractor shall mark out in advance and shall be responsible for the accuracy and size of all cut holes and chases required.

The Contractor shall drill and plug all holes for securing services which require screw or bolt fixing.

Building work requirements in sufficient detail to enable accurate setting out of holes, built-in sleeves and bases shall be detailed by the Contractor well in advance so that exact positions can be agreed. All making good and repair of decoration shall form part of this contract.

1.2.10 Installation Liaison

Particular care shall be taken to ensure there is close liaison with other trades in installing services to prevent obstruction of Services positions etc.

Services through ducts shall be arranged to permit maximum access in the ducts and the services shall be readily accessible for maintenance.

Any work which has to be rectified due to negligence in this respect shall be the responsibility of the Contractor.

The routes of services and the approximate positions of apparatus are shown upon the drawings, but their exact position shall be determined by dimensional detail drawings, or on site by the Contract Administrator/Project Manager/Architect in consultation with the Contractor.

Particular care shall be taken to obtain uniform and tidy arrangements of wall and ceiling mounted equipment. The precise position of a piece of equipment shall be determined as follows: -

a) Single items of equipment which are visually remote from other electrical or mechanical equipment shall be erected at the mounting heights stated in the Specification or shown upon the drawings.

b) Two or more items of equipment whether mechanical or electrical or both, which are to be erected on the same wall, or ceiling, or which shall be otherwise visually close to each other, shall be arranged in a neat and symmetrical group.

Symmetry of arrangement shall be obtained by horizontal and vertical alignment through the centre lines and not the edges of equipment and for this purpose the mounting heights stated in the General Specification or on the drawings may be varied slightly.

1.2.11 Samples Etc

The Contractor shall include for submitting samples of materials, valves, cables, switches, fittings etc., together with sketches, illustrations, leaflets, or drawings if required to the Contract Administrator/Project Manager/Architect. Such samples and illustrations etc., shall remain the property of the Contract Administrator/Project Manager/Architect until the termination of the Contract, when they shall be returned to the Contractor.

No material shall be ordered or used until it has been approved by the Contract Administrator/Project Manager/Architect.

The Contractor shall clearly mark samples etc., with his own name and address and the contract to which they refer.

1.2.12 Electrical Work Associated with Mechanical Services

The Contractor shall ensure that the wiring connections to all plant conforms to the diagrams shown on the tender drawings. If any discrepancy is found, then the Contract Administrator/Project Manager/Architect shall be informed before installation.

1.2.13 Workmanship and Materials

The "Services" shall be executed, manufactured, erected, and completed in the best and most workmanlike manner and with the best materials of their respective kinds and everything is to be done to the full spirit and intent of the Contract which is intended to comprise everything necessary for the perfection completion of the works. The Contractor shall not permit any portion of the works to be carried out by any person not employed under a contract of service by the Contractor.

Where particular materials are called for, the Contract Administrator/Project Manager/Architect shall have authority to reject materials which do not conform to the Specification.

Where the words "equal" and "approved" appear in the Specification, they shall mean an article or articles approved in writing by the Contract Administrator/Project Manager/Architect, being equal in every respect to that or those specified.

In cases where permission is given for a lower priced article to be provided, the Contract price shall be adjusted to suit the difference in cost.

Unless otherwise specified and approved, all design materials and installations shall comply with the latest issue of the relevant current British Standards, British Codes of Practice, Statutory Regulations and Bye Laws etc. Unless otherwise stated, all materials shall be new and unused.

1.2.14 Informing Manufacturers

It is, therefore, essential that the tenderer fully informs the manufacturers and equipment suppliers of the exact requirements as shown in the Specification and drawings as claims for extra costs due to lack of knowledge shall not be entertained.

1.2.15 Programme and Phasing of Works

Commencement, completion, and phasing of the works on site shall be agreed to suit the proposed programme of works as noted in the Main Contract Tender documentation and associated drawings.

The Contractor shall allow in his tender for all of the work and facilities required to meet the programming and phasing of the works including non-productive overtime.

Claims for lack of knowledge in respect of any of the above aspects of the works shall not be entertained.

1.2.16 Refrigerant Recovery (Where Applicable)

The handling of refrigerant or the decommissioning of air conditioning or refrigeration equipment which requires the safe handling of refrigerant shall be carried out by an approved specialist.

A certificate of compliance, witnessed by the Main Contractor, shall be handed to the Consulting Engineers confirming that the appropriate procedures and equipment have been used for the reclamation/removal or re-use of the refrigerant without its loss to the atmosphere.

Where refrigerant has been removed for disposal, a Certificate of Compliance shall be issued to the Consulting Engineer confirming that its disposal conforms to Section 33 of the Environmental Protection Act 1990.

Failure to comply with this section of specification shall entail the Mechanical Contractor being removed from the tender list without notification.

1.2.17 Employer/Contractor Design Warranty

All designed and equipment and areas of the electrical installation work requiring design input from the mechanical Contractor, then the Employer / Contractor Design Warranty shall apply.

1.2.18 Asbestos

If during the stripping out works or during the installation any asbestos is found, the Contractor shall stop work in that area and bring the matter to the attention of the Contract Administrator / Engineer for further instructions to be given.

1.2.19 Building Logbook

The Electrical Contractor shall prepare a building logbook to comply with the Building Legislations approved document, covering the fire alarm and emergency lighting systems.

1.2.20 CDM Regulations

The Contractor shall, whilst as part of their duties as the Electrical Contractor or at any point acting as the Principal Contractor during the Contract, shall fully comply with all the duties of a Principal Contractor as set out in the CDM Regulations, and in particular shall ensure that the Health and Safety Plan has the features required by CDM Regulations 2015.

Any amendments by the Contractor to the Health and Safety Plan shall be notified to the Employer, who shall (where relevant) therein notify the Principal Designer and the Employer's Agent / Engineer / Contract Administrator.

1.2.21 Local Authorities Requirements

The Electrical Contractor shall comply with and give all notices required by any Act of Parliament, regulations or byelaw of any Local Authority, Public Service Company or authority who may have jurisdiction with regard to the work. The Electrical Contractor shall allow within

his tender for any fees or charges legally demandable under such Act of Parliament, regulation, or byelaw in respect.

Where the requirements of any water or electricity authority for the submission to them of any component part of the works for approval, testing, stamping, or certifying, the Electrical Contractor shall at his own expense submit and deliver any such component parts to the place required by such Authority.

After such component parts have been satisfactorily approved, tested stamped, or certified, the Electrical Contractor shall return it to the site for incorporation into the works. Any expense incurred shall be paid by the Electrical Contractor. No extra charge shall be allowed due to failure to allow for these requirements.

1B PREAMBLES

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2.0 GENERAL TECHNICAL CLAUSES

2.1 INTRODUCTION

2.1.1 Definition of Terms

The word "shall" is mandatory.

The word "will" is informative.

The word "should" is advisory.

The word "provide" means supply and fix or install.

The words Contract and Contractor shall read as meaning Sub-Contract and Sub-Contractor when this Specification relates to a Sub-Contract.

This Section specifies the general quality of the Electrical Installation. Section 3 and the accompanying drawings specify in detail the installation to be provided. All clauses in this Section may not apply to this project, only those relevant to the works are applicable.

All work shown on the drawings but not described in the Specification, or vice versa, shall be provided.

The IEE Regulations are identified by a three part number e.g., 413.1.1. Where reference is made in this Section to a two part number, it is to be taken to include all the individual regulation numbers which are covered by that side heading and include two part numbers.

2.1.2 Compliance with Regulations

The installation shall conform to all relevant and generally accepted Standards and Regulations which in all cases shall be the edition in current use including all amendments. The Contractors attention is particularly drawn to the following:-

a) The 17th Edition of the Regulations for Electrical Installations with amendments, issued by the Institution of Electrical Engineers (to be referred to as the IEE Regulations) - BS 7671: 2008. Requirements for electrical installations. IEE Wiring Regulations.

b) The Electricity Supply Regulations 1988 incorporating the latest amendments.

c) The Electricity at Work Regulations 1989.

d) Health and Safety at Work Act 1974.

e) Construction (Design and Management) Regulations 2007 (Including the implementation and development of the Health & Safety Plan - e.g., Production of Method Statement, etc).

f) The Electromagnetic Compatibility Regulations 2006 - SI 2006/3418.

Subsequent references to British Standards, Codes of Practice, Regulations and the like do not give the year of issue or amendment. The published versions which shall apply will be those current ten days before the date set for return of tenders.

All British Standards referred to in this Specification shall include all the latest amendments.

2.1.3 Handover Procedure

a) General

The installation will not be considered as complete and will not UNDER ANY CIRCUMSTANCES be accepted for handover until the following criteria are met :-

1. The installation is fully tested, inspected and commissioned as detailed herein, with certificates provided to prove satisfactory testing, commissioning and operation of the electrical distribution system, fire alarm system, emergency lighting installation, lightning protection, security and all other systems included in the particular specification.

2. Approved copies of the “As Installed” documentation have been provided to the Client’s representative.

b) Inspection

During the installation period the Contractor shall continuously check the whole of the works to ensure complete safety and compliance with the Specification and the IEE Regulations. The following list, although not exhaustive, is an indication of the items to be checked and inspected.

Switchgear shall be checked for correct labelling, warning notices, completed circuit schedules and satisfactory operation by hand.

Interlocking facilities shall also be checked for correct operation.

Clearance around switchgear for operation and maintenance shall be checked for adequacy. Distribution board labels shall be checked for correctness and completion. Fuse/MCB ratings and settings of other protective and monitoring devices shall be verified against circuit schedules and the Specification. MCB boards shall be checked for satisfactory operation by hand. The radius of all cable bends shall be checked as shall the routing of all cables in safe zones together with the provision of adequate fixings, mechanical protection and cable shrouds.

Cable trenches shall be checked for dimensions and the spacing between services, the provision of earthenware ducts, cable tiles, identification tapes and route markers.

All switching and control arrangements shall be checked against drawings and for operation.

Labelling and engraving shall be checked for compliance with drawings and the Specification.

Luminaires shall be inspected for operation, correct colour and rating of lamps, correct methods of fixing, supporting and associated cabling.

Sockets and fused connection units shall be checked to ensure :-

- Compatibility with the Specification and Drawings.

- Labelling and engraving is in accordance with the Specification and drawings.

Three phase power outlets shall be checked to ensure that provision is in accordance with the Specification and Drawings.

All circuits shall be checked to ensure conductors are sized as specified, connected correctly, identified in accordance with the regulations and separately grouped as specified.

All earthing and bonding shall be checked to ensure conductors are correctly sized, connected and labelled.

The electrical installation as a whole shall be checked to ensure :-

- Basic protection and fault protection
- Presence of fire barriers and protection against thermal effect.
- Prevention of mutual detrimental influence.
- Correct IP rating of equipment for the environment.
- Presence of diagrams, instructions and similar information.

When the installation is complete but before testing is commenced, the Contractor shall carry out a final visual inspection and shall provide for the Engineer a schedule listing the items inspected and their compliance with the Specification and regulations.

c) Testing

The Contractor shall provide all the necessary instruments for testing the installation, in accordance with the Regulations and any extra tests called for elsewhere in the Specification (including pressure testing of SWA cables). Details of the type of testing equipment required for routine tests are given below, together with the method of testing. In all tests, evidence of the accuracy of the test instruments must be provided i.e. calibration certificates. Failure to provide such evidence will invalidate the test.

Items shall be tested in the sequence shown within Part 6 (Inspection and Testing) of the IEE Regulations and all results recorded in a format approved by the Engineer.

Each individual circuit shall be separately tested for continuity of live conductors and protective conductors, insulation resistance of all live conductors, polarity and earth fault loop impedance. Final testing shall be carried out in the presence of the Engineer and three copies of a Completion Certificate and Inspection Certificate, as described in the IEE Regulations, Appendix 6, shall be supplied to the Engineer.

This certificate shall be fully compliant with the respective British Standard and shall identify the Contractor's roll number, installation schedule and test results.

In addition, the Contractor shall supply the following:-

i) Fire alarm system installation and commissioning certificate as BS 5839.

ii) Emergency lighting inspection and test certificates as BS 5266.

iii) Completion certificates as BS 7671.

The installation shall not be accepted as being Practically Complete until the Engineer has received the above certificates completed to his satisfaction.

A periodic inspection notice, as described in the IEE Regulations 514.12 shall be provided by the Contractor adjacent the main switchboard.

Tests shall be carried out in accordance with Chapter 61 of the IEE Regulations, using the methods identified in IEE Guidance Note 3, Inspection and Testing. The contractor should also refer to section 12 of CIBSE Guide K. Any failures identified during the test and inspection process shall be rectified by the contractor at his cost, with 7 days notice provided to the engineer of subsequent re-test(s).

d) "As Installed" Documentation

One copy of the "As Installed" documentation shall be submitted for approval at least 10 working days prior to the anticipated handover date for comment and approval.

The final documentation incorporating the Engineers comments shall be made available at handover as previously stated.

Should the Contractor fail to produce the ”As Installed” documentation to the Engineers approval at the date of practical completion the Client may instruct the Engineer to provide the drawings with whatever assistance the Engineer deems necessary and the cost of preparing the drawings will be deducted from the outstanding payments due to the Contractor.

e) Maintenance Manual

No later than 10 working days prior to the programmed date for Practical Completion, provide one draft copy of the Operating and Maintenance manual for comment.

Upon Practical Completion of the installation, the Contractor shall provide three copies of the Operating and Maintenance Manual, which shall incorporate any comments issued on the draft copy. In addition, one electronic copy on recordable CD shall be provided.

The Manual shall be of the loose leaf type, A4 size having stiff covers, with sub-division for each section.

The Contractor shall ensure each manual contains the following information:-

i) Index

ii) A full technical description of each system written to ensure that the Employer's staff fully understand the scope and facilities provided.

iii) A description of the mode of operation of each system.

iv) A list of ‘As Installed’ drawings with a brief description of each.

v) A legend for all colour coded services

vi) Schedules, system by system, of plant and equipment stating their locations, duties and performance figures.

vii) The manufacturers name, address and telephone number for each item of plant and equipment together with catalogue list numbers.

viii) Manufacturers technical literature for all items of plant and equipment.

ix) A copy of all test and commissioning certificates

x) A copy of all completion certificates

xi) A copy of all manufacturer’s guarantees and warranties.

xii) A schedule of all equipment settings established during commissioning.

xiii) Procedures for seasonal changeovers.

xiv) Recommendations as to the preventative maintenance frequency and procedures to be carried out to ensure efficient operation.

xv) Recommended lubricants.

xvi) A list of normal consumables.

xvii) A list of recommended spares.

xviii) A guide to fault finding.

xix) Starting up, operating and shutting down procedures for all equipment and systems.

xx) A copy of each 'As Installed' drawing.

xxi) A list of day time and emergency telephone numbers.

The Contractor shall edit manufacturer's standard operating and maintenance instructions to ensure only that information relevant and pertaining to the works is included in the manual.

The operating and maintenance instructions for each item of equipment shall deal systematically with each system including the following:-

1. Switchgear & Distribution Equipment
2. Electrical Accessories
3. Emergency Lighting
4. Fire Alarms
5. Communication Systems
6. Security Alarms
7. Lighting Installation

f) "As Installed" Drawings and Charts

During the progress of the works the Contractor shall record on drawings in an approved manner, the information necessary for preparing the installation record drawings.

The marked-up drawings shall be made available to the Engineer for inspection and checking at any time during the Contract.

The marked-up drawings shall indicate :-

i) The exact positions of all plant and apparatus.

ii) The size, type and routes of all cables, conduits, trunking etc.

iii) The size, type and date of installation of all underground cables and ducts.

iv) Schematic diagrams of distribution systems and control systems.

v) The exact location and size of all earthing and bonding connections.

vi) The exact locations of all devices performing the functions of protection, isolation and functional switching.

vii) The prospective fault current at the location of each protective device.

viii) Diagrams and charts shall be provided indicating the type and composition of all circuits (points of utilisation served, number and size of conductors and type of wiring).

The Contractor shall provide "As Installed" drawings in CAD format - AutoCAD Release 2008 in DWG and PDF format on a recordable compact disk(s). Drawings shall be produced at a scale of one drawing unit to 1mm. Each engineering service shall constitute one layer and text shall be on a separate layer.

The Engineers design drawings may be available to the Contractor in AutoCAD 2008, DWG format. An appropriate charge shall be made for the provision of this service.

2.1.4 Routine/Witnessed Tests of Plant

Where routine tests are applied to plant before delivery to site, two copies of the relevant test certificates shall be forwarded to the Engineer.

The Engineer may wish to witness tests carried out on plant before delivery to site. These instances will be detailed when required and the Contractor shall give at least seven days notice in writing of the date that the tests are taking place.

Two copies of all test certificates subsequently supplied to the Contractor by the manufacturer shall be supplied to the Engineer.

2.1.5 Demonstration/Instruction Period

The Contractor shall include in his tender for a period of time at the completion of the works to demonstrate all systems and equipment which form part of the contract works. Where necessary the Contractor shall arrange for the specialist contractors or equipment suppliers to be involved in the demonstrations.

The purpose of the demonstrations is to provide instruction to the operation and maintenance staff and their representatives in order to allow them to become familiar with the day to day operation and maintenance of the systems.

The Contractor shall issue a proposed programme for the witnessing, by the Engineer, of the Contractors testing and commissioning procedures along with the proposed dates of the demonstration of the various systems to the Client and their representatives. The Contractor shall issue a proposed programme for the demonstrations no later than twenty eight days prior to practical completion.

The proposed programme shall be based on the Schedule of Demonstrations and Witness Testing contained within Section 4 of this Specification.

2.1.6 Position and Neatness of Installation

The positions of all plant shown on the drawings will be used for the purposes of tendering, but the Contractor shall not scale the drawings for actual site installation.

The Contractor shall make allowance within his tender for locating each item of equipment/plant anywhere within the room in which it is shown on the tender drawings.

The Contractor shall set out work involved and take all measurements and dimensions required for the erection of plant on site, making any modification in detail as found necessary during the progress of work.

The Contractor shall ascertain on site that the installation will not conflict with other services or furniture and any work requiring alteration due to negligence by the Contractor in this respect shall be at the Contractor's expense. Particular care shall be taken to obtain uniform and tidy arrangements of wall and ceiling mounted equipment.

The precise position of an item of equipment shall be determined as follows :

a) Single items of equipment which are visually remote from other electrical or mechanical equipment shall be erected at the following mounting heights except where stated otherwise in the Specification or on the tender drawings.

Item of Equipment	Mounting Height (from floor level to centre line of unit, unless indicated otherwise)
Isolators	1050mm to Centre
Low Level Socket/Spur Outlets & connections to under bench	450mm

Item of Equipment	Mounting Height (from floor level to centre line of unit, unless indicated otherwise)
equipment	
High Level Socket/Spur Outlets	200mm below finished suspended ceiling Level or adjacent equipment where the ceiling is more than 3000mm above finished floor level
Above Bench Socket/Spur Outlets	150mm Above Finished Bench Level
Light Switches	1050mm
Hand Dryers	1050mm to Underside of Unit
Distribution Boards	1000mm to Underside of DB's within Cupboards, or 200mm below ceiling to top of DB where located within accessible areas. In areas with ceiling heights which exceed 2.8m, DB's shall be mounted at the height identified in the particular specification and/or drawings.
Fire Alarm Panel	1500mm to Underside of Unit
Break Glass Unit	1050mm
Sounder/Strobe	200mm Below Finished Suspended Ceiling Level
Disabled Alarm Overdoor Indicator	Unit Centered Between Top of Door Frame and Underside of Finished Suspended Ceiling Level or No More than 200mm Above Door Frame to Centre of Unit
Overdoor Exit Sign	Unit Centered Between Top of Door Frame and Underside of Finished Suspended Ceiling Level or No More than 200mm Above Door Frame to Centre of Unit
Intruder Alarm PIR	2800mm or below ceiling level if ceiling is lower
Disabled Refuge Intercom unit	1050mm AFFL to underside of unit
Dado Trunking	900mm AFFL to centre line of trunking, or 150mm above desk level to centre line.

b) Two or more items of equipment whether electrical or mechanical or both which are to be erected on the same wall or ceiling or which will be otherwise visually close to each other, shall be arranged in a neat and symmetrical group. Symmetry shall be obtained by horizontal and vertical alignment through the centre lines of the equipment and for this purpose the mounting heights may be varied slightly, from those specified or on the tender drawings.

In the planning of arrangements the Contractor shall co-operate with the Main Contractor and any other Contractor involved. Exact positions of plant and equipment shall be marked out on site and agreed with the Engineer prior to installation and before any holes or chases are cut.

Failure to comply with this requirement may result in disruption to other disciplines and the Contractor shall be held responsible for any additional expenditure involved in resolving the issue.

2.1.7 Contractor's Working Drawings

Prior to any works commencing on site, the Contractor shall prepare his own working/installation drawings. These shall be based on the TGA Consulting Engineers LLP tender issue drawings, however the working drawings shall be used by the Contractor for all installation works on site. If any further instructions, details or drawings are required to enable these working drawings to be prepared or any work to be done, the Contractor shall apply in writing to the Engineer for such information.

Two weeks prior to the commencement of the installation works on site the Contractor shall submit working drawings along with manufacturers construction and wiring drawings to the Engineer for comment.

Within a reasonable period after receiving such drawings, the Engineer shall review the drawings and advise the Contractor of his comments. The Engineer's comments on working or manufacturing drawings submitted by the Contractor shall not in any way relieve the Contractor of his responsibility in respect to the accuracy of all such drawings nor from his responsibility for providing equipment suitable in dimension, construction and finish for the location in which it is to be installed, provided that any discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in writing to the Contractor by the Engineer. The Engineer will draw attention to any divergence from the specified requirements or errors which occur to him but his comment shall not imply approval in terms of dimensional accuracy or completeness of detail.

The Contractor shall provide the Engineer with two copies of all drawings which require comment.

The Engineer shall appraise the drawings on a technical nature only in terms of the drawings being compatible with the intent of the design and comment by the Engineer shall not relieve in any way the Contractor from his responsibilities under this Contract, in respect of the accuracy of drawings or the relationship of the drawing content in terms of co-ordination of other trades.

The signed drawings as noted above shall be adhered to unless they are covered by an instruction in the form of a Contract Administrators Instruction or an official Engineer's Instruction.

The Engineer shall have the right at all reasonable times to inspect at the Premises of the Contractor all drawings relating to the services installation.

In the event of any discrepancies in the scale approved to any plan or drawing and the figured dimensions thereon, the figured dimensions shall be taken and held to be correct.

The Contractor shall be responsible for and shall pay the extra cost, if any, occasioned by any discrepancy, error or omissions in the drawings and other particulars supplied by him, whether ”commented on” by the Engineer or not, provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in writing to the Contractor by the Employer or Engineer.

2.2 LOW VOLTAGE SWITCHBOARD PANELS AND DISTRIBUTION FUSEBOARDS

2.2.1 Standards

Comply with the following standards:

BS 4	Structural Steel Sections:
BS 88	Cartridge fuses for voltages up to and including 1000V AC and 1500V DC
BS 91	Specification for electric cable soldering sockets.
BS 159	Specification for busbars and busbar connections.
BS 921	Specification for rubber mats for electrical purposes.
BS EN 60898	Specification for miniature and moulded case circuit-breakers.
BS 4345	Specification for slotted angles.
BS 7668	Specification for weldable structural steels.
BS EN 10210-2	Specification for hot rolled hollow sections.
BS EN 60947-1	Specification for low-voltage switchgear and control gear
BS EN 60947-2	Specification for low-voltage switchgear and control gear, Circuit-breakers
BS EN 60947-3	Specification for low-voltage switchgear and controlgear. Switches, disconnectors, switch-disconnectors and fuse-combination units
BS EN 60898	Electrical accessories
BS EN 60439-1	Low - voltage switchgear and control gear assemblies:
BS EN 60831-1	Specification for Capacitors for connection to Power Frequency Systems.
BS EN 60529	Specification for Degrees of Protection provided by enclosures (IP Code).
BS EN 61008-1	Residual current operated circuit-breakers without integral overcurrent protection for household and similar used (RCCBs).
BS EN 61009-1	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBO's).
BS EN 60439-2	Low voltage switchgear and controlgear assemblies. Particular requirements for busbar trunking systems (busways)
BS EN ISO 1461	Specification for hot dip galvanized coatings on iron and steel articles

All switchboards and distribution equipment shall be designed and manufactured to the appropriate British Standards and adequate for the voltage, current, fault levels and type of supply, all as indicated in Section 3. Form 4 switchboards shall incorporate physical barriers and shall not rely on the body or other parts of MCCBs for any protection.

Switchboards and distribution equipment shall be of the same manufacture throughout the works.

2.2.2 Enclosures

Enclosures shall be of metal construction, with all electrical conductors, contacts etc., totally enclosed and protected to not less than IP41 for indoor use and IP55 for exterior use unless otherwise specified.

Enclosures shall be provided with facilities for padlocking or locking to prevent unauthorised interference and provided with adequate means of isolation, earthing and insulation to ensure safety of operatives during maintenance works.

They shall be adequately ventilated or cooled.

Finish shall be to manufacturer's standard unless otherwise specified. Plain steelwork shall be painted to BS 6150 with red oxide primer and two coats of enamel to match the switchgear.

Operating handles, control knobs, push buttons etc., shall preferably be located within the range of 450mm and 1950mm above floor level.

The enclosure shall be so designed and constructed as to provide effective segregation between incoming circuits/control circuits and equipment. Where equipment is fitted above busbar chambers it shall not be possible for objects to fall into the chamber.

The segregation provided shall prevent the passage of ionised gas, resulting from the making or breaking of any circuit under normal or fault conditions, to any busbar, adjacent switch etc.

Conductors of ac circuits installed in ferrous enclosures shall be arranged such that all phase conductors and neutral conductors are contained in the same enclosure. Where such conductors enter ferrous enclosures they should be arranged such that the conductors are not separated by ferrous material or provision made to prevent circulating eddy currents e.g., (i) single core M.I. cables shall be terminated into a ferrous enclosure using a non-ferrous gland plate, (ii) 4 No. single core cables of a TP&N circuit shall enter a ferrous enclosure through the same bushed entry aperture.

Multicore sheathed cables (e.g., MI; PVC/PVC; LSF/XLPE; PVC/XLPE) entering any electrical enclosure (including H&V control panels) shall have the outer sheath (and armouring where applicable) removed back to the enclosure gland plate (or outer skin). The insulated conductors shall then be run neatly and formally and adequately supported to their termination point.

2.2.3 Switchgear

a) Fuse Switches and Switch Fuses

Fuse switches and switch fuses shall comply with BS EN 60947-1

They shall be fitted with HRC fuses to all phase conductors for ac and to all poles of DC systems and fitted as required with a neutral terminal. For units exceeding 100A this terminal shall have a removable bolted link.

b) Air Circuit Breakers (ACB's) and Moulded Case Circuit Breakers (MCCB's)

ACB's and MCCB's shall comply with BS EN 60947-2 and shall be provided with positive means for preventing any one pole of a multi pole MCCB being operated or tripped, independently of the other poles.

c) Miniature Circuit Breakers (MCB's)

MCB's shall comply with BS EN 60898 and have the voltage and current rating and category of duty as specified with a minimum breaking capacity of 9000 amps.

Multiple pole MCB's shall be provided with positive means of preventing any one pole being operated or tripped independently of the other poles.

The position of the contacts shall be either externally visible or clearly and reliably indicated. An indication of the isolated position shall only occur when the specified isolating distance has been attained in each pole.

d) Residual Current Breaker with Overload protection (RCBO's)

RCBO's shall comply with the relevant sections of BS EN 60898, BS EN 61008-1 and BS EN 61009-1 and shall have the voltage and current rating and category of duty as specified with a minimum breaking capacity of 9000 amps.

Where the specification or distribution board schedules refer to MCB/ RCD outgoing ways, single module RCBO's shall be installed unless indicated otherwise.

Multiple pole MCB's shall be provided with positive means of preventing any one pole being operated or tripped independently of the other poles.

The position of the contacts shall be either externally visible or clearly and reliably indicated. An indication of the isolated position shall only occur when the specified isolating distance has been attained in each pole.

e) Distribution Boards

Distribution boards shall comply with BS EN 60439-1 and fitted with neutral and earth bars having a separate terminal for each outgoing TP&N circuit when required for TP circuits.

For SP&N power and lighting circuits the bars shall have a separate terminal for each outgoing SP circuit.

Each neutral conductor and CPC shall be identified at its termination in the distribution board by a cable ferrule. (Relating it to its associated circuit conductor).

Earth bars shall include high integrity earth facilities and have additional terminals designed for incoming earth and bonding conductors.

Distribution boards shall be fitted with HRC cartridge fuses, MCB's or RCBO's and shall be surface or flush as specified. Fuse type distribution boards shall be provided with cartridge fuses complying with BS 88 of the category of duty and class of fusing factor specified. MCB/ RCBO type distribution boards shall be provided with circuit breakers comply with BS EN 60898.

Surface distribution boards shall be mounted over suitably sized adaptable boxes where they are used on concealed cable installations.

An access aperture cut in the back of the distribution board shall be adequately bushed and the box shall be provided with spare conduits, all effectively bonded to the board.

Fuse ways designated as spare shall be provided with fuse links of the maximum rating of the carrier.

MCB ways designated as spare shall have proprietary blanking plates fitted.

f) Fuses

Fuses shall be to BS 88 HRC cartridge type for general lighting and power applications. They shall be fitted to all insulated carriers so designed that a failed fuse can be readily located.

g) Busbars and Connections

Busbars and connections shall comply with BS EN 60439-2 and of constant cross section copper throughout and air insulated except where solid insulation is a design feature.

They shall be connected to outgoing switches with solid copper connections.

The connections shall be as short and direct as possible. Insulated cable connections will only be used on unit type switchboards or where specifically specified.

Busbars and connections shall be rigidly clamped and secured to prevent undue movement under fault conditions or displacement as a result of the installation of cabling and provided, where necessary, with insulated phase or circuit barriers.

All clamping and supporting bolts, nuts and screws to be plated brass or steel.

Busbars shall be connected by clamps to risers, inter connections and busbar couplers.

Drilled connections to busbars will only be accepted where specifically specified.

Busbars shall be separate for individual supply systems.

Two systems shall not occupy the same busbar chamber unless they are segregated by earthed metal.

Unless specified otherwise terminals shall be capable of accepting copper cables from the smallest to the largest cross sectional area corresponding to the cables noted in the specification and/or drawings. On TP&N circuits the neutral terminal shall allow connection of copper cables having a current carrying capacity of the full current capacity of the phase conductor.

h) Unit Switchboards

Unit switchboards shall comply with BS EN 60439-1 Form 4 and The National Annex.

Separate items of switchgear shall be assembled and connected to provide a switchboard secured by built in fixings or masonry bolts.

A suitable busbar chamber shall house the appropriate bars for the system. The busbar chamber shall be readily extendable.

Busbars shall be of such length within the chamber that outgoing connections are taken from the bars at right angles, undue deviation will not be accepted other than the necessary sets to provide electrical clearance.

In the case of wall mounting units, unit switchboards shall be assembled above and below a busbar chamber extending the full length of the board and wholly supported on floor stands below the chamber.

Additional support shall be provided where required as for wall mounting units.

Switchboards shall be supplied with removable gland plates, drilled for conduit entry, or suitable cable glands, clamps, spreader boxes and reverse entry chambers as required.

Operator's rubber floor mats shall be provided for all switchboards. (1m x length of switchboard minimum).

i) Cubicle Switchboards

Cubicle switchboards shall be designed and constructed to comply with BS EN 60947-2, BS EN 60439-1 Form 4 and the National Annex. Switchboards shall be manufactured from sheet steel, suitably rust proofed and stove enamelled or equal finish to an approved colour. Refer to section 3 of the specification for the detail requirements of the form of separation.

Switchboards shall be generally floor mounting, with access back and front, or front only, as specified in Section 3.

They shall be of modular construction with interchangeable units where applicable and shall not exceed 2250mm in height excluding cable boxes.

Cubicles shall be constructed in sections to facilitate delivery and installation and shall be arranged for the storage of spare fuses within the cubicle.

Switchboards shall be complete with removable gland plates, drilled for conduit entry, or suitable cable glands, clamps and spreader boxes.

Operator's rubber floor mats shall be provided for all switchboards. (1m x length of switchboard minimum)

j) Switchgear Earthing

Switchboards shall be provided with an earthing terminal consisting of a brass threaded stud or copper/brass bar, fixed adjacent the incoming cable.

All incoming and outgoing cables shall be connected to the earthing terminal by copper circuit protective conductors. Similar connections shall be provided to the conduit entry plates and to metal trunking.

Clearance or tapped holes shall be provided in the conduit entry plates, such holes being cleaned and free from paint to ensure a positive connection for the bush/coupling or M.I. gland for earthing purposes.

Circuit protective conductors shall be of flat soft copper strip or LSF cables sheathed green and yellow.

All connecting faces and/or lugs shall be tinned and secured by brass bolts, nuts, washers and locking arrangements.

Any moveable panels or doors carrying items of equipment e.g., push buttons, meters etc. shall be connected to the frame of the switchboard/switchgear by a flexible circuit protective conductor.

k) Labels and Identification

Switchgear shall be fitted with engraved labels to indicate the duty of the unit, its voltage, phase and current rating and size of conductor involved and serial code for any coding system required.

e.g. Main Incoming 95mm5 CU 415 TP&N Main Essential Isolator 160 amp L1, L2, L3+N

Labels shall be of traffolyte with 5mm high black letters on a white background fixed in a readily observable position by screws or nuts and bolts to the outer cover of the unit. All electrical control panels, distribution boards, starters, switch fuses and isolators shall be labelled with the legend detailed. If details are not specified the Contractor shall allow in his tender price for labels to be engraved with a minimum of 30 characters per unit.

At each termination (and at both sides of a bulkhead, wall etc.) every sub main cable shall be labelled (outside the enclosure) using Critchley or equivalent type cable identification labels to adequately identify its function.

A renewable typed circuit chart shall be provided in a transparent plastic envelope permanently fitted inside all distribution board covers indicating :-

i) The source of supply

ii) Incoming cable size, type and designation

iii) Outgoing circuit designations

iv) Location of points controlled by each fuse (or MCB)

v) Cable size (live and protective conductors)

vi) Circuit load (kW or amperes)

vii) Fuse (or MCB) rating

The contractor shall also ensure that all other necessary notices or warning labels are provided including (but not limited to) RCD test labels, Periodic inspection notices, warning notice for 'old' and 'new' cable core colours, etc.

2.2.4 Outdoor Distribution Pillars

Distribution pillars shall be free standing types manufactured using either zinc phosphate resin treated cast iron to BS EN 1561 grade 180 or 5mm mild steel sheet, hot dipped galvanised to BS EN 1461. Pillars shall be designed to provide Ingress protection to IP 54 and be fitted with water tight gasket door seal to IP 65. Pillars shall be suitable for mounting external photocells for the local control of external lighting.

Backboards shall be a minimum of 15mm marine ply, onto which distribution boards, meters, controls, heaters, etc are fixed.

Distribution boards shall be provided in accordance with the particular specification, incorporating BS 88 or MCB/ RCBO circuit protective devices.

Each pillar shall include an anti-condensation heater complete with frost stat, served from a 5A MCB or fused way from the distribution board.

Doors shall be hinged and shall allow doors to open to 180 degrees. Doors shall be provided with an integral door stay/parking facility. Door lock assemblies shall include a universal body and insert arrangement, allowing retrofit lock changing to any of the standard Tri head, Lucy or Recessed Pin Anti Vandal locking mechanisms.

A hazard warning sign shall be fitted to the front of the pillar door, conforming to Electricity at Work and Health & Safety Signs and Signals Regulations.

Doors shall be fitted with an earth fly lead directly from the pillar body to the pillar door to provide earth continuity and aid operator safety during maintenance.

The shell shall be so constructed to ensure ample ventilation, the ventilators having insect barriers and being complete with a separate cast iron or steel root bolted to the shell.

Each distribution pillar shall be complete with 4No door access keys or suitable devices for operating the door lock, circuit identification labels, weatherproof A4 circuit chart mounted on the inside of door.

The Contractor shall ensure that the pillar is bolted firmly to the plinth and that the pillar shell is secure and vertical.

Roots shall be fitted with sheet steel aprons and both roots and aprons shall be protected with an approved bituminous compound and the pillar shell painted with a coat of flat and two coats of good quality gloss paint.

After cabling work at pillars is completed, the void in the root within the pillar shall be filled with sand, which shall be well compacted and the sand covered with a coating of bituminous compound as a damp course.

2.2.5 Treatment Notice

Adjacent the main switchboard (exact position to be decided on site) the Contractor shall provide a plastic coated "Treatment for Electric Shock" Notice 350mm x 450mm.

A suitable notice is obtainable from Seton, Wildmere Industrial Estate, Banbury, Oxfordshire, OX16 3JU or Label Source, PO Box 130, Cardiff, South Glamorgan, CF14 7TX.

2.2.6 Low Voltage Distribution Schematic

Provide and install a copy of the ”as fitted” low voltage distribution schematic adjacent the main switchboard (exact position to be decided on site). This shall be suitably protected against moisture and the environment using a glass frame or other suitable housing and shall be a A1 size or larger.

2.3 CONTAINMENT SYSTEMS

2.3.1 Standards

Comply with the following standards:

BS 31	Specification. Steel conduit and fittings for electrical wiring
BS EN 50086-1	Specification for conduit systems for cable management. General requirements
BS EN 12163	Specification for copper and copper alloy rods and sections.
BS 4568	Specification for steel conduit and fittings with metric threads of ISO form for electrical installations. Steel conduit, bends and couplers
BS 4607	Non-metallic conduits and fittings for electrical installations. Specification for fittings and components of insulating material
BS 4678-4	Specification for cable trunking made of insulating material.
BS EN50085	Specification for steel surface cable trunking
BS EN 61386-1	Specification for conduit systems for cable management. General requirements
BS EN 60529 Code).	Specification for Degrees of Protection provided by enclosures (IP
BS EN ISO 1461	Specification for hot dip galvanized coatings on iron and steel articles

2.3.2 Metal Conduits

a) General Requirements

Conduit installation shall generally be concealed in internal areas which have plastered or similar finishes. In other areas, surface mounted conduits shall be permitted.

Conduits and trunking shall be installed in vertical or horizontal runs. Diagonal runs will not be permitted. Conduits and trunking installed on ceiling or roof structures shall be parallel with or perpendicular to the structural elements of the building.

Any special tools required to gain access into the trunking or conduit systems shall be identified and included in the Tender.

Conduits shall be no smaller than 20mm diameter and to BS EN 50086-1 for sizes up to 32mm or to BS 31 for sizes above 32mm

Conduit for general purpose internal installations shall be seam welded, heavy gauge, finished Class 2 (galvanised). Conduits for external applications shall be solid drawn heavy gauge, finished Class 3 (galvanised). For flameproof installations conduit shall be solid drawn, heavy gauge, finish Class 4 (galvanised).

Where expansion couplings are installed, bonding shall be provided by means of earth continuity links comprising 4.0mm² green/yellow insulated copper wires.

Connections to distribution boards shall be provided by means of conduit coupling and hexagon male smooth bore brass bush.

b) Metal Conduit Fittings

All fittings shall comply with BS EN 50086-1 and shall have the same protective finish as the conduit with which they are being used.

Conduit boxes used shall be screwed, circular pattern for 20mm and 25mm and circular large pattern for 32mm conduit. Boxes for sizes above 32mm shall be rectangular.

All conduit boxes shall have flat steel covers secured by brass screws. Gaskets shall be fitted for all Class 4 finishes (galvanised).

Boxes shall be fitted with oversized lids when used as flush inspection boxes and with break joint rings at all visible ceiling outlet points.

Adaptable boxes shall be of steel or cast iron and shall have overlapping lids where used as part of a flush installation.

Where necessary to segregate services, earthed steel barriers shall be provided.

Adaptable boxes used in Class 4 installations shall have external fixing lugs and gasketed lids.

All boxes shall be fixed in accessible positions and be of adequate size for the number and size of cables in the box and for the largest size of conduit connected to the box.

All outlet boxes for lighting fittings, switches, sockets etc., shall be securely fixed by at least two round head screws and in a flush installation shall be recessed approximately 2mm below the wall or ceiling finish. To ensure this dimension is met the Contractor shall verify on site the finished levels of walls and ceilings.

Threaded nipples and blanking plugs shall be manufacturers proprietary items, not site manufactured.

c) Metal Conduit Installation

The installation shall be surface or concealed as specified.

All burrs, sharp edges, dirt, oil and surplus paint shall be removed form conduit prior to erection.

Care shall be taken to prevent ingress of dirt or moisture during erection and all conduits shall be swabbed through before wiring commences. Where threads are exposed or the finish is damaged the conduit shall be cleaned and treated with a rust inhibiting paint immediately after erection, all in accordance with manufacturer's instructions.

Conduits shall only be run in floor screeds where specified, conduits which are specified to be installed in the screed shall be galvanised and provided with temporary protection until the floor screed is laid.

Bends and sets shall be formed from straight lengths, with manufactured bends only where essential. Expansion couplings shall be installed on all building movement joints. Conduits shall be bent on site to suit installation requirements using a bending machine to ensure minimal deformation of bore. Inspection elbows shall not be used. Draw-in boxes shall be provided in all runs exceeding 6m in length or containing more than two right angle bends.

Cast in or buried conduits shall be configured in a 'loop in' system, covered by a minimum of 25mm in concrete or 5mm in plaster. Electrical continuity and resistance shall be tested prior to pouring concrete. Where steel conduit is buried within the building fabric, two coats of bitumastic paint shall be applied to exposed threads, vice marks, etc

Running couplings shall be kept to a minimum but where required they shall be fitted with milled circular lock-nuts at each end.

On vertical runs the running thread shall be above the coupling.

Where condensation is likely, the conduit shall be fitted with adequate drainage points and installed so that the relevant section is isolated by means of a compound filled conduit box located in the higher sections of the conduit run.

On vertical drops or risers, a running coupler socket shall be inserted within 300mm of the ceiling or floor.

Conduits shall be fixed using crampets when concealed in plaster or concrete etc., and distance saddles when surface fixed, minimum fixing centres shall be as follows:-

Conduit Size	Vertical and Horizontal
22mm and 25mm	1.2m
32mm and 40mm	1.5m
50mm	1.8m

A clearance of 150mm shall be maintained between electrical conduits and other services running parallel and 25mm when crossing.

Surface conduits shall be installed as neatly and unobtrusively as possible, parallel to general building lines, using distance saddles.

Concealed conduits shall be installed in such a manner that inspection and draw-in boxes are accessible, using crampets where buried in plaster or concrete, or saddles in roof voids etc.

Conduits shall be run in a straight line from point to point.

Where distribution boards are installed with recessed conduits, spare 25mm diameter conduits shall be provided from the distribution board to the nearest accessible duct or ceiling void. One spare conduit shall be provided for every two spare ways on the distribution board. The minimum of spare conduits shall be one.

The conduit shall terminate in a through conduit box with the unused way blanked off.

Where practical all wall chases shall be vertical.

Saddles shall be rigidly fixed to the structure by means of proprietary wall plugs and screws to a depth to suit the structure, all fixing holes being made with a masonry drill.

When assessing conduit capacities, which shall be in accordance with the BS 7671 Regulations and Guidance notes, circuit protective conductors shall be taken into account.

Conduit systems shall be complete before the commencement of wiring.

d) Continuity

All conduits shall be screwed and butted solidly in boxes and conduit fittings etc., and be satisfactorily mechanically continuous, before drawing-in of cables commences.

The system shall also be tested for electrical continuity before plastering or screeding is done and before cabling is installed.

Where boxes without screwed spout entries are used, conduit termination at the box shall be in accordance with the following :-

i) Where one end of the conduit run terminates at a spouted entry (i.e. conduit end box, through box etc.) the termination at the unspouted entry shall be made using a standard coupling and smooth bore male brass bush fitted with either a compression washer, split washer or serrated washer.

The washer must be installed between the bush and the box and is required to ensure a good mechanical contact.

ii) Where both ends of the conduit run terminate at unspouted entries (e.g. a conduit drop from a trunking system or adaptable box to a switch or socket outlet box), one termination shall be made using an earthing coupling and smooth bore male brass bush fitted with either a compression washer, split washer or serrated washer.

An insulated earth continuity conductor shall be connected from the coupling to the earth stud or similar connection.

Wherever possible the earthing coupling shall be mounted in an unobtrusive location. Where conduits run from trunking or an adaptable box in the ceiling void the earthing coupling shall be at that point (i.e. in the ceiling void) rather than at the switch or socket outlet box.

The other termination on such conduit runs shall be made as described in (1).

2.3.3 Insulated Conduit Installation

a) General Requirements

Conduits shall be heavy gauge, high impact, PVC smooth inside and outside and free from imperfections. No conduit less than 20mm diameter shall be installed. Non-metallic conduit, fittings and accessories shall be from a single manufacturer and in a uniform colour throughout the project.

Conduits shall comply with BS 4607 or BS EN 50086-1 as applicable and shall be metric sizes.

While in storage and during installation, conduits shall be protected from the weather and mechanical damage and shall be fitted with plastic plugs or plastic caps to prevent the ingress of foreign matter.

Conduits shall be suitable for jointing by PVC solution

Prior to erection conduits shall be reamed, to remove all sharp edges and burrs after cutting.

Fittings or luminaires shall not be fixed from non-metallic conduit boxes

b) Insulated Conduit Fittings

Fittings shall be of the same manufacture as the conduit, complying with BS 4607. All boxes shall be PVC except for those to which lighting fittings will be directly fixed, which shall be metal conduit boxes complying with BS 31 or BS 4568. PVC boxes shall not be used for supporting lighting fittings or other suspensions.

Self-tapping screws for suspension purposes shall not be allowed.

c) Insulated Conduit Installation

The installation of a rigid PVC conduit system shall be generally in accordance with that specified for a metal conduit system.

Bends and sets formed on site shall be carried out using a helical spring fitted internally.

The conduit shall be warmed sufficiently for it to bend without deformation of the bore and without avoidable wall thinning on the outside of the bend.

Couplings to equipment not having shaped or smooth conduit entries shall be by means of plastic bushes fitted inside the equipment, with lock rings.

Expansion couplers shall be provided at intervals not exceeding 6.0 metres on straight runs, with clearance between the ends of the conduits and having the couplers secured to one conduit with adhesive and a sliding fit to the other sealed with mineral jelly to prevent ingress of moisture.

Fire collars shall be fitted to conduits which pass through fire compartment walls.

The conduit system shall be installed in accordance with the manufacturers instructions and the circuit protective conductor shall be connected at all exposed metal items to provide electrical continuity. Conduit systems shall be complete before the commencement of wiring.

When accessing conduit capacities, which shall be in accordance with the IEE Regulations, circuit protective conductors shall be taken into account. PVC conduit shall not be installed where the ambient temperature is below 5°C or when the working temperature is above 60°C.

2.3.4 Flexible Conduit Installation

Flexible conduits shall be PVC sheathed of type 'B' to BS EN 50086-1 or shall be double leaded steel foil interleaved type of heavy duty grade complete with solid type couplers.

An insulated protective conductor shall be run within the conduit and bonded at each end.

Terminations shall be made on the correct type bolted terminals.

Couplings and connections shall be to BS EN 50086-1 cadmium plated mild steel with shake proof accessories.

Flexible conduit shall be used with items of equipment which are withdrawable or subject to vibration or adjustment and shall be of sufficient length to allow the necessary full range of movement.

Where used externally, weatherproof grade of conduit and fittings shall be used.

2.3.5 Metal Trunking and Tray Plate

a) Cable Trunking

Trunking shall be manufactured from rust proofed sheet steel in the following gauges.

i. Up to and including 50mm x 50mm or equivalent C.S.A. - 1.25mm U.

ii. Above 50mm x 50mm and up to and including 100mm x 100mm or equivalent C.S.A. - 1.6mm U.

iii. Above 100mm x 100mm or equivalent C.S.A. 2mm U.

The trunking shall comply with BS EN50085 and shall be fitted with an overlapping well-fitting, drip proof, removable cover fixed with captive screws in such a manner that damage to cables is avoided. Self tapping screws or fixed bridge pieces shall not be allowed for fixing the cover. When installed the trunking lids shall be on 'top' of the trunking wherever possible.

The system shall be free from all sharp edges and projections.

The trunking finish shall be Class 4.

The trunking shall be fitted with a fixed section of cover where trunking passes through the structure. Such fixed section shall be restricted to the minimum length necessary.

Internal fire barriers in accordance with IEE Regulations 527 shall be provided by binding the cables and filling the spaces with non-asbestos fire resisting material to provide a fire rating not less than the structure through which the trunking passes.

Insulated cable support pins shall be fitted at intervals of 1.2m in vertical runs of trunking exceeding 2m in length. Where the removable cover is on the underside of the trunking, cable retaining straps or holders shall be provided at intervals not exceeding 600mm.

The trunking system shall be electrically and mechanically continuous throughout, with every joint bridged by a tinned copper bonding strap to ensure electrical continuity.

All links shall be visible and all bonding connections cleaned and free of paint.

The entire system shall be adequately connected to the distribution system earthed network.

Holes cut in trunking for the passage of cables shall be provided with grommets, bushed or lined to protect the cables from damage.

All trunking fittings such as elbows, tees and end plates shall be as supplied by the trunking manufacturer, unless specified otherwise. All transitional fittings (e.g., bends elbows, tees etc) shall be "gusseted" to facilitate cable installation.

Fittings and cover plates shall be the same gauge as the trunking body wall.

Trunking shall be fitted with factory made flanged adaptors for connections to equipment.

Partitions in trunking for multi compartment systems shall be of the same material and finish as the trunking and may be up to 0.5mm thinner than the trunking material with a minimum thickness of 1.0mm (20 swg). Segregation in multi-compartment trunking shall be maintained throughout including all accessories. The welded edge of the partition where it is attached to the trunking shall be arranged to present a clear flat face over the full width to accommodate conduit connection or supporting nuts and bolts.

The exposed edge of the partition shall be turned up 12mm to present a flat face.

Electrical continuity between trunking and steel conduit systems shall be provided by means of a smooth bore male brass bush, serrated washer and earthing coupling with the earth coupling bonded to a terminal on the trunking by an insulated cable sized in accordance with the Regulations.

The cable shall be terminated at the trunking with a crimped lug onto an M5 brass bolt. The M5 brass bolt shall provide a permanent connection and shall be securely fixed utilising serrated washers and locknuts.

Alternatively, a circular conduit box fixed by a smooth bore male brass bush, lock nut and female bush can be used with the male bush fitted through the back of the conduit box within the lock nut and female bush inside the trunking. Earth continuity shall be achieved via a short length of protective conductor run from an earth stud in the conduit box to a similar connection on the trunking.

Where the finish is removed by cutting or drilling, it shall be made good to match the original manufacturers finish.

Unless otherwise specified trunking shall be fixed to the building fabric or structure at regular intervals not exceeding the following:

Cross Sectional Area of Trunking	Vertical and Horizontal Spacing
Exceeding 1500mm^2 and not exceeding 2500mm^2	1.0m
Exceeding 2500mm^2 and not exceeding 5000mm^2	1.2m
Exceeding 5000mm^2	1.5m

Note : Supports shall be provided within 225mm of bends and intersections.

The above note vertical and horizontal spacing of trunking fixings shall only be permitted where the trunking design is adequate for the particular requirements.

Trunking installed in suspended ceilings shall not rely on the ceiling suspension system for support (unless specifically indicated otherwise).

Expansion couplings shall be installed at building movement joints. On long continuous runs, expansion joints shall be provided in accordance with manufacturer's recommendations.

Supporting metalwork displaying signs of oxidisation shall be wire-brushed, cleaned and painted with zinc rich primer (e.g. zinc phosphate)

Trunking, exceeding 100mm wide suspended from the structure shall be adequately fixed utilising trapeze type suspensions (2 No. drop rods).

Single drop rod "stirrup" suspensions are only acceptable for trunking not exceeding 100mm wide.

The method of support shall incorporate appropriate anti-vibration washers etc., to maintain the security of the fixings.

The trunking system shall be complete before the commencement of wiring.

b) Cable Basket Systems

Cable basket shall be manufactured from rigid steel wire of at least 3.5mm diameter for sizes up to 200mm wide and at least 4.5mm diameter for larger sizes.

Baskets shall be hot dip galvanised to BS EN 1461 where used externally and zinc plated where used internally, except where specified otherwise.

Baskets and supports shall be adequately sized to avoid unnecessary bunching of cables and to prevent undue deflection of the system when fully loaded. The maximum deflection shall be 1/200L.

Bare copper sheathed cable shall not be installed on cable basket.

Fixings shall be zinc plated nuts and bolts with proprietary fixings and suspension brackets. All baskets shall be supported using propriety suspension brackets and twin 6mm screwed drop rods, 1 No. at each edge of the basket. Fixing points shall be at regular intervals not exceeding 1.2 metres. Screwed drop rod supports shall be cut back to within 25mm and the cut ends protected by proprietary plastic end caps. The method of support shall incorporate appropriate anti-vibration washers etc., to maintain the security of the fixings.

All baskets shall be mounted in the horizontal plane with return flanges facing up.

Baskets shall only be wall fixed where specifically indicated. In this instance proprietary cantilever brackets shall be utilised.

When sections are cut, all sharp edges shall be removed and exposed metal edges painted with rust inhibitor. Sections of basket shall be joined using proprietary coupling plates fixed with zinc plated nuts and bolts. Bends and tees shall utilise proprietary components and fixed using zinc plated nuts and bolts.

At each fixing position, two fixings shall be provided and for trays wider than 300mm three fixings shall be provided where the tray is to be supported from the underside of roofs or ceilings.

Where cabling exits the tray via rigid or flexible conduit systems (as specified) the conduits shall be terminated at the basket flange using proprietary mounting brackets. Where such conduit is steel, earth couplings shall be used, the earth cabling terminating at the bracket fixing via a crimped lug.

Cable fixings shall be by means of proprietary forms of plastic or PVC covered copper or brass cable clips, brass saddles or straps. Brass nuts and bolts or galvanised roofing bolts shall be used to fasten the fixings to the basket.

Reference shall be made to the appropriate section of the Specification with respect to the type of cable to be installed and the fixing method to be adopted.

The cable basket installation shall be electrically and mechanically continuous and shall be adequately connected to the distribution system earthing network.

The basket system shall be complete before the commencement of wiring.

c) Cable Tray

Perforated cable tray shall be plain steel sheet type complying with BS EN 61537.

Trays shall be galvanised in external locations and provided with an approved alternative rust resisting finish such as zinc phosphate for internal applications.

Galvanising shall be hot-dipped to BS EN 1461

Trays shall be of adequate size to avoid undue bunching of cables and shall be supported so that undue deflection, when fully loaded is avoided. The maximum deflection shall be 1/200L.

Bare copper sheathed cable shall not be installed on galvanised cable tray.

Fixings shall be by sheradised nuts and bolts with a gap of 25mm between the structure and the tray.

Fixings for tray shall be at regular intervals not exceeding 1.2metres and at 225mm for bends and intersections.

At each fixing position, two fixings shall be provided and for trays wider than 300mm three fixings shall be provided where the tray is to be supported from the underside of roofs or ceilings.

Cable tray supports shall be by means of unistrut or similar proprietary products. When used with galvanised cable tray, supports shall be hot-dipped galvanised to BS 1461.

Drop screwed rod supports shall be cut back to within 25mm and the cut ends protected by proprietary plastic end caps. The method of support shall incorporate appropriate anti-vibration washers etc., to maintain security.

Site fabricated accessories and supports for internal applications shall be wire brushed, cleaned and painted before erection to ensure that the fixing bolts or screws are protected. When sections are cut or drilled, all sharp edges shall be removed and exposed metal painted with a rust inhibitor. Areas of finish damaged by welding shall also be made good as described above (e.g. zinc phosphate paint).

Holes cut in the tray for the passage of cables shall be provided with grommets, bushed or lined.

Bends and tees shall be factory made using the same material, thickness and finish as the tray.

Site fabrication of accessories shall be kept to a minimum and manufacturers standard items and method of installation shall be used.

Where special sections are required the material, thickness and finish shall be as specified for standard items.

Where cut sections are used for sets they shall be free from sharp edges and joined by means of fish plates bolted to each section with mushroom head steel roofing bolts complying with BS 1494-1.

Cable tray shall only be cut along a line of plain metal and not through perforations.

Cable fixings shall be by means of proprietary forms of plastic or PVC covered copper or brass cable clips, brass saddles or straps. Brass nuts and bolts or galvanised roofing bolts shall be used to fasten the fixings to the fixings to the tray.

Reference should be made to the appropriate section of the Specification on the type of cable to be installed for the fixing method to be adopted.

The cable tray installation shall be electrically and mechanically continuous and shall be adequately connected to the distribution system earthed network.

The tray system shall be complete before the commencement of wiring.

d) PVC Trunking Installation

Trunking shall be extruded unplasticised PVC compound of the colours specified. It shall be smooth inside and outside and free from imperfections.

Gauge and type shall be as specified and it shall be fitted with a drip-proof well fitting lid of an approved type. Where the cover is on the underside, cable retaining straps at intervals not exceeding 1.2m shall be fitted. In vertical runs exceeding 1.8m, insulated cable support pins shall be fitted at intervals of 1.2m, the first pin, in cases where junction occur, being not more than 0.3m from the junction.

Internal fire barriers shall be fitted in the trunking in accordance with IEE Regulation 527 to provide a fire rating not less than the original construction. All joints, tees, off-sets, and other fittings shall be the manufacturer's standard items, joints being made using standard internal connectors without the use of solvent and as instructed by the manufacturer.

Environmental conditions appertaining to the installation of PVC conduit shall also apply to PVC trunking.

The trunking system shall be mechanically continuous throughout containing a separate insulated circuit protective conductor to ensure electrical continuity between exposed metal items.

The whole system shall be adequately supported and substantially fixed to the building structure using purpose made supports 50mm each side of all joints and elsewhere at regular intervals, not exceeding the following:

Cross Sectional Area of Trunking	**Vertical and Horizontal**
Exceeding 300mm^2 and not exceeding 1500 mm^2	0.5m
Exceeding 1500 mm^2	1.0m

General conditions relating to supporting metalwork shall be as specified for metal trunking.

Fire collars shall be fitted to trunking systems that pass through fire compartment walls.

The trunking system shall be complete before the commencement of wiring.

2.4 POWER DISTRIBUTION CABLES

2.4.1 Standards

Comply with the following standards:

BS 6480	Specification for impregnated paper-insulated lead or lead alloy sheathed electric cables of rated voltages up to and including 33000 Volts
BS 6724	Specification for armoured cables for electricity supply having thermosetting insulation with low emission of smoke and corrosive gases when affected by fire
BS 6007	Electric cables. Single core unsheathed heat resisting cables for voltages up to and including 450/750 V, for internal wiring
BS 5467	Electric cables. Thermosetting insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V
BS 6346	Electric cables. PVC insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V
BS 2484	Specification for straight concrete and clayware cable covers
BS 7919	Electric cables. Flexible cables rated up to 450/750V, for use with appliances and equipment intended for industrial and similar environments
BS 6500	Electric cables. Flexible cords rated up to 300/500 V, for use with appliances and equipment intended for domestic, office and similar environments
BS EN 61914	Cable cleats for electrical installations
BS EN ISO 29453	Soft solder alloys. Chemical compositions and forms

2.4.2 General

All cables shall be of the type and voltage grade as specified and be BASEC approved.

When delivered to site each drum or coil of cable shall have attached the manufacturer's labels giving details of the cable and manufacturer's test certificate. Replacement of faulty cable shall be at the Contractors expense.

All cables shall have a BASEC or BASEC <HAR> marking on the outer sheath as appropriate.

All cables shall be run on routes indicated on the drawings and in the Specification. Any deviation shall be approved by the Engineer before laying commences.

The routes shall be measured by the Contractor on site and he shall be responsible for ensuring that correct lengths are ordered. All cables laid direct in the ground shall have an overall sheath of PVC.

PVC/LSF sheathed cables shall not be installed in direct contact with any form of polystyrene.

Cables which pass through fire compartment walls shall be suitably protected.

Cables shall be installed only when both the cable and ambient temperatures are not less than 5° and have been so for the previous 24 hours, or when special precautions have been taken to maintain the cable at or above this temperature.

Single core cables armoured with steel wire or tape shall not be used for ac.

2.4.3 Paper Insulated Cables (Up To and Including 11 kV)

These shall be mass impregnated non-draining belted type, complying with BS 6480 and unless stated otherwise are for use on an earthed system.

They shall have copper conductors, lead sheath and be armoured. The type of overall sheath, if any, shall be as specified and cables shall have shaped cores of identical cross-sectional area including neutral.

Each cable shall be kept sealed before installation by means of wiped joints and end caps.

2.4.4 XLPE Insulated Cables (Up To and Including 3.3 kV)

These shall comply with BS 6724 or BS 5467 having cores of identical cross-sectional area (including neutral).

Cables shall have an overall protective sheath as follows :-

a) Internally installed - LSF sheath (BS 6724)

b) Externally installed - PVC sheath (BS 5467)

External circuits installed internally exceeding 30 metres in length shall be deemed internal to first point of utilisation.

Where cables are connected to equipment or accessories designed to operate at a temperature of 70°C or installed in an enclosure containing cables (e.g. PVC insulated) rated at 70°C, the current ratings shall be as given in the equivalent table of the IEE Regulations for 70°C PVC insulated cables (BS 6004, BS 6346).

Cables shall be armoured and have copper conductors as specified.

2.4.5 Cable Routing

Cables shall be run between termination points in continuous length. Joints shall not be allowed unless specified or unless agreed by the Engineer.

Where cables are installed in the ground, they are to be laid at depths and spacings specified below :-

Minimum depth of cable trenches:

Type of Cable	General Conditions	Traffic Roads	Cultivated Areas	Areas Beneath Drainage
Road Lighting	500 mm	750mm to top of ducts	600mm	1.0m
Communication	500 mm	750mm to top of ducts	600mm	1.0m
Alarm	500 mm	750mm to top of ducts	600mm	1.0m
Low Voltage	500 mm	750mm to top of ducts	600mm	1.0m
High Voltage	800mm	1.0m to top of ducts	1.0m	1.0m

Minimum spacing between services laid direct in the ground (general conditions):

Cable	HV/EHV	LV	Communication and Alarm	Gas and Water	Hot Services
HV/EHV	150mm	300mm	600mm	600mm	800mm
LV	300mm	75mm	300mm	600mm	800mm
Communication and Alarm	600mm	300mm	50mm	600mm	800mm

Minimum width of cable trenches for required depths:

Nominal Depth	Nominal Width
Down to 500mm	300mm
Down to 800mm	500mm
Down to 1.0m	500mm
Down to 1.5m	700mm
Below 1.5m	800mm

Where scheduled minimum depths cannot be accommodated, cables shall be installed in PVC ducts set in concrete.

Where cables laid in the ground follow the same route they shall be laid in horizontal formation with spacing between cables where possible of not less than 150mm with the exception of single core cables which shall be run in trefoil formation and touching along their entire length.

Underground cables shall be laid on 75mm of sand and covered by 75mm of sand with interlocking cable tiles to BS 2484 laid on the sand directly over the cable. Tiles shall be of such width as to provide a minimum overlap of 50mm on each side of the cable.

Trenches shall be backfilled with the excavated material which shall be well compacted at intervals of 150mm.

At approximately 300mm below finished ground floor level a continuous strip of plastic marker tape marked "DANGER ELECTRIC CABLES" shall be laid in position directly above the cable. All excavation, backfilling, laying of sand and tiles and laying of tape will be done by others unless otherwise specified, but it shall be the Contractors responsibility to ensure that the complete installation is correctly carried out.

Concrete cable markers shall be used to indicate the route of buried cables at intervals of not more than 50 metres and at points where change of direction and joints occur and at each side of every road crossing. Markers shall be of the type identified in section 3 of this specification.

Cables under roads, paths, floors through walls or skirting buildings shall be run in self-sealing PVC ducts of minimum diameter 100mm.

At roadway crossings the ducts shall extend 1.0m on either side of the roadway.

Where the cable ducts terminate in buildings they shall be sealed with a permanently plastic waterproof sealing compound to prevent ingress of water, foreign matter and vermin.

Ducts shall be colour coded to signify their purpose.

When passing through floors or walls the PVC ducts shall be fitted with a fire resisting material to comply with the IEE Regulations.

Cables shall be protected from mechanical damage up to a height of 1.5m above floor level where run on the surface of walls. Paper insulated cables shall be installed without removing the wiped joint end cap until it is necessary for making the actual termination.

Cables shall be installed only when both the cable and ambient temperatures are at or above a temperature to avoid risk of damage during handling.

Paper insulated and armoured XLPE cables run in air (including engineering service ducts) shall be fixed with aluminium alloy claw type cable cleats with galvanised back straps using galvanised bolts conforming to BS EN 61914 with maximum spacing between supports not exceeding the following:

OD (overall diameter) of cable	Maximum Spacing Of Fixing Vertical/Horizontal
Exceeding 9mm and not exceeding 15mm	350mm
Exceeding 15mm and not exceeding 20mm	400mm
Exceeding 20mm and not exceeding 40mm	450mm

Cables up to and including 10mm OD shall be fixed by single bolt and above 40mm OD by 2 bolt fixing.

The correct size of cleat fixing stud must be provided to suit the cable size and to ensure that the stud does not extend below the nut.

Excess pressure of cleats on cables is to be avoided to prevent deformation of the sheathing.

Suitable supporting steelwork and/or galvanised cable tray shall be provided where cables cross open spaces of greater than 1m distance, such steelwork to be protected by a rust inhibiting paint. Unserved aluminium sheathed cables shall not be installed in contact with walls or floors.

2.4.6 Minimum Installation Radius

Cables shall not be bent to a radius less than the manufacturers recommended minimum.

2.4.7 Jointing and Termination

a) General

The jointing and termination of all paper, PVC, LSF and XLPE insulated cables shall be carried out by an experienced cable jointer trained and fully conversant with modern techniques and once the cable is cut for the purpose of making a joint or termination the work involved must be carried out and completed without interruptions. If for any reason the work cannot be carried out it is essential that the cable ends are sealed immediately as follows :-

Lead Sheathed Cables - Solder or wipe a copper or lead cap on the sheath

Armoured PVC & XLPE Cables - Seal with PVC tape.

Joints and cable terminations shall be suitable for the environment in which they need to operate and in particular fully weatherproof kits shall be used for outdoor situations.

b) Paper Insulated lead sheathed cables with stranded copper or aluminium conductors

i) Joints

Conductors shall be sweated with ferrules not less than the cross sectional area of the conductor for which it is designed.

Only tinned aluminium ferrules shall be used with aluminium conductors.

Solder for making copper joints shall be Grade 'M' or Grade 'G' complying with BS EN ISO 9453

The Flux shall be resin or other non-corrosive type.

Solder for making aluminium joints shall be of the cadmium free type.

Flux shall be of a type approved by the cable manufacturer. The insulation of the joints conductors shall be either of the following :-

i. Impregnated cotton tape or paper cotton tape wrapped around each jointed conductor to a built up thickness over the ferrule equal to not less than one and a half times the thickness of the cable core insulation.

ii. Impregnated paper rolls of adequate dimensions as supplied by the manufacturers for use with a specific type and size of cable wrapped around each jointed conductor.

iii. Impregnated cotton tape or paper cotton tape wrapped around each jointed conductor and surrounded by a tube of paper or paper mica composition.

For 3 core cables the jointed cores shall have separators of impregnated cotton tape or paper inserted between the cores and the cores bound overall with impregnated cotton tape or paper binders.

The insulated joints shall be housed in a compound filled lead or tinned copper sleeve plumbed to the sheath of the cable.

Solder for plumbing the sleeve to a lead sheathed cable shall be Grade 'D' complying with BS EN ISO 9453

The methods and materials for plumbing of aluminium cable sheath to the sleeve shall be in accordance with the manufacturer's instructions. Compound filling holes in the lead or copper sleeves shall have caps for plumbing over the holes after filling with compound. The manufacturers recommended compound shall be used for filling the sleeve.

Outer protection boxes shall be of either cast iron or reinforced concrete of an approved type and shall be filled with a suitable compound. Cast iron boxes shall be provided with armour clamps where armoured cable is specified to provide efficient mechanical and electrical bonding of the armour across the joint.

After completion of the joint all cast iron boxes shall be given two coats of bitumastic paint to prevent rusting of the box.

Where non metallic outer protection boxes are used with armoured cable, suitable armour clamps and copper strip shall be used to provide electrical bonding/continuity between the sections of cable. The copper strip shall be sized in accordance with Table 54.7 of the IEE Regulations.

ii) Terminations

Terminations shall be made in compound filled sealing boxes and no soldered ferrule or joint will be permitted inside a sealing chamber.

The cable cores shall terminate in correctly sized compression or sweating type lugs and the tails shall be wrapped with not less than two layers of bitumastic or waterproof tape.

The tails shall be colour coded to indicate phase and neutral conductors.

Tail-less terminations shall be completely compound filled.

On medium voltage networks where connecting tails are required the cable ends shall be soldered solid and PVC insulated tails jointed by suitable compression jointing sleeves, the joints being insulated with varnished cambric or other suitable insulation and the joint and tails over wrapped with bitumastic or waterproof tape.

The lead or aluminium shall be neatly plumbed to the gland on the sealing chamber. Where armoured cable is specified the armouring is to be clamped to the gland, the armouring being neatly arranged and the serving cut and bound below the plumbed joint.

c) XLPE Insulated Armoured Cables, PVC & LSF Sheathed with Stranded Copper or Aluminium Conductors

Jointing and termination techniques may be either :-

i) as for paper insulated cables using the manufacturers recommended joint boxes and cold pouring compound.

or

ii) compression techniques as for solid aluminium conductors.

d) XLPE Insulated Aluminium Armoured PVC & LSF Sheathed Solid Aluminium Conductors

All joints are to be of the indented compression type by means of a hydraulic compression ram head and suitable compression dies according to the core size of the cable with strict adherence to the cable manufacturer's recommendations on accessories, ferrules, compression pressure and jointing techniques.

Joint boxes shall be as specified. Where cast iron or earthenware boxes are employed the box shall be filled with a bitumen compound whose pouring temperature shall not exceed 140°C.

Where plastic boxes are used an approved polyester resin shall be used to fill the joint box.

Particular attention should be paid to ensure electrical continuity of the cable armouring.

Note : Unless specified otherwise all cables shall have stranded copper conductors. Reference to solid aluminium conductors is for situations where they are specifically required elsewhere in this document.

Terminations shall be made using the indented compressions method with sockets of soft aluminium shaped to match the profile of the conductor core.

Suitable approved aluminium cable glands with bonding lugs shall be used and shall be protected with PVC/LSF cable shrouds. All metal joints at termination joints, gland to armour contact and dissimilar metal joints shall be smeared with Densal tape.

2.4.8 Pressure Testing

Pressure tests shall be executed on all submain cables which will be inaccessible after completion of the installation e.g. underground cables. Pressure tests shall also be carried

out on selected cables as detailed in section 3 of this specification. Tests shall be undertaken prior to energisation.

After installation the cable shall be pressure tested by the Contractor in the presence of the Engineer. The Contractor must notify the Engineer in writing, seven days before such tests are to be carried out and shall submit to the Engineer duplicate copies of a test certificate on completion.

The Contractor shall be responsible for rectifying any faults on any part of the installation which fails or breaks down as a result of the pressure tests. Tests shall be made on each separate length of cable and for this purpose isolators and fuse switches must be in the open position and wedges in feeder pillars must be removed.

The tests shall be carried out with DC, the voltage to be applied and increased gradually to the full value and maintained for 5 minutes between conductors and between earth conductor and sheath.

Cable Voltage	DC Test Voltage	
	Between Conductors	Between All Conductors and Sheath
600/1000V	1000V	1000V
1900/3300V	5000V	3000V
3800/6600V	10000V	6000V
6350/11000V	17000V	10000V

2.5 MINERAL INSULATED CABLES

2.5.1 Standards

Comply with the following standards:

BS EN 60702-1	Mineral insulated cables and their terminations not exceeding 750V cables.
BS EN 60702-2	Mineral insulated cables and their terminations not exceeding 750V terminations

2.5.2 General

Cables shall have copper conductors and seamless copper sheath (or welded, seamed copper sheath where the mineral insulation is moisture resistant).

They shall be of the 750 volt (heavy duty) grade except for single phase final circuits where 500 volt (light duty) grade cables may be used.

All M.I. cables shall have an LSF (BICC "Fire Safe" or equal) outer covering.

Cables buried underground shall have a PVC outer covering.

Cables shall be of only one manufacturer for a particular Contract and shall be delivered to site having the manufacturer's seal and identification labels intact.

All accessories (glands, seals, saddles, clips, etc.) shall be of the same manufacture as the cable.

All cables shall have a BASEC or BASEC <HAR> marking on the outer sheath as appropriate.

2.5.3 Installation

Cables shall be securely fixed to the structure using copper saddles at a maximum spacing in accordance with the manufacturer’s recommendations and to the IEE Regulations.

Where several cables are run together, multiple saddles shall be used, fixings being as detailed for conduit. Where multiple runs occur in plant rooms, roof spaces and ducts etc., the cables shall be run on cable tray, having saddles fixed with brass round head screws and nuts. Unsheathed copper cables shall be secured with copper clips or saddles fixed with brass screws.

Covered cables shall be secured with copper saddles (with covering compatible with the respective cable covering i.e. LSF or PVC) with brass screws. Not less than 24 hours after installation and completion of seals, cables shall be tested by the Contractor in the presence of the Engineer or his representative.

Alterative fixings will be considered (e.g. BICC Pyrotenex - "Pyro Ties"), however express written permission shall be obtained by the Contractor from the Engineer for the use of any such alterative. Non-metallic cable clips or cable ties are not acceptable for securing mineral insulated cables.

Cables shall be tested before and after being covered with concrete, plaster or buried in the ground. Cables shall be protected from mechanical damage while in storage and during installation especially when floor screeds and wall finishes intended to cover cables are not applied immediately following the cable installation.

Cables shall be protected by fibre sleeves where passing through floors, walls, ducts etc. After passing through a floor an exposed cable shall be protected on the wall by conduit or trunking to a height of 300mm above floor level. Cables shall be run at least 150mm clear of non-electrical services.

Cables shall be installed only by tradesmen fully conversant with M.I. installation and jointing techniques and only those tools recommended by the cable manufacturer shall be used.

Where connections are to be made to motor and equipment where vibration or movement due to expansion etc. is likely to occur the cable shall be formed into one complete loop immediately before entering into the equipment terminal box.

Surge voltage diverters as recommended by the cable manufacturers shall be connected across the tractive coils of all motor starters and star connected surge diverters connected in the motor terminal box on all motors rated 2kW (3 hp.) or less.

When laid direct in ground cables shall be protected with sand and cable tiles as specified for armoured cables.

Where subsidence is likely to occur the cable shall be "snaked" along the route.

a) Jointing and Termination

Except at termination at an appliance or fitting, joints shall not be allowed without the Engineer's consent. If allowed these shall be made using only manufacturers' accessories and connections may be either soldered or crimped. Crimping shall only be carried out with a ratchet type crimping tool which ensures that the crimp is fully complete prior to release of the tool.

Buried joints or joints in corrosive situations must be protected with layers of self-amalgamating tape.

Terminations shall be made using cold seals of the type recommended by the cable manufacturer to suit the size and type of cable or as specified.

Tails shall be protected by neoprene sleeves and colour coded as prescribed in the IEE Regulations.

Conductors 16mm² and above shall be terminated using cone grip lug type cable sockets.

At equipment in which terminals are not provided connection of the tails to the equipment tails shall be made using pinching screw terminals or flat clamp type connectors.

The M.I. cable tails shall be provided long enough to connect directly to the equipment.

Joints in these tails shall not be allowed.

Cable glands shall be of the same manufacture as the cable.

When served cables are used the serving removed for the purpose of termination shall be replaced with tape to match the serving and the whole gland assembly protected with a shroud (to match the serving).

Damaged serving will not be accepted.

Cables are not to be concealed in plaster unless specified or with the consent of the Engineer, but where this is unavoidable, terminations shall be made using cold seals having circuit protective conductors incorporated.

The CPC shall be insulated by Neoprene or PVC sleeving and shall terminate in the junction box at 2BA or 5mm tapped screw inside the box.

When it is specified that glands shall not be fitted, because of space restrictions, the cables shall be securely fixed to the outlet box using suitable clamps fitted to the box. Where the CPC is to be carried through a lighting fitting a three way connector can be used in the conduit box, the third way being used to carry the CPC.

b) Continuity and Earthing

Where boxes without screwed spout entries are used, the M.I. cable gland shall be secured to the box by means of a smooth bore male brass bush and earthing coupling with compression washers used. An insulated circuit protective conductor shall be connected from the box to the equipment fixed to the box. This requirement shall not apply when terminations using integral circuit protective conductors are used.

2.6 CABLES IN CONDUIT AND TRUNKING

2.6.1 Standards

Comply with the following standards:

BS 6007	Electric cables. Single core unsheathed heat resisting cables for voltages up to and including 450/750V for internal wiring.
BS 7211	Electric cables. Thermosetting insulated non-armoured cables for voltages up to and including 450/750V for electric power, lighting and internal wiring and having low emission of smoke and corrosive gases when effected by fire.

2.6.2 General

Cables to be drawn into conduit or trunking systems shall be LSF insulated single core 450/750 volt grade with copper conductors for situations where the ambient temperature does not exceed 65°C.

Where conditions are such that this temperature may be exceeded the cable shall be of the elastomer - insulated type, 300/500V (150°C) or 450/750V (85°C) grade to BS 6007 and shall be type GP1 rubber insulated and braided for temperatures up to 85°C. and type E1 2 rubber insulated and braided for temperatures up to 150°C.

The elastomer-insulated cables shall be identified throughout the length of the cable by legends "Heat Resisting 85" for e.p. or butyl rubber insulated and "Heat Resisting 150" for silicone rubber insulated. Identification shall be either on an internal tape or shall be embossed externally, the gap between legends being not more than 300mm.

The situations in which elastomer-insulated cables shall be used and the type to be installed, shall be as specified and/or on the drawings.

Cable which must be BASEC approved shall be delivered to site with each coil having its seal intact and bearing the name of the manufacturer, classification, size, description, length and grade.

All cables shall have a BASEC or BASEC <HAR> marking on the outer sheath as appropriate.

2.6.3 Installation

Cables shall be installed only when both the cable and ambient temperatures are not less than 5°C. and have been so for the previous 24 hours, or when special precautions have been taken to maintain the cable at or above this temperature.

No joints shall be allowed except at termination at an appliance or fitting.

Cable sizes shall be as detailed or as shown on the drawings, however, the minimum cable size for lighting circuits shall be 1.5mm^2 and for 32 amp ring circuits 2.5mm^2. Cables shall be colour coded in accordance with Table 51 of the IEE Regulations.

Colour sleeves shall only be used with the written consent of the Engineer.

Cables shall not pass through lighting fittings unless they are of the heat resisting type to BS 6007 Table 7 and shall not be connected direct to a lampholder or other appliance where temperatures are likely to exceed the maximum operating temperature for the insulation specified in the appropriate BS

Conductors shall be terminated by one of the following methods unless stated otherwise.

a) Sweated lugs

b) Compression type lugs

c) Pinch screw type terminals of the type that do not spread the conductors.

d) Clamp type terminals.

For all single connections of conductor sizes up to and including 2.5mm^2 the conductor shall be doubled back on itself at the termination.

2.7 INSULATED AND SHEATHED CABLES

2.7.1 Standards

Comply with the following standards:

BS 7211	Electric cables. Thermosetting insulated non-armoured cables for voltages up to and including 450/750V for electric power, lighting and internal wiring, and having low emission of smoke and corrosive gases when effected by fire.

2.7.2 General

Cable sizes shall be as specified.

All cables shall have a BASEC or BASEC <HAR> marking on the outer sheath as appropriate.

2.7.3 Installation

Cables shall be concealed or run on the surface as specified.

Cables which are concealed in ceilings, floors, walls or partitions shall be suitably protected in accordance with the detail requirements of the IEE Regulations. Cables which are concealed at a depth of less than 50mm shall be enclosed in earthed steel conduit providing mechanical protection along its entire length. Conduit concealed in the wall fabric shall have a minimum cover of 13mm.

Entries to accessory boxes and fittings shall be fitted with suitable grommets to prevent damage to the cable sheath. Metal accessory boxes shall be bonded.

Cables shall not be buried in floor screeds without the written approval of the Engineer but when this is authorised they shall be protected throughout their entire length by galvanised steel conduit having a minimum of 35mm cover of screed.

Cables on walls shall be run vertically or horizontally. Cables installed on ceilings or in the ceiling voids shall be run parallel to the walls.

Diagonally run cables shall not be allowed.

Cables shall be fixed using suitable clips or saddles not exceeding the following:

Overall diameter of cable	Maximum Spacing of Fixings	
	Vertical	Horizontal
Not exceeding 9mm	250mm	400mm
Exceeding 9mm and not exceeding 15mm	300mm	400mm
Exceeding 15mm and not exceeding 20mm	350mm	450mm
Exceeding 20mm and not exceeding 40mm	400mm	550mm

Fixings shall not be more than 70mm on either side of a fitting, accessory or bend. Cables running along joists shall be run on a level clear of ceiling boards and as near as possible to the centre of the joist.

Where multiple runs (i.e. more than 2 No. (two) cables together) occur in ceiling voids, ducts etc., cables shall be fixed to galvanised cable tray.

Where run in intermediate floors, cables shall be threaded through holes not exceeding 25mm diameter drilled at half joist depth and at least 50mm clear of top/bottom of floor or ceiling finishes.

Cables shall not be installed in direct contact with any form of polystyrene.

Conductors shall be terminated as stated for PVC cables in conduit. Joints shall not be allowed, except at termination at an appliance or fitting, the conductors being terminated as specified for PVC cables in conduit.

Cables shall be installed only when both the cable and ambient temperature are not less than 5°C and have been so for the previous 24 hours, or when special precautions have been taken to maintain the cable at or above this temperature.

2.7.4 Flexible Cords

These shall be of the 300/500 volt grade to BS 6500. The type of insulation, number of cores, size of conductors, braiding and sheathed will depend on the service for which the cable is intended and shall be as specified.

No cable smaller than 0.75mm^2 shall be used.

2.8 POWER SOCKET OUTLETS AND FUSED CONNECTION UNITS

2.8.1 Standards

Comply with the following standards:

BS 546 Two-pole and earthing-pin plugs, socket outlets and socket outlet adapters.

BS 88-2	Low-voltage fuses. Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application).
BS 88-3	Low-voltage fuses. Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household or similar applications).
BS 1362	General purpose fuse links for domestic and similar purposes.
BS 1363	13A plugs, switched and unswitched socket outlets and boxes.
BS EN 6060669-1	Switches for household and similar fixed electrical installations.
BS 4177	Cooker control units rated at 30 amperes and 45 amperes, 250 volt single phase.
BS EN 60309-2	Plugs, socket-outlets and couplers for industrial purposes.
BS 4573	Two-pin reversible plugs and shaver socket outlets.
BS 5733	General requirements for electrical accessories.

2.8.2 General

The requirements for type and finish of all outlets are given in the Specification Schedules and/or on the Tender Drawings.

Each outlet shall be connected in a ring circuit or on its own dedicated radial circuit. Spur circuits from ring circuits shall not be permitted.

RCD protected socket outlets utilised to serve equipment outside the area of main equipotential bonding, shall be engraved, "For Outdoor Equipment".

All connection units shall be engraved with the name of the item they feed/control.

Plugs shall be of the same manufacture as the socket outlets used.

2.9 EMERGENCY LIGHTING SYSTEMS

2.9.1 Standards

Comply with the following standards:

BS 764	Automatic change-over Contactors
BS 5266	Emergency lighting
BS EN 50171	Central power supply systems
BS EN 50172	Emergency escape lighting systems
BS EN 60598-2-22	Particular requirements – luminaires for emergency lighting
ICEL 1001	Scheme of product and authenticated photometric data registration for emergency luminaires and conversion units
ICEL 1004	Requirements for the re-engineering of luminaires for emergency lighting use

2.9.2 Type of Installation

The requirements for the type of emergency lighting to be used are given in the Specification Schedules and/or on the Tender Drawings.

2.10 LIGHTING

2.10.1 Standards

Comply with the following standards:

BS EN 60598	Luminaires
BS 67	Specification for ceiling roses
BS EN 60669	Switches for household and similar fixed electrical installations.
BS 5733	Specification for general requirements for electrical accessories
BS EN 60079	Explosive atmospheres. Equipment. General requirements
BS EN 61347	Tubular fluorescent lamps for general lighting service
BS EN 60188	Specification for high pressure mercury vapour lamps
BS EN 60192	Specification for low pressure sodium vapour lamps
BS EN 60662	Specification for high pressure sodium lamps
BS EN 60064	Tungsten filament lamps for domestic and similar general lighting purposes - Performance requirements.
BS EN 60432	Safety specification for incandescent lamps. Tungsten filament lamps for domestic and similar general lighting purposes.
BS EN 60920	Ballasts for tubular fluorescent lamps. General and safety requirements
BS EN 60081	Double capped fluorescent lamps. Performance Specification
BS EN 61195	Double capped fluorescent lamps. Safety Specification
BS EN 60901	Single capped fluorescent lamps. Performance Specification
BS EN 61199	Single capped fluorescent lamps. Safety Specification
BS EN ISO 1461	Specification for hot dip galvanized coatings on iron and steel articles
BS 5972	Specification for photoelectric control units for road lighting

The requirements for the type of systems to be installed are given in the Specification Schedules and/or on the Tender Drawings.

2.10.2 General

The Contractor shall provide all luminaires which shall comply with the appropriate British Standards noted above and as listed in the lighting schedule and as shown on the drawings.

2.10.3 Connection of Luminaires

Luminaires shall be connected as specified in one of the ways detailed below:

a) The cabling or conduit system shall terminate in a BS conduit box mounted on the structure in the ceiling void. A 3 or 4 pin plug-in type ceiling rose shall be fitted to this box. A 3 or 4 core (one core being the circuit protective conductor) 1.0mm^2 heat resistant flexible cord (insulation and sheath as specified) shall be run from the plug in the ceiling rose to the terminals of the luminaire The flexible cord shall pass through a brass stuffing gland fixed in the wall of the luminaire.

The luminaire shall be suspended from the structure, unless otherwise stated using rod or conduit suspensions.

b) The cabling or conduit system shall terminate in a BS conduit box mounted on the structure. A ceiling rose incorporating a circuit protective terminal shall be fitted to this box.

A 3 or 4 core (one core being the circuit protective conductor) 1.0mm^2 flexible cord (insulation and sheath as specified shall be run to the terminals of the luminaires which shall be fitted with a brass stuffing gland for cable entry.

Suspension of luminaires shall be as in (i) above.

c) The cabling or conduit system shall terminate in a metal conduit box mounted flush with the ceiling and supported from the structure.

Wiring shall terminate in a porcelain connector from which a 3 or 4 core 0.75mm^2 or 1.0mm^2 heat resistant flexible cord for 5A and 10A circuits respectively shall be run to the luminaires which shall be mounted directly beneath the box. Boxes shall be fitted with break rings when the luminaires does not overlap the box.

Luminaires shall be suitably supported directly from the structure, unless stated otherwise. When terminating the PVC final circuit cables in a BS conduit box to which a close ceiling tungsten luminaires is to be attached, care should be taken to ensure that the PVC tails are as short as possible and that the extra length on tails required to install the luminaires is left on the heat resisting tails specified. This is to prevent the PVC tails coming into contact with the luminaire and subsequently resulting in insulation failure due to the excessive heat.

d) For pendant luminaires the cabling or conduit system shall terminate at ceiling height in a flush mounted conduit box supported from the structure to which shall be fitted a ceiling rose to incorporating a protective conductor terminal. A length of 1.0mm^2 heat resisting flexible cord shall be provided from the ceiling rose to the luminaires. (The length of cord or alternatively the mounting height of the luminaires shall be specified elsewhere)

At the luminaire the flexible cord shall terminate in a heat resisting bayonet cap lampholder.

For rod type pendant luminaires the wiring system shall terminate in a porcelain connector housed within the conduit box. A heat resisting flexible cord (0.75mm^2 or 1mm^2 for 5A and 10A circuits respectively), shall be connected between the connector and the luminaires lampholder.

Break-joint rings shall be fitted between the conduit box and the luminaires which shall be mounted at the height specified.

The Contractor shall allow for cutting and making good rod-pendants where non-standard lengths are specified.

e) For surface installations the conduit or cable installation shall terminate in a metal BS conduit box fixed to the structure.

Wiring shall terminate in a porcelain connector from which a 3 or 4 core 0.75mm^2 or 1.00mm^2 for 5A and 10A circuits respectively shall be run to the luminaires which shall be supported from the structure directly beneath the box.

f) For wall mounted lighting luminaires connected to concealed cable or conduit systems the conduit or cable installation shall terminate in a recessed junction box accommodating a porcelain connector as described previously, however, the Contractor shall ensure that the junction box employed is small enough to be completely covered by the luminaires.

Luminaires with tube suspensions shall be fitted with non-rigid joints of ball and socket type which shall be independent of the ball joint.

2.10.4 Fixings for Luminaires

Luminaires Supported from Conduit Boxes

Provide a second conduit box as an additional fixing point for all fluorescent luminaires longer than 600mm.

Fix luminaires to each conduit box using 2 No brass round head bolts.

Use the back entry loop-in system for flush ceiling points on conduit installations.

On flush installations use conduit box extension rings as necessary to bring the lower edge of the conduit box flush with the ceiling/wall finish.

Luminaires shall not be directly suspended from a PVC conduit box.

Luminaires Mounted Directly onto Lighting Trunking

Mount luminaires directly to the underside of the trunking using 2 No bushed suspension units with locking rings as manufactured by the trunking manufacturer. Terminate cables into a 3 way 15A connector block within the trunking and make final connections to the luminaire using 3 core heat resisting flexible cord.

Luminaires Suspended from Lighting Trunking

Luminaires mounted directly onto lighting trunking, shall utilise bushed suspension units incorporating dome hooks.

Use galvanised or other approved solid link steel chain, fixed to the luminaires by means of eye bolts, to suspend the luminaire from the dome hooks to the heights shown in the Particular Specification, Schedules and/or on the Tender Drawings.

Independently Supported Luminaires with Plug-In Connections

Independently support the luminaire from the building structure by means of 10mm dia. threaded drop rod suspensions, conduit drop suspensions or gripple wire suspensions. Use the number of suspension points recommended by the luminaire manufacturer and the type that will enable the final height of the luminaire to be adequately adjusted.

Terminate the conduit/cable system in a conduit box mounted in the ceiling void immediately above the luminaire, or on the structural soffit or 750mm above the luminaire whichever is the less.

Fit the conduit box with a plug-in ceiling rose and make the final connection to the luminaire using a length of 3 core heat resisting flexible cord.

Where the luminaire is of the recessed mounting type with the access to the ceiling void by means of the luminaire ceiling opening use a flexible cord of such a length as to enable the luminaire to be removed to provide sufficient access to enable the plug-in rose to be readily disconnected.

Ceiling Supported Luminaires with Plug-In Connections

Support luminaires from suspended ceiling only where specifically indicated.

Use one of the following methods, as appropriate:

a) Support recessed fluorescent luminaires directly from the suspended ceiling grid by means of the supporting brackets provided as part of the luminaire.

b) Support surface luminaires directly from the suspended ceiling grid by means of proprietary clip-on brackets specifically designed to suit the ceiling grid system.

c) Support recessed tungsten luminaires from the ceiling or ceiling tile (reinforced with timber backplate if necessary) by means of the fixing rings and plates provided as part of the luminaire.

Terminate the conduit/cable system in a conduit box mounted in the ceiling void immediately above the luminaire, or on the structural soffit or 750mm above the luminaire whichever is the less.

Fit the conduit box with a plug-in ceiling rose and make the final connection to the luminaire using a length of 3 core heat resisting flexible cord.

Where the luminaire is a recessed mounting type with the access to the ceiling void by means of the luminaire ceiling opening use a flexible cord of such a length as to enable the luminaire to be removed and to enable the plug-in rose to be readily disconnected.

Surface Mounted Luminaires with Direct Cable/Conduit Entry

Surface mount the luminaires using not less than 2 No screw and plug fixings and terminate the cables/conduit directly into the luminaire knockouts.

2.10.5 Lampholders

Lampholders shall comply with the relevant British Standards and be appropriate for lamp type wattage and application.

2.10.6 Lamps

All luminaires shall be provided with the appropriate lamps, be suitable for the supply voltage, compatible with the luminaire control gear and as recommended by the luminaire manufacturer.

Lamps shall be of the colours specified.

Tungsten lamps shall be of the pearl type and for 100 watt rating and below shall be of the coiled coil pattern.

Unless otherwise specified lamps shall comply with the British Standards identified in the foregoing Lighting ‘standards’ section of this specification.

2.10.7 Lighting Switches

Switches shall be rated at 15A minimum. Flush mounting switches shall be rated as specified and mounted in pressed steel boxes with cover plates, as specified.

All switches shall be connected into the 'phase' circuit conductor.

Unless otherwise specified, switches shall be fitted in boxes with adjustable grids and fixing flanges to allow for variations in the thickness of building finish. Grids and boxes shall be fitted with protective conductor terminals which shall be bonded using insulated circuit protective conductors of equal size to the maximum CPC present at the switch position.

Where more than one phase is brought into a switch box segregation shall be achieved in accordance with the IEE Regulations by the provision of steel barriers within the box.

Each section shall have its own cover plate with suitable engraving to warn of the maximum voltage present at the switch position.

Multigang switch units shall be provided where more than one switch is shown in the same position with each switch arranged to match the relevant positions of the lighting points it controls. Ceiling switches shall be fixed to BS conduit boxes using break joint rings. The switches shall be of the underling type white or ivory coloured having a white operating cord terminating in a white plastic moulding 1.5m above the floor.

Surface switches shall be of the rating, finish and type specified and shall be mounted in enamelled pressed steel boxes.

The swing of all doors shall be checked on site before finalising any switch positions.

Water tight switches shall be to IP56 and designed for outdoor use, have polycarbonate enclosure and back box suitable for cable gland or conduit entry.

2.10.8 Street Lighting

a) General

The installation shall be provided in accordance with the relevant items of the following :-

i) The Code of Practice for Electrical Safety Engineering, Recommendations G39 published by The Electricity Council.

The Contractor shall alert the engineer to any potential issues safe working associated with the location of columns with respect to vehicular access, overhead lines, trees etc.

b) Underground Services

All information possessed by the Engineer regarding the position of existing mains and services will be made available to the Contractor without any guarantee as to its accuracy. The Contractor is in no way relieved of his obligations under the conditions of contract and must make all necessary arrangements and representations with statutory bodies to ensure that no existing mains or services are damaged or interrupted.

c) Lighting Columns and Brackets

Where hinged columns are specified, they shall be operated on the counter balance principle using a pivot arm and no special equipment shall be required to undertake the raising and lowering operation. The lower part should fit snugly around the main column shaft.

The securing of the bracket arm to the column shall be positive to ensure that the arm cannot rotate and can be fitted in any one of 4 x 90° positions in relation to the door opening. Bracket fixing screws shall be of stainless steel.

Doors on columns mounted on the outside of parapets on bridges, viaducts, raised walkways, etc. shall be captive. Non-corrodible welded link chain shall be used for this purpose and the column or door shall not be drilled to effect the securing of the chain.

Where columns are mounted on the outside of the parapets, the contractor shall ensure that the door is above the parapet guard rail, etc. and that access shall be available from the deck of the bridge, viaduct, walkway, etc.

All column doors except where captive shall be readily interchangeable amongst similar types of columns.

Columns shall be provided with rot proof, non-hydroscopic wooden back boards not less than 15mm thick and of sufficient size to accommodate the electrical equipment on such devices so as to permit the cables to be terminated and anchored. The base board is to be positively secured to the column.

d) Internal Wiring of Columns

The wiring shall be 2.5mm^2 copper single or multicored PVC insulation and sheathed and comply with BS 6004. The grade shall be 600/1000 volt.

The wiring shall be neat in appearance with sufficient length at termination points for several re-makes. Wiring going up the column shaft shall be clipped to the

backboard. Appropriate colour coded cable shall be used. A circular self coloured plastic disc shall be fitted to all backboards with a brass panel pin indicating the outgoing phase of the termination. The presence of 415 Volt terminations in lighting columns shall be avoided and only permitted where specifically identified in the particular specification or contract drawings. 415V labels shall be attached to all cut-outs housing 3 phases.

e) Earthing

An earth terminal shall be fitted to the baseboard of each column and the earthing terminals of all equipment shall be bonded together and to the earth terminal. Bare earth conductors shall be sleeved with yellow/green PVC sleeving. The cable armours, earth terminal and column shall be bonded out in 6mm^2 copper PVC insulated yellow/green cable. The whole of the installation shall be effectively earthed in accordance with BS 7430

Column doors are required to be separately earthed with 6mm^2 conductor.

f) Cable Laying

Cables shall be installed in accordance with the Power Distribution Cables section of this specification.

Columns will require one or more 50mm diameter flexible PVC ducts through the concrete base into the cable slot to facilitate the entry of cables. The concrete shall be Class E.

All columns subject to at works inspection are checked for trueness. Off loading and stacking therefore must be carried out in such a manner that no undue stresses are placed upon the columns. An ample supply of stout wooden battens shall be provided by the Contractor for the purpose of stacking the columns. Stacks of columns shall be staked or otherwise held to prevent collapse. Any column which in the opinion of the Engineer is bent shall be replaced by the Contractor at no cost.

Except in the case of columns with post top lanterns or flange plates, the shaft only shall be erected. After the concrete foundation has had time to set as agreed with the Engineer, brackets, lanterns, control gear etc. may be fitted.

Flange plates columns shall be carefully lowered onto the prepared foundations and shall be set vertically using galvanised or sheradised steel shims as necessary. Where bolts are cast into the foundation nuts and washers shall be provided. Where expandable type bolts are to be used these are to be provided by the Contractor (normally M24) after consultation with the Engineer. Nuts and bolts shall be tightened to the torque setting as recommended by the manufacturer. Exposed nuts and/or bolts shall be protected with Denso tape.

The space between the flange plate and foundation base shall be sealed with a suitable mastic compound

The bolts shall be hot dipped galvanised to BS EN ISO 1461 or equivalent approved protection, or be manufactured from an approved corrosive resistant material.

The approximate position of the columns are shown on the drawings. Before a column is installed its exact position shall be determined on site in consultation with the Engineer.

Unless otherwise agreed all single arm columns are to be installed with the door openings facing away from oncoming traffic. The doors on all columns in the central reservation are to face in the same direction along the centre line of the central reserve.

The direction of all hinged columns shall be determined by the Engineer.

Columns in the vicinity of overhead lines shall be fitted with warning plates.

g) Erection of Lanterns

The lantern shall be fixed to the spigot in accordance with the manufacturers recommendations. The Contractor shall use a suitable torque wrench to secure lanterns to spigots.

The lamp and all parts of the lantern affecting the photometric performance shall be cleaned before the lamp is installed.

h) Underground Cabling

Single phase cables shall be 600/1000V grade two core copper XLPE SWA PVC to BS 5467.

Three phase cable shall be 600/1000V grade four core copper XLPE SWA PVC to BS 5467.

At feeder pillar positions and gantry intake boxes the cable shall be secured to a gland plate by means of a brass or aluminium glands depending on cable specified complete with earthing tags. The gland body is to be covered with a PVC shroud.

All cables to be B.A.S.E.C. approved.

i) Termination Units

Termination units shall be detailed on the drawings.

j) Erection of Columns and Bracket Arms

The holes for planted root columns shall be excavated to the depth detailed below. The columns shall be placed in a hole allowing a minimum of 150mm of clearance all round the base of the column for the full excavation depth. The column shall be surrounded by concrete of radial thickness 150mm minimum to the depth detailed below :-

Mounting Height	Planting Depth	Depth of Concrete	Approximate Volume of Concrete
5m	800mm	450mm	0.068m^3
8m	1200mm	900mm	0.136m^3
10m	1500mm	1000mm	0.162m^3
12m	1700mm	1200mm	0.210m^3

Each column shall be provided with an 8mm minimum diameter earthing terminal with two plain washers and nuts all of which shall be of corrosion resistance material. The earthing terminal shall be so positioned as to be readily accessible through the door opening.

Root type steel columns after galvanising shall have that part of the column extending from the butt to 150m above ground level coated internally and externally with heavy duty black bituminous solution. The coating shall be preceded by degreasing and pre-treatment of the surface in accordance with the recommendation in CP 231 to ensure adhesion. The thickness of the protective coating shall be not less than 0.25mm.

Six keys for each different type of door opening shall be provided to the Engineer.

Doors on columns shall be positioned facing opposite to the direction of oncoming traffic.

k) Cable Joints

Joints shall be made using jointing kits, which shall be installed in accordance with the manufacture's instructions.

Prior to any cable laying the Contractor shall furnish to the Engineer evidence of the jointers competence in the use of the adopted cable joint kit. Unless agreed by the Engineer a record shall be kept to enable cable joints to be identified with the jointer responsible for the work.

Cable joints shall only be installed where called for on the schedules or drawings. Joints between cable drum lengths must be arranged to coincide with a specified joint position. The approval of the Engineer is required for the provision of additional joints and they shall not be provided for cables situated in a duct or trench.

The Contractor shall provide the Engineer with a reasonable opportunity to inspect each joint (a) before the filing compound is inserted into the box, (b) before the joint is buried.

Jointing shall only be carried out when all materials used in the jointing are free from visible signs of moisture and joints must be left protected from the weather during the curing period.

Cable joints shall be installed in accordance with the joint kit instructions. Jointing shall not take place in wet weather conditions unless suitable protection is erected to ensure that moisture cannot enter the joint during the jointing

Cable joints shall be installed 500mm below finished ground level on a bed of sand not less that 75mm deep and covered by a layer of equal depth.

Joints shall be adequately supported at all times. Backfilling shall not take place until the completed joint is in a fit condition to withstand any stresses which may be imposed upon it.

l) Feeder Pillars

All feeder pillars should be as specified in Outdoor Distribution Pillar section of this specification.

m) Photo Electric Control Units

All PECU's shall be of the electronic type and be a one or two part unit and comply with BS 5972.

The switching operation shall be capable of handling gas discharge lighting having a load up to 1 kW at 0.8 power factor.

The switch on level shall be 70 lux with an on/off ratio of not more than 1:2.

A delay shall be incorporated so that transient variations in ambient illuminations do not cause the lamps to be switched on or off.

In the event of a fault occurring in the photo electric cell circuit it is to fail safe (i.e. the controlled circuits are to switch on).

n) Cable Terminations

A suitable street lighting type cut-out as detailed on the drawings, incorporating an earth terminal shall be provided and fitted in the base compartment of each lighting column into which cables are to be terminated.

Termination for armoured cable shall incorporate a method of making off the armour which ensures a permanent earth bond between the cables terminated to the satisfaction of the Engineer. The cable armour shall be bonded to the earth terminal block in each column.

Single phase cut-outs shall be suitable for terminating cables up to 25mm^2 cross sectional area and three phase cut-outs shall be suitable for terminating the cables specified.

Each cut-out shall be complete with H.R.C. fuse(s) or MCB of the appropriate rating to control the lighting of the column or sign in which the cut-out is fixed, as detailed on the drawings. (Where fuses are used the unit shall incorporate a lockable safety isolator (L.S.I.) as specified.

Where dis-similar metals are in contact the Contractor shall ensure that the whole area of each contact surface is clean and dry and shall then coat with Densal jointing paste or other similar approved paste.

2.11 SOCKET OUTLETS AND FUSED CONNECTION UNITS

2.11.1 Standards

Comply with the following standards:

BS 1363	3 A plugs, socket-outlets, adaptors and connection units. Specification for 13 A switched and unswitched socket-outlets
BS 4662	Boxes for flush mounting of electrical accessories. Requirements, test methods and dimensions
BS 7288	Specification for socket outlets incorporating residual current devices (S.R.C.D.s)
BS 5733	Specification for general requirements for electrical accessories

2.11.2 General

All socket outlets shall except where stated otherwise for special applications, be 13 amp 3-pin switched type to BS 1363 mounted in pressed steel boxes fitted with brass protective conductor terminals. Cover plates shall be as specified and for surface installations the steel boxes shall have an enamel paint finish.

Weatherproof assemblies shall be as specified.

Fused connection units shall be of the same finish and manufacture as the socket outlets and shall be specified in detail elsewhere in this Specification.

All socket outlets, spur units, plugs and lighting switches shall be of the same pattern and manufacture unless otherwise identified.

The Contractor shall show a rate for connection plugs to apparatus supplied by the Client. This rate shall be used in pricing the number of plugs connected.

All socket outlets shall have two earth terminals with protective conductors on a ring circuit connected individually to each terminal. The protective conductor shall be not less than 1.5mm^2.

2.12 SINGLE PHASE AND THREE PHASE EQUIPMENT

2.12.1 General

Plant not associated with lighting and single phase ring main circuits shall be wired as specified and as shown on the drawings.

2.13 EARTHING, BONDING AND PROTECTIVE CONDUCTORS

2.13.1 Standards

Comply with the following standards:

BS 7430 Code of Practice for Earthing

BS 7671 Requirements for electrical installations. IEE Wiring Regulations.

2.13.2 General

Earthing arrangements and protective conductors shall be in accordance with Chapter 54 of the IEE Regulations and the recommendations in BS 7430.

Main equipotential bonding conductors shall connect all incoming metallic piped services to the main earthing terminal except incoming voice or data services.

Main equipotential bonding conductors shall be provided and installed for each installation to connect the following extraneous conductive parts to the main earthing terminal :-

a) Main water pipes.

b) Main gas pipes.

c) Other services pipes and ducting.

d) Risers of central heating and air conditioning systems.

e) Exposed metallic parts of the building structure.

f) Lightning protection system (if installed).

g) Functional earthing (data processing equipment, where applicable).

If there is more than one entry of any of the above services into the building, equipotential bonding shall be provided and installed for each entry. The equipotential bonding connection shall be made as near as practical to the point of entry of those services into the building, provided that where there is an insulating section or insert at the point, the connection shall be made to the metal work on the consumer's side of that section of insert. For a gas service, the bonding connection shall be on the consumer's side of the meter, between the meter outlet union and any branch pipework.

Extraneous conductive parts of all other separate metallic services in the building shall be bonded, including central heating, air conditioning and medical gases, etc. and exposed metallic parts of the building fabric.

All metal sinks shall be bonded locally to the sink, to the earthed electrical system and associated pipework. Cabling to be used shall be 4mm^2, single core, PVC (Cu).

Where necessary, the extraneous conductive parts of exposed metal work shall be connected to circuit protective conductors by local supplementary bonding conductors to maintain an equipotential zone.

At all main switchgear positions, an earth conductor consisting of copper strip (physical size to be in accordance with the IEE Regulations) shall be provided and all equipment, including the metal sheath and armouring of cables, metal cases of all switches, distribution fuse boards and metal frames of switch boards shall be bonded directly to it, using copper strip or cable as appropriate.

All copper strip shall be soft high conductivity copper, untinned except where stated otherwise. The tape shall be fixed by means of purpose made brass or bronze saddles and shall not be drilled for fixings.

Connections to equipment and joints in the tape shall be made by tinning the contact area and clamping, or by drilling the tape, tinning the contact area and bolting with high tensile brass bolts, flat washers, nut and lock nuts. If corrosion is possible, then bronze fittings shall be used.

Where fixed externally, run in ground etc., or where corrosion is likely, the strip shall be PVC sheathed, coloured green and yellow. Where run in earth, the strip shall be laid in sand and protected by cable tiles.

The earth conductor referred to above shall be connected by means of strip or cable to the earth electrode system.

Earthing of sub main distribution equipment shall be made by means of connections to the sub main cable. Where this is lead covered and/or armoured, mineral insulated or conduit, the installation is to be carried out in accordance with the relevant clauses of this Specification. On test, the earth continuity resistance shall not exceed the value specified in the IEE Regulations.

Where the Electricity Supply Authority provides an earth terminal or earth cable sheath, the earth conductor shall, with their permission, be connected and bonded to this point.

Where an earth electrode system is specified, it shall, unless otherwise detailed, comprise solid drawn, high conductivity rods in the arrangement specified and to meet site conditions.

Earth electrode rods shall be of proprietary manufacture, 15mm diameter driven into the ground, to a minimum depth of 2.4m, made up in sections 1.25mm long with internal screw and socket joints and fitted with hardened steel tip and driving cap.

Connection to the rod shall be by means of a purpose made clamp and the actual connection shall be made below ground level in a concrete inspection pit having a removable cover.

The earth resistance of the electrode system shall be tested in accordance with IEE Regulations by the Electrical Contractor in the presence of the Engineer.

A removable test link of equivalent cross-section to the earthing conductor and suitably labelled shall be provided inside the building as near as possible to the earth electrode for isolation of this electrode for test purposes.

Where the system of earthing provided is that known as "protective multiple earthing" (PME), bonding of mechanical services shall be as detailed in accordance with the Supply Authority's requirements.

In existing buildings, the requirements for bonding mechanical services pipework shall be as detailed in this Specification. When altering or extending existing installations, the Electrical Contractor shall ensure that any existing earth system to which he wishes to connect complies with the IEE Regulations.

If it is found that the system does not comply, the Electrical Contractor shall inform the Engineer immediately.

All earthing and bonding connections shall be labelled in accordance with IEE Regulations clause 514.13.

Unless detailed otherwise, all circuits shall be provided with separate circuit protective conductors of PVC (Cu) cable of cross sectional area sized in accordance with Table 54.7 of the IEE Regulations. The only exception is mineral insulated cables of 10mm5 conductors or larger, where the sheath is acceptable.

Where a low voltage switchboard is constructed using "loose gear", a main earth bar shall be installed at the supply intake position adjacent the switchboard.

The earth bar shall be of high conductivity hard drawn copper bar of cross sectional area determined by the maximum prospective earth fault current of the incoming supply.

The length of the earth bar shall allow for terminating :-

a) The earthing conductor from the Supply Authority earthing terminal.

b) The circuit protective conductors (CPC's) for each of the incoming or outgoing supplies from the switchboard.

c) The "clean" or "dedicated" earth CPC's, where applicable.

d) The equipotential bonding conductors.

e) With a spare capacity of 25% for future use.

The earth bar terminations shall consist of suitably drilled and tapped holes to accept brass set screws complete with one brass full nut, one brass half nut and two flat washers.

Each protective conductor connected to the main earth bar shall terminate in a suitably sized copper crimp type lug.

The earth bar shall be model No 1000MEB as manufactured by EATON MEM Limited, or other similar approved equivalent.

Where a cubicle type low voltage switchboard is specified, full earth bonding shall be required and an earth bar termination of suitable size provided adjacent each set of air circuit breaker or fuse switch cable connections. In addition, at the incoming supply cable position, the earth bar shall be provided with ten earth terminations of M10 size for the earthing conductor, equipotential bonding conductors and "clean" or "dedicated" earth protective conductors.

2.14 FIRE ALARM SYSTEMS

2.14.1 Standards

Comply with the following standards:

BS 5839 Fire detection and alarm systems in buildings.

BS EN 54 Fire detection and fire alarm systems.

BS EN 60702 Mineral insulated cables and their terminations with a rated voltage not exceeding 750V

The requirements for the type of system to be installed are given in the Specification Schedules and/or on the Tender Drawings.

2.14.2 Programmable, Automatic Systems

The proposed designations and uses of rooms, fire zones etc are given on the Tender Drawings. Use these designations as text references for Room Names, Zones References and Area Characteristics etc unless instructed otherwise

Allow for all re-programming and other measures necessary to update initial text references to those which match the designations of rooms, zones etc immediately prior to practical completion. Obtain these references from the Engineer.

Employ the equipment manufacturer (or an approved representative) to test and commission the completed installation in accordance with the British Standard Specification. Forward three copies of the manufacturer's test and commissioning certificate to the Engineer on completion of the commissioning and include a copy in the 'As Installed' documentation.

2.14.3 Installation

Install, test and commission the complete system in accordance with the recommendations of the manufacturer.

All fire alarm cables shall be multi-core MI/LSF (red), or as detailed in the particular section of this specification. The number of cores and csa to be as recommended by the manufacturer of the fire alarm system unless noted otherwise. The cables shall be concealed within the building structure, ceiling voids etc unless noted otherwise. Cable joints will not be permitted.

Where cables are installed surface or clipped direct to building structure they shall be fixed using LSF (red) sleeved 'P' clips with brass round head screws (for single runs) or using LSF coated metal all round band (for multiple runs).

Within ceiling voids fire alarm cables shall be clipped to a new cable tray installation on a dedicated cable tray which shall be used solely for the purpose of fire alarm cabling. All containment systems shall be mounted on the horizontal plane and shall not be inverted.

Surface mounted detectors and detectors mounted on the soffit in ceiling voids shall be fixed directly to a BS conduit box of through or end pattern as appropriate.

Fix detectors mounted on suspended ceilings to a BS back entry loop-in conduit box mounted with its underside flush with the ceiling and supported from the slab soffit by means of a conduit drop suspension or supported from a plywood backboard fitted directly behind the suspended ceiling. Terminate the MICS cable into the rear of the conduit box.

Remote indicators or light emitting diodes (associated with detectors above suspended ceilings) shall be mounted on the underside of the suspended ceiling directly below the detector in the void. Mount and support the units in the same manner as the ceiling mounted detectors, and wire from the detector to the indicator using MICS cable as recommended by the manufacturer

Where required by the manufacturer, install end of line diodes or resistors within the end of line equipment or within a BS conduit box adjacent to the end of line equipment. Label the conduit box or equipment "End of Line".

2.14.4 Demonstration of system

The Contractor shall allow for a full and complete demonstration of the operation of the fire detection and alarm system to the Client's representatives on completion of the works and prior to handover.

2.14.5 Audibility Tests

Audibility tests shall be undertaken for all areas included in the project, which shall be clearly marked onto a record drawing to show the audibility levels recorded. Systems which include voice alarm messages shall undergo formal speech intelligibility tests and the results shall be recorded. Any variations from British Standard 5839 shall be brought to the attention of the Engineer in writing.

2.14.6 Record Information and Log Book

Within or adjacent to the main control equipment provide 1 No. copy of the operating instructions for the fire alarm system.

In addition to the “as installed” drawings as detailed in Section 2 and 3 of this specification the Contractor shall also provide a schematic drawing of the fire alarm system. The schematic shall detail the detection and alarm devices (including addresses), interfacing arrangements, interfacing positions, plant shutdowns, zones, power supply units and remote monitoring. This drawing shall be included in the Operating and Maintenance documentation and provided in a glazed frame on A3 format adjacent the Fire Alarm Panel.

The contractor shall also provide fire alarm layout drawings indicating all sounders, devices, zones etc, including fire alarm addresses and cable routes.

Supply a log book for the system in compliance with the requirements of the British Standard Specification.

2.14.7 Maintenance

The Contractor shall allow within his tender for 12 months servicing and maintenance of the whole of the fire alarm system (in accordance with the recommendations in BS 5839) by the fire alarm system manufacturer.

2.15 LIGHTNING PROTECTION

2.15.1 Standards

Comply with the following standards:

BS EN 62305	Protection against lightning
BS EN 13601	Copper and copper alloys. Copper rod, bar and wire for general electrical purposes.
BS EN 50164	Lightning protection components (LPC) Requirements for component fasteners.
BS2898	Specification for wrought aluminium and aluminium alloys for electrical purposes.
BS EN 61643-11	Low-voltage surge protective devices

2.15.2 General

The requirements for the lightning protection system are given in the Specification Schedules and/or on the Tender Drawings.

2.15.3 Installation

Install earth rods where indicated upon the drawings.

Earth rods shall be copper bonded steel type comprising a high carbon steel core with 99.9% pure copper layer greater than 0.25mm thick. The copper layer shall be molecularly bonded to the steel. Coupling threads shall maintain at least 0.05mm copper thickness in the roots. Rods shall be made up of lengths and couplings shall be silicon aluminium bronze of sufficient length counterbored to shield all threads on the rods. Rods shall be provided with high tensile cap-head Allen screw driving studs.

Earth rods shall be driven into the ground by means of manual or power hammers.

Earth rods shall be connected to the earthing cable/tape below ground level by means of approved connector type pressure clamps of a size suitable for the rod and cable/tape sizes specified. Clamps shall be manufactured from cast silicon, aluminium bronze or leaded gunmetal and fitted with phosphor bronze screws.

Ensure connection clamps are accessible for inspection and protected against mechanical damage and corrosion by means of being wrapped in Denso tape.

Where the connection is made to the earth rod provide an indelible label with the works "Safety Electrical Connection - Do Not Remove" in accordance with the IEE Wiring Regulations.

Provide 300mm x 300mm concrete block electrode inspection pits with removable lids, as Furse Ltd. ref. PT005 or other equal and approved, immediately above each earth rod.

Agree the precise position of the earth rods on site with the Engineer prior to installation.

Use 25mm x 3mm high conductivity copper earth tapes.

Provide PVC sheaths for earth tapes buried underground.

Use bare earth tapes above ground level unless specifically indicated otherwise elsewhere. Where PVC sheathed tapes are specified agree the colour of the sheath with the Engineer prior to ordering.

Use electrical interconnections manufactured from copper or phosphor bronze.

Use bimetallic connectors for jointing aluminium protection systems to copper protection systems.

Ensure that joints between dissimilar metal conductive parts of a protection system are made with the appropriate accessories.

Fix earth tapes run on membrane or felted roofs by means of strips of membrane laid over the tape and solvent welded to the roof membrane.

Fix earth tapes run on decking roofs to the external roof and roof parapet by means of phosphor bronze saddles fixed by screws to the roof decking and parapets.

Ensure all holes drilled through the cappings or claddings or metal decking are sealed with mastic and weatherproofed after completion of the work.

Fix earth tapes run on slated roofs by means of proprietary slate fixing holdfast saddles.

Fix earth tape down conductors to the walls or columns using phosphor bronze saddles fixed by screw fixings.

Fix long vertical or horizontal tapes to permit latitude for expansion and contraction of the conductor under extreme weather conditions, do not impose undue stress on fixings in these circumstances.

Fix tape clips not less frequently than the undernoted:

a) Vertical tapes - from ground to 20m – 1.0m spacing
above 20m – 0.5m spacing

b) Horizontal tapes - on horizontal surfaces – 1.0m spacing
on vertical surfaces – 0.5m spacing

Make joints and terminations using manufactured junction clamps and bonding units of Furse & Co. Ltd., manufacture (or equivalent). Keep the number of joints to a minimum.

Ensure all metallic projections above the roof level such as masts, ducts, handrails, pipes, chimneys etc. are connected to the air termination network.

Fit each down conductor with an oblong or plate type test clamp in an accessible position not more than 1800mm above finished ground level. Run the tape from the test clamp to the associated earth rod in a single unbroken length.

Test the complete system in the presence of the Engineer.

Protection devices which are designed to protect connected electronic equipment from transient overvoltages on the mains supply shall be compliant with BS EN 62305.

Protection devices which are designed to protect data communication and signal lines from transient overvoltages shall be compliant with BS EN 61643-11.

3.0 SCOPE OF CONTRACT

INDEX

3.1 SCOPE OF CONTRACT

3.1.1 General Information

Throughout this specification, the word ‘Contractor' shall read as meaning the electrical engineering services contractor.

This technical specification, the Appendices and the accompanying schematic design drawings defines the electrical engineering services performance requirements and provides technical descriptions for the proposed Fibre Integrated Receiving System (FIRS) installation.

All Client requirements are not covered within this documentation, and it is incumbent upon the Contractor to develop this documentation such that it addresses all aspects of the project and accords with all Client requirements including compliance with current and forthcoming design requirements and British Standards, agreement of strategies and solutions, compliance with planning and legislative requirements and any health, safety, and welfare issues.

Interfaces with RBKC and its representatives (including planning, technical standards department and HSE), statutory authorities and specialist utility providers shall be established by the Design and Build Contractor.

The electrical engineering services contract works include the design, specification, supply, delivery to site, off-loading, positioning, installations, and commissioning of all items of plant, equipment and materials including all skilled and unskilled labour and all sundry items necessarily required to complete the works in accordance with this specification and the drawings.

All materials shall be procured, and the works shall be executed in good time in order to meet the Main Contractor’s master programme and the completed installations, together with all hand-over documentation, shall be completed and ready at practical completion of the contract. Throughout this specification, the word ‘Contractor' shall read as meaning electrical engineering services Contractor.

The contract works comprise the following:

- Development of the scope as part of the design and build contract.
- Works within the building and externally in the local vicinity.
- Detailed design and specification of all parts of the installations, performing detailed coordination with all other design disciplines.
- Attendance works, programming and procurement associated with incoming services.
- Fibre Integrated Receiving System.
- Earthing and bonding.
- Inspection, testing and commissioning.
- ‘As Installed’ drawings and maintenance manuals.
- Building Logbook
- Routine maintenance of the installation for twelve months from practical completion.

Please note that the above list is *not* exhaustive.

In addition to the above, the contractor shall carry out a desktop study to research the history of the site, identify any legal constraints, listed buildings, protected trees, above and below ground services, local planning policy requirements, etc. and ensure that plant and equipment (for example: meter boxes, pipes, cables, electronic communications antenna and air conditioning units) are not placed on important elevations - where possible it should be fully

integrated into the building or located in visually inconspicuous locations within effective and robust screened enclosures.

The electrical services sub-contractor must be a registered NICEIC Contractor/business.

The Contractor shall employ specialist designers and trade Contractors as required, with demonstrable experience in undertaking the class of work involved, to undertake the design, installation and commissioning activities detailed in this specification.

A suitably qualified and experienced building services design engineer/design consultant shall be employed to undertake and complete the electrical engineering services design, including the production of design drawings, calculations, and equipment schedules.

Final designs shall be thoroughly checked and signed-off by a chartered engineer employed by the nominated designer/design organisation.

The chosen electrical services designer/design organisation shall be identified at time of tender.

This specification shall be read in conjunction with the accompanying electrical engineering services drawings and with the specifications and drawings relating to all other building and engineering disciplines including Architect's information.

3.1.2 Development Descriptions

3.1.2.1 General

TGA|CE have been appointed by the Royal Borough of Kensington and Chelsea to work with the Lancaster West Estates Team to upgrade the IRS (Integrated Reception Systems), door entry/access control, & CCTV across the Lancaster West Estate (LWE) in conjunction with other professionals providing architectural, mechanical, electrical, and public health engineering services.

The works have been split up into a series of lots, as listed below, which include one or more residential buildings/complexes on the estate.

Lot 1 – Hurstway Walk, Testerton Walk, Barandon Walk

Lot 2 – Clarendon Walk, Camelford Court, Camelford Walk, Talbot Walk

Lot 3 – Morland House, Talbot Grove House

Lot 4 – Treadgold House

Lot 5 – Camborne Mews

Lot 6 – Verity Close

The following specification covers the performance requirements for the Fibre Integrated Receiving (FIRS) system design and installation which can be applied to some or all of the above developments.

3.2 CONTRACTORS OBLIGATIONS

3.2.1 General

The Contractor shall include for the full design and installations of all works required to provide a full and complete working installations, in accordance with the true intent of the Employer's Requirements specification.

The Contractor shall include for any works detailed in this specification but not shown on the drawings, or vice versa, plus any works not specifically detailed which are required to provide complete installations.

The Contractor shall note that the information contained in this document and on any associated indicative drawings is outlined to RIBA Stage 4a and is intended to provide the Contractor with the design intent only, to allow them to develop the design during the detailed design stages to meet the Design Standards. The Contractor shall make allowance for this and include in their tender for the same.

In certain instances, reference may be made to quotations for equipment or services. The quotations are for general technical guidance only and the Contractor is required to inform manufacturers of the exact requirements of the specification when formulating their tender and when ordering.

3.2.2 Co-ordination

At the design stage and prior to the installation of any equipment the Contractor shall agree with the other trades, the location of equipment, routes for cabling, trunking, ductwork, pipework etc., in order to avoid friction between the trades.

3.2.3 Duplication of Specification Clauses

The specific technical details contained within Sections 3 and 4 of this specification shall take precedence over the general technical clauses of section 2 of this specification.

Reference shall be made to Section 2 for details of any item of plant, equipment or ancillary components not specifically identified in Sections 3 or 4.

3.2.4 Site Visit

The Contractor shall be deemed to have visited the site during the tender period, acquainting themselves fully with local conditions and obtained all information required to accurately formulate their tender.

Any apparent discrepancies or queries shall be referred to the Employer's Agent for clarification prior to submission of tender.

Claims for lack of knowledge shall not be considered.

The Contractor shall contact a Client representative to arrange to visit the site.

3.2.5 Programme

The contract programme shall be notified by the Main Contractor and in accordance with the Main Contractor's sequence of works.

The Contractor shall liaise with the Main Contractor and Architect before carrying out any work.

The Contractor shall note that any of the aforementioned works may have to be carried out outside normal working hours, and therefore the associated cost for overtime or premium time working shall be included in their tender.

3.2.6 Construction (Design and Management) Regulations 2015

The Contractor shall note that this project shall be carried out in accordance with the Health & Safety Executive's Construction (Design and Management) Regulations 2015.

The Contractor shall include in their tender for complying with the CDM Regulations 2015 in full, and as detailed in the information provided by the Principal Designer and Principal Contractor.

Any clarification in this respect shall be obtained from the prospective Main Contract tenderers.

3.2.7 Installation/Design Requirements

All services shall be designed and installed to achieve reliability and disruption-free operations. All components shall be fully accessible for maintenance and replacement. Items requiring regular adjustment or affording isolation facilities, where located in concealed positions, shall have removable access covers, tiles, or other suitable provision made to afford ease of access.

The Contractor shall satisfy themselves that all plant spaces are adequate to house all items of plant as described.

All services shall be designed with all aspects of Health & Safety at Work fully considered.

All systems shall be designed to be economical in operation, and particular emphasis shall be placed on the use of energy conserving design techniques and reliable components.

When preparing design drawings, the Contractor shall have due regard for all aspects of the building design, location of all services and shall make themselves aware of any co-ordination issues which need to be resolved before the installation commences.

The Contractor shall retain on site a full set of up-to-date drawings, marked up showing current progress (including any agreed amendments), and these shall be available for inspection at all times.

All dimensions given on drawings shall be verified by the Contractor on site before the installation commences.

The Contractor shall comply fully with Section 2 (Inspection and Testing) of this specification.

3.2.8 Equipment Specifications

The Contractor shall Design/select plant and equipment to achieve the best 'life' cycles. The annual operation of the building shall be taken into consideration when selecting plant equipment/systems.

All systems shall be designed to operate at maximum efficiencies throughout the full life cycle of the plant/equipment. The Contractor shall select equipment to maximise the overall system efficiency. Plant/equipment shall be selected at or near the maximum efficiency of the component taking into consideration any future growth requirements.

The Contractor shall define the optimum 'life cycle' of all equipment and its effect on the overall system, and the associated maintenance requirements to achieve the overall life cycle.

The Contractor shall ensure all equipment/system selections have proven reliability in use with minimum failure statistics.

The Contractor shall note that where specific reference to equipment specifications are made, these are deemed to be 'or equal and approved' and is therefore not precluded from using alternative equipment, however, it is incumbent upon the Contractor to demonstrate that their proposed alternatives are identical in all respects, including standards of construction and workmanship, technical performance, visual appearance, dimension and manufacturer's warranty.

Any alternative must be approved by the Client, Architect and Consulting Engineer prior to ordering and the Contractor is responsible for ensuring that all reasonable opportunity is afforded to the Design Team to inspect and approve such equipment.

The Employer's Agent reserves the right to reject any equipment that is deemed to be unsatisfactory, and no consideration shall be given to any claim for alleged delay caused by such rejection or failure by the Contractor to provide adequate information.

All manufactured equipment, products and materials incorporated into the contract works shall comply with the Construction Products Regulations 2013 and be 'CE' marked.

3.2.9 Builders Work

Builders work in connection (BWIC) with the electrical engineering installations shall be executed by the Main Contractor.

BWIC comprises those elements of building work necessary to incorporate the mechanical and electrical engineering services installations into the building, structure, fabric, and finishes, including the cutting of mortises, chases, notches and holes, forming openings and building in pipe and duct sleeves, casing pits and provision of supports/noggins/pattresses/clips in walls and ceilings. The Contractor shall allow for all necessary provisions

The Contractor shall be responsible for producing detailed builders work drawings and for marking-out work onsite, as required.

All making good, painting and decorating shall be carried out by the Main Contractor.

3.3 DESIGN, INSTALLATION AND DOCUMENTATION REQUIREMENTS

3.3.1 Standards, Guides and Codes of Practice

The installation shall be designed, installed, and commissioned in accordance with good, current practice. The installation shall comply with all statutory instruments and regulations, relating to the area of the sites current at the date of tender.

The Contractor shall supply plant and equipment to achieve the specified design conditions and to provide stable control.

Provide all materials and works in accordance with the appropriate British Standard or Code of Practice. Where no British Standard or Code of Practice is applicable an Agreement Certificate for the particular item is required.

The installation shall comply with the requirements of the Local Authority Building Inspector.

Comply with all Statutory Obligations arising from the current legislations and regulations, together with other requirements, including, but not limited to, the following: -

a) All relevant byelaws, regulations, and statutory instrument.

b) All relevant BS, EN & ISO Standards.

c) All relevant BSRIA Technical Memoranda and Application Guides.

d) All relevant CIBSE Guides.

e) All relevant IET Guides.

f) Health and Safety at Work Act 1974 and all current amendments.

g) The Working Time Regulations 1998.

h) The Construction (Design and Management) Regulations 2015.

i) Health and Safety Executive Approved Codes of Practice.

j) Current Edition of the Building Regulations and all amendments.

k) Electricity at Work Regulations 1989.

l) Electrical Supply Regulations 1988 and all current amendments.

m) Electricity, Safety, Quality and Continuity Regulations 2002.

n) Construction Products Regulations 2013

o) Current RBKC Technical & Design Standards.

p) All prior material supporting the planning application and planning policy requirements (national and local) and specific conditions set.

q) Secured by Design Homes.

r) Insurance Company Requirements.

s) NICEIC Standards.

t) Any other standard, technical or manufacturer's installation guidance not mentioned above, but relevant to the installation.

The Contractor shall notify all authorities in accordance with their regulations and obtain any required approvals for the installation.

Where no specific design, performance or installation standards are quoted the following shall apply: -

- CIBSE Guides
- CIBSE Technical Memoranda

The Contractor shall ensure all equipment and systems are designed and installed in accordance with the relevant standards and that operational compatibility exists between the systems and any other system installed at the same location.

NB: The development shall be designed to meet the carbon reduction targets set out in the Energy and Sustainability statements submitted as part of the planning submission.

3.3.2 Test Certificates

Where testing specific to the project is required, ensure test certificates include: -

- Project title
- Description and details of test
- Date of test
- Test instruments used, serial numbers, calibration dates
- Signature of those witnessing test
- Contractor's name
- Specific location of the item in the Works.

3.3.3 Testing and Commissioning of Services

The Contractor shall appoint a 'Commissioning Engineer' to manage and supervise the whole of the setting to work, commissioning and final acceptance testing activities and shall deliver 'user' training to the Employers Staff prior to practical completion.

Agree a programme for pre-commissioning checks, setting to work, commissioning and final performance testing, and allow for all costs incurred. Provide all specialised personnel (including manufacturer's representatives) and co-ordinate their activities.

Where required, provide formal method statements supported by risk assessments detailing all commissioning procedures.

Give notice to and state any requirements for the attendance and co-operation of all other relevant parties. The period of notice shall be not less than ten working days.

Provide all necessary facilities to enable tests to be witnessed and inspections carried out either on site or at a manufacturer's works.

The Contractor shall ensure that installations have been proven to operate in accordance with the design intent prior to offering same for witnessing by the Employer's Agent. The Employer's Agent shall only witness test proceedings, confirm recorded results and determine if the specific requirements have been satisfied.

If, following test or inspection, any plant or part thereof is shown to be defective or not conforming to the specification the Employer's Agent shall reject such defective parts, stating in writing, the grounds upon which such rejection has been made.

Test all equipment, material, and systems in accordance with manufacturer's instructions, commissioning codes, best practice and where appropriate as detailed in Employer's Requirements. If an inspection or test fails, repeat the procedure, until satisfactory results are obtained.

- Complete all tests before any paint, cladding or similar materials are applied or before services are concealed.
- Ensure all requirements such as cleanliness, protection from harmful external and internal elements etc. are provided prior to commencement of commissioning.
- Following satisfactory completion of testing and when the installations are in a safe and satisfactory condition, set to work, regulate, and adjust, as necessary, to meet the specified design requirements.
- Provide all necessary instruments and recorders to monitor systems during commissioning and performance testing.
- Provide test equipment subject to a quality assurance procedure complying with BS EN ISO 10012.
- Do not start programme testing, including demonstration, system proving or environmental and capacity testing, until commissioning of the system is completed to the satisfaction of the Employer's Agent.

Maintain on site full records of all commissioning and performance testing that shall be cross referenced to system components and, on completion of the works, include a copy in each Operating and Maintenance Manual.

Provide all certification documents for approval by the Employer's Agent before any system is offered for final acceptance.

Gas, fuel, oil, electricity, and water required for testing and commissioning shall be provided by the Contractor and all costs and charges shall be included in their tender.

3.3.4 Operation of Systems Before the Production of Drawings and/or Operating and Maintenance Manuals

Provide attendance, at no expense to the Employer, to put into service, operate 24 hours a day and maintain the systems to the Employer's requirements, including the provision of suitable competent labour, in the event that the Record Drawings and/or Maintenance Manuals are not available when the works would, in the opinion of the Employer's Agent, otherwise qualify for Practical Completion.

In the event of the Contractor failing to provide this service satisfactorily the Employer shall be entitled to make his own arrangements and recover the full cost through the contract.

3.3.5 Supervision

In addition to the constant management and supervision of the works provided by the Contractor's person in charge, all significant types of work must be under the close control of competent trade supervisors to ensure maintenance of satisfactory quality and progress.

The Contractor shall give reasonable and maximum notice prior to changing trade supervisors to the person in charge or site agent.

3.3.6 Co-ordination of Engineering Services

The site organisation staff must include one or more persons with appropriate knowledge and experience of mechanical and electrical engineering services to ensure compatibility between engineering services and the works generally.

Submit to the PM when requested CV's or other documentary evidence relating to the staff concerned.

3.3.7 Access for Inspection

Before removing scaffolding or other access facilities, the Contractor shall give notice of not less than 7 days.

3.3.8 Defects in completed work

When defective completed work is discovered, immediately give notice. Do not proceed with affected related work until response has been received.

Documented remedial work: Do not execute work which may:

- Hinder access to defective products or work; or
- Be rendered abortive by remedial work.

3.3.9 Making Good Defects

Wherever inspection or testing identifies that the work, materials, or goods are not in accordance with the contract and measures are required to establish the precise status of the item (e.g., testing, opening up, experimental making good) all such activities shall be at the Contractor's expense and shall not be considered as grounds for an extension of time under the contract.

When a defect is reported the Contractor shall arrange a suitable date and time to carry out remedial works with the Employers Agent / Client or Client's Appointed Representative. The Contractor shall include for notifying the same party when the remedial works have been completed.

Make good all damage consequent upon the work.

Remove temporary markings, coverings and protective wrappings unless otherwise instructed.

Clean the works thoroughly inside and out, including all accessible ducts and voids. Remove all deposits, rubbish, and surplus materials.

Adjust, ease, and lubricate as necessary moving parts of new work to ensure easy and efficient operation of appliances, valves, and controls.

3.3.10 Security at Completion

Ensure that the installation is secure with, where appropriate, all accesses locked.

3.3.11 Equipment Warranties

The Contractor shall ensure that the completed installations shall be warranted and maintained for twelve months following practical completion of the main contract. The Contractor shall ensure that individual manufacturer's warranties are extended accordingly.

Materials, equipment, and products which include longer warranties shall be re-assigned to the Employer. The contactor shall provide a schedule of all such items which include longer warranties.

Installations shall include features, fittings, and appliance such that manufacturers' warranties are not invalidated.

3.3.12 Plant Maintenance

After completion of the works and acceptance of the installation by the Employer's Agent, the Contractor shall be responsible for the maintenance of all items of equipment and systems outlined in the specification in accordance with the manufacturer's recommendations, inclusive of the provision of all consumable items, for the duration of the twenty-four months' defects liability period.

3.4 INFORMATION TO BE PROVIDED BY THE CONTRACTOR

3.4.1 General

The Contractor shall provide during the course of the contract, technical submissions for review by the Employer's Agent.

Technical submissions shall include design drawings, detailed calculations, and equipment schedules; installations, co-ordination and shop drawings and technical particulars supplied by equipment vendors.

Technical submissions shall be provided in good time, with information release dates clearly scheduled in accordance with the master programme and agreed procurement schedules, in order to allow the Employer's Agent sufficient time to review and provide comment.

When directed by the Employer's Agent, the Contractor shall re-submit a technical submission that is deemed to be unacceptable.

Adequate time shall be allowed for the normal and proper processing of each technical submission by the Employer's Agent. All costs associated with providing information and for reworking and resubmission shall be borne by the Contractor.

3.4.2 Design Calculations

The Contractor shall produce a full and verified set of design calculations and submit to the Employer's Agent for review.

Design calculations shall be carried out using appropriate industry standard software packages and shall be submitted in a methodically organised calculations file.

3.4.3 Design Information Provided

Information to be included as a minimum requirement are: -

a) Wiring diagrams for all plant and equipment requiring electrical connections.

Where manufacturer's original data sheets are used, they shall be specific to the relevant plant and all references to optional features, other machines of a range etc., shall be deleted. All wiring diagrams shall clearly indicate the wiring which forms part of or is connected to the equipment as delivered.

b) Detailed installation room data sheets of all plant and equipment.

c) Installation room data sheets showing the general distribution of services from the main service intake up to and including the point of final connection at a scale of not less than 1:50.

d) Any detailed room data sheets, or manufacturers room data sheets required prior to, or found necessary during erection, manufacture and progress of the works.

e) Detailed room data sheets of all fabricated items.

f) Circuit schedules for all sub circuits and final circuits.

g) Detailed plans, sections and elevations showing all required builders work, including the size and position of all bases, plinths, holding down bolts, holes, chases, trenches, etc., in the structure or building fabric related where applicable to the column/building grid lines, steelwork to be built in or attached to the structure.

h) Diagrammatic, schematic and wiring diagrams of all automatic control systems, including arrangements and description of operation of the automatic control installation.

i) Manufacturers data/room data sheets of all equipment, assemblies, components, and installation clearly indicating operating characteristics of the equipment.

j) A detailed specification indicating the full extent of all services, together with schedules of the precise components, equipment, and manufacturers which the design is based upon.

k) Equipment schedules detailing the output, rating, capacity, manufacturer, type and model number of all plant and equipment e.g., main switchboard, distribution boards, isolators, accessories, and the like.

l) A Summary of Tender sectionalised to correspond with the specification identifying the installed cost of all items of plant and equipment.

m) All design calculations. Detailed calculations shall be carried out using an appropriate software package such as Amtech or other approved software and shall be submitted incorporating but not limited to the following:

i) Maximum demand calculations

ii) Connected load calculations

iii) Cable calculations (including all circuit calculations, diversities applied, disconnection times etc.)

iv) Lighting calculations

v) Emergency lighting calculations

vi) Fire alarm system audibility calculations

vii) Compliance with latest requirements of Building Regulations Part L1.

3.4.4 Documentation & Drawings

Prior to commencing works on site, the contractor shall prepare and submit to the Employers' Agent, detailed design, installation, shop and working drawings, which accurately define the mechanical engineering services design.

Drawings shall include plans, sections, and elevations, wiring diagrams, schematic diagrams, and details to show the proposed installations, accurately reflecting the design specification.

All drawings shall be comprehensively detailed in accordance, as a minimum to BSRIA BG6, giving dimensions, tolerances, finishes, fixings, builders work, materials, etc. Documents, drawings, and equipment details to be included as a minimum requirement are:

- Detailed design drawings showing the general distribution of services from the main service intake up to and including the point of final connection at a scale of not less than 1:50.
- Any detailed drawings, or manufacturers drawings required prior to, or found necessary during erection, manufacture, and progress of the works.
- Detailed drawings of all fabricated items.
- Detailed plans, sections and elevations showing all required builders work, including the size and position of all bases, plinths, holding down bolts, holes, chases, trenches etc., in the structure or building fabric related where applicable to the column/building grid lines, steelwork to be built in or attached to the structure.

- Diagrammatic, schematic and wiring diagrams of all automatic control systems, including arrangements and description of operation of the automatic control installation.
- A detailed specification, indicating the full extent of all services, together with the precise components, equipment, and manufacturers which the design is based upon.
- Equipment schedules detailing the output, rating, capacity, manufacturer, type and model number of all plant and equipment.
- Detailed shop drawings for all plant and equipment.
- A Summary of Tender sectionalised to correspond with the specification identifying the installed cost of all items of plant and equipment.
- Coordinated reflected ceiling plans showing the accurate locations of all electrical and mechanical outlets.

The Contractor shall provide 2No. copies of the above information.

The Contractor shall complete the Summary of Tender enclosed with this specification and return it with their tender submission.

All information is subject to the approval of the Employer's Agent.

4.0 EMPLOYER'S REQUIREMENTS

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4.1 TYPE OF INSTALLATION

4.1.1 General

The electrical installation shall generally be integrated into the building structure and fabric and within roof and floor voids, service risers, toilet pods, entrance lobby etc. as applicable. The Contractor shall agree all routes and coordinate the new services with the building's structures, building fabric and finishes and in accordance with listed approval requirements, limitations, and stipulations etc.

All new cables shall comply with the new European Harmonisation of Cable Colour Sections of BS 7671 2018.

This shall include the identification of phase conductors as L1, L2, and L3, and neutral conductors as N.

4.1.2 Wiring Systems

The following method of wiring shall be employed:

- **Sub-mains** - Multicore XLPE/SWA/LSF insulated armoured cabling on dedicated medium duty returned flange galvanised steel cable tray concealed within ceiling / floor voids and risers.
- **Lighting & Power Communal / Landlord** – Single Core LSZH cables within HG steel conduits shall run within trunking in suspended ceiling voids and the vertical risers. Conduits shall be chased into the walls and concealed throughout, except in the following locations where conduits shall be run on the surface:
    - Intake cupboards
    - Risers
    - Plant rooms
    - Refuse stores

  All conduits shall be fully rewire-able with adequate draw-in boxes installed at accessible ceiling void positions.
- **Lighting & Power Domestic** - Twin and Earth PVC/LSF cables within suspended ceiling voids, studwork walls, plastered walls, etc., are to be protected by capping and conduit as appropriate.

  All conduits shall be installed in a neat and orderly manner and shall be fully re-wire able throughout.

  For the wiring system to extract fans and lighting switches with neon indicators, attention is drawn to the requirements for two poles switching and for a neutral connection to the neon indicator.

  The installations within all areas shall be completely flush with flush mounting accessories used throughout.

  A single power circuit should not cover more than 100m" and lighting not more than 60m². Minimum cable sizes to suit relevant and latest regulations.

  All switches and sockets shall be mounted on metal boxes.
- **External lighting** - Where external lighting is located remotely to the building, cabling shall be XLPE/SWA/LSF type run in suitably sized cable duct, buried in ground with installation methods meeting that required by NJUGS.

- **Emergency Lighting** – As per relevant lighting cabling.
- **Fire Alarms -** Multicore FP Plus Enhanced cable type, with red sheath, run in galvanised steel cable tray located in risers and ceiling voids. Single cable runs can be fixed direct to the building fabric.

  Cable fixings shall be provided via LSF (red) proprietary fire rated fixings in accordance with BS 5839: Part 1 2017, providing the same fire rating as the cable itself.

  Field cabling for fire alarms shall not be run with other services. Cable clips shall be proprietary type and compliant with BS5839-1-2017. Standard tie-wraps are not permitted.
- **Life Safety Submains -** Multicore FP600 Enhanced insulated armoured cabling on dedicated medium duty returned flange galvanised steel cable tray concealed within ceiling / floor voids and risers.
- **Structured -** Multi-pair CAT 6A, run in galvanised steel cable tray located in risers and ceiling voids. Where cables rise / drop to serve accessories or in any plant space, these shall be run in suitably sized galvanised steel conduit. No more than 2 No. CAT 6 cables shall be run in any conduit.
- **CCTV –** As per structured cabling wiring
- **Intruder / Security -** System wiring to be routed within floor, ceiling, roof voids and service risers. Cable types as designated by system specialist.
- **Electrical Services Associated with Mechanical Services Installation -** As appropriate for types of cables specified. with Mechanical Services Installation

The segregation of electrical services as detailed in BS7671 shall be maintained at all times.

Structured cabling and life safety cabling, including fire alarm cables shall not be run through common holes / compartments or containment. Failure to meet these segregation requirements will require cables to be removed and reinstalled correctly at the Contractors cost.

4.1.3 Approved Specialist Sub Contractors / Manufacturers

The manufacturers included in this specification detail the approved manufacturers / installation contractors for this project. The tender shall be fully compliant with these manufacturers/ installation contractors or equal and approved, submitted for final approval by the design team.

All suppliers / manufacturers named in the following document are for specification purposes and deemed to equal and approved status, please refer to the main contractor's invitation to tender document for additional instructions.

Should the tendering Contractor wish to use any alternatives, details shall be submitted at tender stage, along with any programme or financial incentives to the client. Once tenders have been let, no alternatives will be permitted.

The Contractor shall liaise with their selected specialist sub-contractors throughout the design and installation process, ensuring that the client's requirements are met in full. In addition, the electrical contractor shall provide and install all power supplies and containment as necessary for these systems.

Orders for all sub-contractors and manufacturers shall be placed to allow sufficient time for lead in times, including any holiday periods, to allow materials and labour to arrive on site in accordance with the main contract programme. The Engineer and Client reserve the right to inspect any orders for materials or labour in the event of any delays on site.

The Main Contractor shall ultimately be responsible for the overall timely completion of the project, with the expectation that progress meetings between the various trades be held at least monthly, with minutes being forwarded to all parties within two weeks of each meeting.

4.1.4 Summary of Tender

The Contractor must complete the individual items of works detailed in the schedule of works in Section 5 of this Specification and in the Summary of Tender for each individual area at the time of tender. Failure to do so may invalidate the tender submission.

4.1.5 Deleterious Materials

The use of the following materials or components is not acceptable on this project:

- Asbestos containing materials or asbestos based products.
- Urea formaldehyde foam.
- Silicone bricks or tiles.
- Re-wire able fuses.
- Halon / C.F.Cs
- Any other material generally known or thought to be deleterious to health or in contravention of any relevant British or European Standard Specification, Code of Practice or EEC Legislation.

4.2 FIBRE INTEGRATED RECEPTION SYSTEM (FIRS)

4.2.1 General

The Contractor shall design, supply, and install a complete Fibre Integrated Reception System (IRS) in accordance with the Employer's Requirements.

The distribution equipment shall be located in a secure accessible position at the top of the riser or on the roof within a weatherproof enclosure. Distribution cabling from this equipment shall be installed via the dedicated service risers and communal areas, to the utility cupboard in each apartment and to all outlet positions within the apartment.

The FIRS system shall be capable of receiving, and distributing to all dwellings terrestrial and digital signals, FM, DAB, digital Satellite (complete with Sky Q or PLUS) and Hotbird satellite signals. The system must be set to allow digital Sky, Hotbird, Astra 28 and Turksat signals to be received at both satellite outlets within each dwelling and not such that only one outlet position within the dwellings receives the digital signals.

Satellite head end equipment and distribution infrastructure shall be capable of receiving and distributing Sky Q satellite signals. The Apartments FIRS system shall be adaptable to provide Sky Q in the future in units where required.

The system shall generally consist of roof mounted satellite dishes (4No.) per building for receiving digital signal along with aerials for receiving radio signals. Cables shall be routed to main riser position and where required combining the signals in distribution equipment to allow routing of individual fibre cable service to each dwelling.

Each building shall be complete with roof mounted satellite dishes for receiving digital signal along with aerials for receiving radio signals within internal distribution point as listed below and as indicated on the drawings.

The main system shall be fibre solution using bespoke stacking technologies combined with DWDM x4SAT TX equipment allowing transmission of up to 4 Satellite signals over a single fibre infrastructure to each apartment.

The internal fit out shall consist of a 4 way fibre DCSS GTU and a quad legacy GTU to provide signals internally from the Astra 28 Degree platform including Sky Q, all Terrestrial DTT, FM & DAB UK stations. The 4 way GTU will be initially provided with 1No. quad legacy GTU allowing a base Channel provision, this can be increased individually for each apartment depending on the channel requirement per apartment.

To allow additional channels in any apartment for future, additional Quad GTU's can be added to any individual apartment allowing connection to any of the remaining 3No. satellites and can be switchable between these by simply changing the position of the predetermined fibre port providing access to additional non UK channels. The GTU's shall be fed from a DWDM internal unit designed to split the signals from the single incoming fibre back to the 4No. separate wavelengths.

The internal enclosures shall be bespoke to accommodate available space following site surveys.

The Contractor shall typically provide to each Apartment the following:

Service cupboard – Gateway Termination Unit (GTU)

Main lounge – Combined quad plate including TV, Satellite (2 No.), FM/DAB Radio + separate single outlet (IEC) female

Master bedroom – Combined triplex plate including TV, Satellite and FM/DAB Radio connected to the single outlet (IEC) female next to the quad plate in the main lounge.

At the TV position within the main lounge, the Contractor shall also ensure a BT master telephone outlet and 2No. twin socket outlets are provided.

The Contractor shall allow for supplying the following LS0H leads at practical completion for each outlet in each dwelling:

- 2 metre screened coaxial aerial fly lead in white for TV
- 2 metre screened coaxial aerial fly lead in white for IF outlet point to a satellite receiver
- 2 metre screened coaxial aerial fly lead in white for connection to a radio tuner

4.2.2 Wiring Systems and Equipment

The system shall be in accordance with the Employer's Requirements document for all equipment used and shall comply with EU and National Standards, where such standards have been established, and to the codes of practice issued by the relevant industry bodies.

All equipment to cope with the minimum and maximum signal levels as approved in the CAI SMATV code of practice.

The contractor shall ensure provision is allowed within the system to mitigate interference from 4 & 5G telecommunications and future scaffolding systems to limit tenant viewing disruption of the FIRS system.

The system to comply with current technical conditions of the licensing authorities, all installations to be designed are to consider of the visual impact on the building.

The system planning process shall include confirmation of the suitability of services and local conditions.

The Contractor shall undertake a site test at each location to determine that all the services listed are available at the levels required for distribution. If any service is as a result of the site test found not to be available this must be reported to the Employer's Agent immediately so that an agreement may be made as to which services shall be provided.

The IRS system shall provide the following services

Service	Programmes	Frequency
Satellite Digital 4No.	All horizontal and vertical transmissions, both low band and high band from the 28 degree east orbital position, in the transmission range from 10,700MHz – 12,750 MHz enabling multiple international channels globally.	IF
FM Radio	The national and local services legally transmitted to the general area of the site concerned	Band II
DAB	Radio programmes provided by DAB services	Band III

4.3 DEMONSTRATIONS OF SYSTEMS

The Contractor shall include for the demonstration of all systems at completion of the works.

Where necessary, Specialist Contractors shall be included in such demonstrations, however the Contractor shall be present throughout all demonstrations.

The purpose of the demonstration is to familiarise the client's representatives and caretaker with the day-to-day operation of the systems and routine maintenance requirements.

The Contractor shall allow for the demonstration of the systems to the client's representative and operatives on separate occasions if necessary.

4.4 STAGE 4B AND 4C COORDINATED WORKING DRAWINGS AND MEP MODEL

The Contractor shall develop the Stage 4A information as part of the Stage 4 Technical Design process in order to provide Coordinated Working Drawings.

The Contractor shall also include any specific design development during this process resulting from input from their chosen supply chain partners, manufacturers and / or specialists.

- The Contractor shall refer to BG6 4th Edition for guidance with regard to the information required for the provision of Working Drawings.
- Installation drawings shall be prepared from the information provided within the specification and tender drawings, which includes the following:
- Plan layouts should be to a scale of at least 1:50 and be accompanied by cross-sections to a scale of at least 1:20 for all congested areas.
- The drawing should make allowance for installation working space and space to facilitate commissioning and maintenance.
- The drawings should be spatially co-ordinated and there should be no physical clashes between the system components when installed. Critical dimensions, datum levels and invert levels should be provided.
- The spaces between pipe and duct runs shown on the drawing should make allowance for the service at its widest point. Insulation, standard fitting dimensions and joint widths should therefore have been allowed for on the drawing.
- The drawings should indicate positions of main fixing points and supports where they have significance to the structural design or spatial constraints.

The Contractor will be expected to provide the Coordinated working drawings using Revit MEP and will develop the model in accordance with project specific reequipments. This may include Employers Information Requirements or a specific BIM Execution Plan.

4.5 STAGE 5 INSTALLATION DRAWINGS

The Contractor shall provide fully coordinated installation drawings as part of the Stage 5 development process, generally following the recommendations set out in BSRIA BG6 4th Edition.

The installation drawings are drawings based on the technical design drawings / co-ordinated working drawings with the primary purpose of defining the information required for installation purposes.

The main features of installation drawings should be as per coordinated working drawings, plus: -

- Allowances should be made for inclusion of all supports and fixings necessary to install the works.
- The drawing should make allowances for installation details provided from manufacturers' drawings.
- Allowances should be made for plant and equipment. This includes any alternatives to the designer's original specified option that have been chosen.

The Contractor shall provide the installation drawings to the Engineer for comment prior to commencing site works. Note that the installation drawings shall include the following as a minimum:

- Coordinated ceiling plans comprising all ceiling mounted services including extract grilles, supply diffusers and comfort cooling units. Services shall be coordinated with the electrical installation. (scale 1:50).
- Main pipework routes (scale 1:50) and cross sections within congested areas (scale 1:20).
- Main ductwork routes (scale 1:50) and cross sections within congested areas (scale 1:20).
- Mechanical Plantroom layouts (scale 1:20).
- Complete builder's work drawings to complement the information provide within the specification and drawings.

As part of the Stage 5 development of information, the Contractor shall note that BSRIA BG6 refers to the following as being required with regard to the MEP Revit model: -

The MEP model shall be updated to include all equipment and components with their actual sizes as well as typical supports and fixings necessary for installation.

- Typical object parameters to include, along with geometry at this stage, would include: -
- Actual size of object
- Actual weight of object
- Identification of actual item to be installed (make / model number)

4.6 'AS INSTALLED' RECORD DRAWING, MEP MODEL AND MAINTENANCE MANUALS

During the progress of the contract, the Contractor shall record on drawings, in an approved manner, the information necessary for preparing the installation record drawings and MEP model.

The marked-up drawings shall be made available to the Engineer for inspection and checking at any time during the contract.

Record drawings are to be showing the building and services installations as installed at the date of practical completion. The main features of the record drawings should be as follows: -

- The drawings should be to a scale not less than that of the installation drawings.
- Locations of all the mechanical, electrical, and public health systems and components installed including ducts, pipes, cables, busbars, plant items, pumps, fans, valves, dampers, control devices, strainers, terminals, electrical switchgear and components, security and fire sensors and control equipment.
- The drawings should be labelled with appropriate pipe, duct and cable sizes, pressures, and flow rates.
- The drawings should have marked on them positions of access points for operating and maintenance purposes.
- The drawings should not be dimensioned unless the inclusion of a dimension is considered necessary for location.

The MEP model at this stage shall show all as-built engineering systems, components, and equipment. All pipes, ducts and cable objects contain data about their sizes, flow rates, flow direction, voltages (as appropriate), and the model should include access information for equipment maintenance and replacement.

Typical object parameters at this stage, along with geometry, would include:

- Model numbers and serial numbers of actual components and equipment installed
- Results from commissioning works (flowrates or set points for all control equipment)
- Links to stored plant and equipment details (specification, manufacturers details, operation, and maintenance information)

4.7 PROJECT COMPLETION AND HANDOVER REQUIREMENTS

The Contractor shall, prior to the issue of the Practical Completion Certificate, carry out the following:

a) Fourteen days prior to handover, provide 1 No. copy of the Operating and Maintenance Manuals and 'As Installed' drawings and MEP model for approval. (Note: Following approval and incorporation of Engineer's comments, one paper final copy and one electronic final copy shall be provided to the client for the handover meeting).

b) Following physical completion of the installation, arrange to carry out a complete test of the installation in accordance with the Specification in the presence of TGA Consulting Engineers.

c) Arrange to demonstrate the services installation to the Client.

d) Provide building logbook in relation to the building services in accordance with CIBSE TM31 and TM54

e) Part L Calculation

f) Energy Performance Certificate

g) Fitwell evidence Collation

h) Soft Landings evidence Collation

Failure to complete the above shall result in refusal to accept the engineering services installation and the issue of the Practical Completion Certificate until such time as the above are completed.

Refer to Section 2, Part 1 of the General Technical Clauses for the detailed requirements associated with the provision of 'As Installed' drawings and operating and maintenance manuals.

4.8 12 MONTHS MAINTENANCE FOLLOWING PRACTICAL COMPLETION

The Contractor shall include in the tender for providing maintenance services consisting of labour, materials, all consumable items, and head office supervision for a twelve-month period following Practical Completion.

Maintenance services shall be carried out in accordance with manufacturers' requirements and the maintenance schedules included in the operating and maintenance manual.

5.0 SUMMARY OF TENDER

ELECTRICAL TENDER SUMMARY

1.0	Preliminaries	£
2.0	General Technical Clauses	£
3.1	Scope of Contract	£
3.2	Contractors Obligations	£
3.3	Design, Installation and Documentation Requirements	£
3.4	Information to be provided by the Contractor	£
4.1	Type of Installation	£
4.2	Fibre Integrated Reception System (FIRS)	£
4.3	Inspection and Testing	£
4.4	Demonstration of Systems	£
4.5	Stage 4B and 4C Coordinated Working Drawings and MEP Model	£
4.6	Stage 5 Installation Drawings	£
4.7	'As Installed' Record Drawing, MEP Model, and Maintenance Manuals	£
4.8	Project Completion and Handover Requirements	£
4.9	12 Months Maintenance Following	£
4.10	Practical Completion	£
	Sub Total	£
	Add Main Contractors Discount	£
	Total Tender Sum	£

It is important that the Summary is completed accurately to indicate the costs associated with the various headings.

Breakdown of items inputted in 'Other Items' is required. A lump sum would not be accepted.

DECLARATION

We hereby submit our Fixed Price Summary of Tender, being the sum total for the works defined in the Specification and on the drawings.

We have not deviated or alternatively priced, in any way, from the specified articles, nominated suppliers, Sub-Contractors or materials, or the manner in which they are specified to be fixed.

Signed.....Date.....

For & On Behalf Of.....

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