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Consulting Engineers

Sport Wales National Centre – Sophia Gardens

Switchboard replacement and upgrade works

Stage 4 Specification for Electrical Engineering Services

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Sport Wales National Centre – Sophia Gardens
Switchgear Replacement and Upgrade Works

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ELECTRICAL SPECIFICATION SCHEDULES

1.0 CONTRACT CONDITIONS AND PRELIMINARIES

1.01 General

For details of Contract Conditions and Preliminaries, refer to Main Contract Documents issued by the Employer/Employer's Agent.

This specification, together with any accompanied drawings, provides indicative design requirements and criteria for the Electrical Engineering Services Installations for the construction of **Replacement Main Switchgear and Upgrade Works**. The Contractor shall note that should there be any discrepancies between the documents then the most onerous requirements shall apply.

The building is to an existing unit.

The documents indicate minimum Employers Requirements to enable the Contractor to provide a tender for the works.

The total supply, installation, setting to work and commissioning of the Engineering Services shall be the responsibility of the Contractor.

1.02 Scope Of Works

The Contractor shall be fully responsible for the supply and installation throughout and shall ensure full compliance with all current recognised standards and recommendations.

The scheme installations and commissioning shall comply with all relevant standards, regulations and legislation (except where expressly modified and/or extended as indicated elsewhere), including the following:-

- Latest edition of the Regulations for Electrical Installations, IET Wiring Regulations and any amendments (BS 7671).
- CIBSE Guides and any amendments published by the Chartered Institute of Building Service Engineers.
- British Standards and British Standards Code of Practice and any amendments issued by the British Standards Institution.
- BSRIA Applications and Commissioning Guides.
- The Health and Safety at Work Act including the Management of Health and Safety at Work Regulations, The Construction (Health, Safety and Welfare) Regulations. The Construction (Design and Management) Regulations for both Design and Construction Duties.
- BS 8300 Approved Document M and The Disability Discrimination Act.
- Electricity at Work Regulations.
- The Electrical Supply Regulations.
- The County Fire Officer's Recommendations.
- Building Regulations and other Statutory Requirements.
- The requirements of the Electricity Supply Companies.
- For Teaching Facilities - the Education (School Premises) Regulations 1999 and Building Bulletin 87 Guidelines for Environmental Design in Schools.
- Any other appropriate Design Guides and Guidance Notes.
- Consortium of Local Authorities in Wales (CLAW).

The Contractor shall install, set to work and commission the following systems (where applicable):-

- Incoming Services
- Low Voltage Distribution
- Lighting
- Emergency Lighting
- External Lighting and Floodlighting
- Earthing
- Temporary Supplies

The Contractor shall ensure that all necessary materials are obtained in time to bring the works to a satisfactory conclusion in accordance with the contract programme for the works.

1.03 Submission of Documents and Approvals During Installation Period

Upon appointment, the Contractor shall forthwith proceed to prepare for comment preliminary installation drawings, certifications and builders information drawings which shall be developed from the Contractor's Revit Model. Approval must be obtained from the Contract Administrator before any work commences on any particular part of the installation.

Approval by the Employers Representative will mean the acceptance in principle and, in the event of any omission or error by the Contractor in the information provided, the works shall nevertheless be executed as if they had been correctly shown, without additional payment.

All documentation shall be submitted progressively for review and in sufficient time to meet the contract programme and to avoid delays to the contract allowing for a minimum review period of two weeks.

Installation drawings shall consist of the following, but not be limited to these requirements.

- General Electrical Services Layout Drawings (1:50, 1:100 scale).
- Distribution Drawings (NTS).
- Manufacturers General Arrangement Drawings of all equipment, plant, special fittings, etc. as required by the Engineer.
- Wiring Control Diagrams and Schematics forming part of the works (NTS).

When all installation, co-ordination drawings and any other relevant documents have been finally completed, the Contractor shall provide to the Employers Representative up to six copies of all these items for general use.

1.04 Building Regulation Compliance

The Contractor shall ensure that the installation is in compliance with the Building Regulations.

The selection of equipment shall be integrated with the building fabric, mechanical services and sustainable technologies to ensure satisfactory SBEM calculation result.

2.0 STANDARD SPECIFICATION

2.01 General Details

2.01.01 Compliance with Specification

This section of the Specification describes standard requirements for workmanship, materials and management procedures to be used in the execution of the works described in this Specification and on the drawings.

The works shall comply with all relevant requirements of standard sections of this Specification except where contrary requirements are indicated in the particular Specification and the drawings shall take precedence.

Costs incurred by the Employer's Representative as a result of any part of the works failing to comply with specified requirements shall be deducted from payments due for the cost of the works. Such deductions shall include but not be limited to costs incurred for:

- * Preparation of snagging lists, defects lists or other supervisory documents made necessary by the existence of an unreasonable number of items still requiring attention after any section of the works has been offered to the Employer's Representative, as being complete and ready for inspection;
- * Additional inspections, witnessing, approvals or other attendances;
- * Any associated redesign work;
- * Preparation and printing of drawings and details;
- * Supervision and administrations.

2.01.02 Definitions

The following definitions and associated requirements shall apply to terms used in this Specification.

Approval of a drawing or any other element of the works shall be deemed to indicate that the Employer's Representative has no immediate objections or comments. Such "approval" shall not be construed as acceptance of any responsibility for the accuracy or quality of the works or for any fault, error, omission, defect or deficiency that may subsequently be noted. All approvals shall be subject to written confirmation signed or countersigned as appropriate by the Employer's Representative.

The Drawings are the drawings issued in conjunction with this Specification for tendering purposes or subsequently issued under the Contract.

Working Drawings shall be any necessary drawings, sketches, diagrams, schematics, programmes or other illustrations provided in the execution of the works:

- * To determine the locations, dimensions, wiring requirements, builders work and other details of elements of the works, as necessary for the execution of the works and/or;
- * For approval of such details by the Employer's Representative or any other relevant authority.

The Employer's Representative shall be the Architect, the Engineer, the Project Manager or other party designated under the Conditions of Contract to inspect, approve, witness or accept the works on behalf of the Employer and to issue instructions under the Conditions of Contract.

Issued for Construction or similar phrases used in the course of issuing drawings or information by the Employer's Representative shall be deemed to mean that such drawings or information shall be used as the basis for the production of working drawings.

Materials shall be any materials, plant, equipment, drawings, expendable items, packaging, rubbish or any other elements used in or arising from the implementation of the works, as appropriate to the context.

The Specification shall be this Specification together with the drawings and any other relevant requirements of the Contract or instructions issued under the Conditions of Contract.

Witnessing of a test, commissioning or any other activity shall be construed as confirmation of the results of such activity; it shall not be construed as either approval or acceptance. The same qualifications shall apply as for "Approval".

The Works shall include all materials, labour, plant, testing, commissioning and other commodities or activities necessary for the completion of the work described in or implied by the Specification and governed by the Conditions of Contract.

2.01.03 Extent of the Works

The works shall be deemed to include every item described in the Specification and every item shown on the drawings together with all activities, materials, labour, plant, adjustments, attendance, fixings, supports, brackets, the preparation of working drawings and other items necessary for the provision and commissioning of complete installations in accordance with the intent of the Specification and the drawings and in accordance with good practice.

The works shall include all necessary provision to take account of details not shown on the drawings owing to their diagrammatic nature. This requirement shall include all materials and activities necessary for the co-ordination of the works with details on architectural, structural and other drawings available at the time of tendering or subsequently issued under the Conditions of Contract.

Such terms as 'provided', 'supplied', 'fitted', 'fixed', 'installed', etc, when used in this Specification or on the drawings shall be deemed to include the supply, fixing, placing in position, adjusting, testing, regulation, commissioning and putting into working order of the relevant equipment including any necessary ancillary equipment or activity, except where the intended meaning is specifically limited by such phrases as 'supply only' or 'supply and had to the Employer's Representative'.

2.01.04 Co-ordination and Access

The works shall be installed in co-ordination with other services installations and the building fabric. Details of such co-ordination shall be agreed before fixing of any item in each particular area of work.

Every component shall be installed in such a manner as to be readily and safely accessible for any normal observation, adjustment, maintenance or other activity required of its use. The works shall be deemed to include all reasonable provision for compliance with this requirement, including co-ordination with other services and structural features.

The decision of the Employer's Representative shall be final in respect of what is readily and safely accessible.

Any apparent instance of a component being shown on the drawings in an inaccessible position shall be drawn to the attention of the Employer's Representative before the item and associated components are installed.

All components shall be delivered to site in a form suitable for the access available for positioning, assembly, installation and eventual renewal and replacement.

Co-ordination of the works shall be deemed to include any necessary moving or circumventing of any plant or other obstructions placed on site during the course of building or other trades work.

2.01.05 Mandatory Requirements

The term "shall" indicates that a statement is a mandatory requirement of this Specification.

The decision of the Employer's Representative shall be final in respect of whether any other statement in the Specification can reasonably be interpreted as being a mandatory requirement.

2.01.06 Confidential Documents

This Specification, the drawings and all other associated documents shall be regarded as confidential.

All confidential documents shall be returned to the Employer's Representative after being used for tendering purposes.

2.01.07 Letters of Intent

In certain circumstances, the Employer may find it necessary to issue a letter of intent to a supplier before the Contract is placed, in order to reserve materials for delivery on a date to suit the anticipated programme of work. Immediately after the Contract is placed, an order shall be issued for the supply of any reserved materials.

The order placed for reserved materials shall confirm all requirements as detailed in the Specification and the drawings. All requirements of the Specification and the drawings shall take precedence over any different or less detailed requirements contained in the letter of intent.

2.01.08 Beneficial use of the Works prior to Practical Completion

In certain circumstances, e.g. involving modifications to existing installations, the Employer's Representative shall have the option to instruct that any part of the works be operated for the beneficial use of the Employer before the issue of a Certificate of Practical Completion.

Except where specific provision for such beneficial use is included in the particular Specification, the Employer shall reimburse reasonable costs associated with the operation of the system and any measures necessary to enable the full defects liability period to be effective from the date of Practical Completion. Such reimbursements shall be evaluated in accordance with the Conditions of Contract.

2.01.09 Familiarity with Site

The works shall be deemed to include all necessary provision for factors particular to the site that could be ascertained by visiting the site prior to the submission of the tender for the works. Such factors shall include but not be limited to:

- * Access;
- * Existing buildings;
- * Existing services;
- * Any other factors that could affect the progress of the works or the cost of the works.

2.02 Regulations and Standards

2.02.01 Conformity with Regulations

The current requirements and recommendations of all relevant codes of practice, statutory regulations, bylaws, commissioning codes and installation instructions shall be complied with during the execution of the works, including the following:

- * The Health and Safety at Work Act;
- * The Construction (Design & Management) Regulations 2015;
- * The Workplace (Health, Safety & Welfare) Regulations 1992;
- * The Factories Act;
- * The Clean Air Act;
- * The Mines and Quarries Act;
- * The Public Health Act;
- * The Offices, Shops and Railway Premises Act;
- * The Building Regulations;
- * British Standards Institution Publications or, in the absence of a relevant British Standard, the appropriate ISO or CEN/CENELEC standard;
- * Requirements and recommendations of the local Fire Officer;
- * Requirements of local supply authorities for gas, water, electricity and mains drainage;

- * Gas Safety (Installation & Use) Regulations 1984;
- * Requirements of any insurance companies concerned;
- * IET Regulations for Electrical Installations;
- * The Electricity at Work Regulations;
- * CIBSE Commissioning Codes, Guides, Technical Memoranda and Practice Notes.
- * British Telecom LN139 (all buried ducts for services other than piped or LV/HV cabling).

Authorities shall be notified as necessary about the connection of electricity, gas, water and drainage.

The Contractor shall be responsible for liaison with the public utilities to facilitate the programming and co-ordination of the various utilities to meet his installation programme.

The Contractor shall also be responsible for submission of working drawings to the public utilities for approval.

2.02.02 Safety and Fire Precautions

Fully comply with the requirements of the latest version of the construction (design and management) regulations and adhere to the requirements of the Health and Safety Plan.

Safe methods of working and access shall be employed throughout the execution of the works.

All necessary precautions shall be observed in respect of special areas of work where hazards may exist in connection with dangerous substances.

Due cognizance shall be given to the risks of explosion, toxic gases and infection in existing drains. Particular care shall be taken in prisons and hospitals.

The works shall include all necessary provision for protective clothing, masks, goggles, breathing apparatus, safety lines and other equipment.

All necessary precautions shall be adopted to safeguard against fire and explosion and especially where the execution of the works involves lames, sparks, other sources of ignition or the use of flammable or explosive materials.

All necessary provision shall be made for maintaining the integrity of fire compartment walls, floors and other structural elements in the course of an after completion of the works.

2.03 Documentation

2.03.01 Drawings

The Drawings

The tender drawings are intended to depict the scope and intent of the works to such an extent as to allow tenders to be submitted and subsequently for use as a basis for the preparation of working drawings. The drawings shall be deemed to be not suitable for use as working drawings.

Any apparent conflict between requirements indicated on the drawings and requirements of the Specification shall be brought to the attention of the Employer's Representative. The Employer's Representative's decision shall be final as to which requirement should take precedence.

Working Drawings

Working drawings shall be submitted to the Employer's Representative within reasonable time to allow comment to be made to meet the required date in the agreed programme of work. In the event of additional details, drawings or other information being required to enable the working drawings to be completed, these shall be requested from the Employer's Representative at a time which is neither unreasonably distant from nor unreasonably close to the date required.

The working drawings shall include details of all builders work together with any additional information required for the preparation of final architectural details, e.g. of services shafts, floor ducts, brickwork surrounds for louvres, building-in of fire dampers, sleeves or cable transits, etc.

Triplicate copies shall be provided to the Employer's Representative of all working drawings. This requirement applies to issues for approval and, where appropriate, final issues.

Drawings to Scale

All drawings to scale shall conform with standard metric scales, i.e., 1:1, 1:5, 1:10, 1:20, 1:50, 1:100, 1:200, 1:500, etc. The Employer's Representative shall refuse to approve any drawings using a non standard scale, e.g. 1:25, 1:33, etc.

Manufacturers' Drawings

The working drawings shall include certified manufacturers' drawings. These shall include details of all plant, machinery, control panels, switch panels. Purpose built equipment and other such items as may be requested by the Employer's Representative.

Manufacturers' drawings shall include the following, as appropriate:

- * Dimensions and weights;
- * Holding down bolt locations and other builders work details;
- * Wiring details, including terminal numbers;
- * Cabling requirements;
- * Starting and running currents and fuse ratings;
- * Required capacity of water, gas, steam or any other associated piped services;

- * Positions of connections of pipework, cables, flues and other components;
- * Integral maintenance access;
- * External access required for maintenance;
- * Any particular requirements for the operating environment.

As Fitted Drawings

As fitted drawings shall be provided as described under Record Documents.

Plant Room and Control Room Drawings

The works shall include the provision of plant room and/or control room drawings (hereinafter referred to as plant room drawings).

Plant room drawings for wall mounting shall be printed black on white plastic sheet or other approved material and framed and fixed on walls of the appropriate rooms. Frames shall be of hardwood and glazed. Where drawings are required to be mounted on control/indicating panels and/or consoles, they shall be engraved on traffolyte or similar approved plastic laminate.

Plant room drawings shall include the following appropriate and agreed with the Employer's Representative:

- * Detailed plant layout;
- * Plant operation charts and relevant instructions;
- * Plant room valve chart;
- * Controls Schematics;
- * System schematics;
- * Appropriate zone locations;
- * Any other details as may reasonably be required by the Employer's Representative for the safe and efficient operation of the relevant system(s).

2.03.02 Record Documents

Record documents shall comprise:

- * Drawings and schedules giving details of all installations “as installed”;
- * All test certificates;
- * All commissioning records/certificates;
- * All guarantees and warranties;
- * All insurance inspection reports and certificates;
- * Project completion records.

Record documents shall be available in draft form one month prior to Practical Completion or earlier to suit the requirements of user tuition during the commissioning period or sectional completion dates within the contract.

Record documents shall be approved by the Employer’s Representative before being finally issued to the Employer.

Record documents shall conform with all relevant requirements specified for working drawings.

The final issue of approved record documents shall be delivered to the Employer on site or other such location as may be required by the Employer’s Representative. A receipt including a detailed list of all record documents delivered shall be obtained and copied to the recipient and the Employer’s Representative.

Three complete sets of record documents shall be provided.

Each set of record documents shall comprise:-

- * A flash drive containing all drawings A3 and larger in **AutoCAD** drawing format files provided on an IBM PC compatible computer;
- * A set of paper prints of each drawing larger than A3 size, each contained in transparent PVC wallets;
- * A set of ring binders of appropriate size containing all ‘As Installed’ drawings and other record documents including a detailed drawing index;
- * A flash drive containing all record documents (other than drawings) in PDF format.

Record drawings shall provide at least as much detail as the drawings in respect of the locations of all plant, equipment, valves, isolators, switches, dampers, control panels, distribution boards, access panels, etc and the routes of pipes, trays, conduits, ducts, etc and any other components of the works.

Record drawings shall include schematic and diagrammatic details giving at least as much detail as the drawings together with all additional details included in the working drawings in respect of wiring diagrams, control panels, control systems, distribution boards, other specialist systems/ equipment and instrumentation. They shall include any other details necessary for the operation, maintenance,

dismantling, reassembly and possible future modification of all components of the installations included in the works.

Record drawings shall include all details necessary for the identification, location, size, rating, capacity or other detail necessary for the maintenance, operation, replacement or any other relevant activity of all plant, equipment, apparatus or other materials.

Record drawings may include appropriate details in schedule form.

Record drawings shall include all relevant details of builders work essential to the works. This shall include services shafts, cable containers, air ducts or waterways, structural supports and any other relevant items.

Record drawings shall include comprehensive details of all power wiring, control wiring, pneumatic or other controls system piping. Such details shall include sizes and types of conductors and piping and identify the terminal points of each.

The scales used on record drawings shall conform with those used on the drawings except where a more detailed scale is required by the following list:-

<u>Detail</u>	<u>Scale</u>
External Services	1:200
General Layouts	1:100
Plant/Equipment Room Layouts	1:50
Manufacturer's Details of Equipment requiring servicing	1:20

The size and scale of all record drawings shall be adequate to meet the approval of the Employer's Representative.

In the event of any record documents being unavailable at the time necessary for acceptance of the works as being practically complete, the Employer's Representative shall be empowered to employ any measures necessary for their production and to deduct the cost of such measures from payments applicable for completion of the works.

2.03.03 Operating and Maintenance Manuals

Comprehensive manuals shall be provided to assist the user in the safe and efficient operation and maintenance of all systems and equipment incorporated in the works.

The manuals shall include:

- * A general description of the scope and manner of working of each system and each item of plant and equipment;
- * A detailed description of the scope and manner of working for each automatic control/monitoring system, including wiring diagrams and schematics showing the interconnection between all plant and equipment;
- * Clear and comprehensive instructions for the method of starting up, running and shutting down of all systems, plant and equipment;
- * Details of all normal operating conditions and control set points;

- * Instructions in respect of any necessary precautions against damage to the installed works, e.g. from rust, corrosion, etc;
- * Instructions and schedules listing all items requiring periodic servicing and/or inspection, together with details of the necessary activities and recommended frequency thereof;
- * A detailed list of recommended spare and replacement parts, lubricants and any other expandable items, including catalogue references, part numbers, etc, as necessary for the identification of each item.
- * An electronic copy of the manual stored on a flash drive containing all sections of the completed manual including manufacturer's literature in PDF format.

Manufacturers' leaflets, booklets or other documentation that does not conform with A4 size shall be indexed and cross referenced in the manuals. Such documentation shall be presented in suitable box files or folders.

Operating and Maintenance Manuals shall be available in draft form one month prior to Practical Completion or earlier to suit the requirements of user tuition during the commissioning period or sectional completion dates within the contract.

Operating and Maintenance Manuals shall be approved by the Employer's Representative before being finally issued to the Employer.

The final issue of approved Operating and Maintenance Manuals shall be delivered to the Employer on site or other such location as may be required by the Employer's Representative. A receipt including a detailed list of all documents delivered shall be obtained and copied to the recipient and the Employer's Representative.

Three complete sets of Operating and Maintenance Manuals shall be provided. The Manuals shall be presented in the form of loose leaves contained in appropriate ring binders, lever arch files. The binders shall contain cardboard divisions between each section. A ready means of reference and a detailed index shall be included.

In the event of operating and maintenance instructions being unavailable at the time necessary for acceptance of the works as being practically complete, the Employer's Representative shall be empowered to employ any measures necessary for their production and to deduct the cost of such measures from payments applicable for completion of the works.

2.03.04 Progress and Completion Records

A progress record shall be maintained on site throughout the course of the works. The progress record shall include a set of working drawings together with other supporting documentation as may reasonably be required by the Employer's Representative.

The progress record shall be updated weekly to indicate the progress of the works to date. The record shall include marked up drawings with dates for completion of each section of the works and summaries of percentage completions for comparison with the Summary of Tender.

A project completions record shall be maintained on site throughout the course of the works. The project completions record shall comprise:

- * An index of all test certificates, commissioning certificates, insurance certificates and other documentation used to record witnessing and approval of all elements of the works, together with copies of all such documents;
- * A project completions schedule showing the dates on which each element of the works was completed.

The index of test certificates, etc, shall include an exclusive reference number for each certificate. This reference number shall be entered on the project completions schedule against the date for the relevant item.

The project completions schedule shall conform with the format shown in Appendix 2.01 of this Specification. A separate column shall be allocated on the schedule for each:

- * Item of plant;
- * Control Panel;
- * Distribution Board;
- * Lighting system, floor by floor, zone by zone, etc;
- * Power distribution system;
- * Fire alarm/security/public address/CCTV, etc, system or part thereof individually;
- * Lift/hoist/escalator;
- * Control system;
- * Pipework system;
- * Ductwork system;
- * Any other individual system or part system as may reasonably be required by the Employer's Representative.

The detailed format of the project completions schedule shall be submitted to the Employer's Representative for approval at the same time as the programme of works.

The relevant project completions record documents shall be completed before the works are offered as being practically complete.

The project completions record documents shall be included in the final issue of the record documents.

2.04 Contract Management

2.04.01 Site Visits and Meeting

The works shall include all necessary visits to the site for purposes of liaison, co-ordination, inspection and discussion, including attendance at regular site meetings and at other times as may reasonably be required by the Employer's Representative to suit particular circumstances.

2.04.02 Defects Liability

The defects liability period for the works shall be twelve months, commencing from the date of Practical Completion.

All defective materials, defective workmanship of items of outstanding work listed at the time of Practical Completion shall be dealt with within fourteen days or other reasonable period as may be agreed by the Employer's Representative.

Any faults or defective items becoming apparent during the defects liability period shall be dealt with within fourteen days of notification being given.

All defective materials or workmanship listed at the end of the defects liability period shall be dealt with within fourteen days.

In the event of an unreasonable period of time elapsing before defective or outstanding items are dealt with, the Employer's Representative shall be empowered to arrange for such items to be carried out by other parties and to deduct all associated costs from payments due under the Conditions of Contract.

2.04.03 Testing

General

All electrical engineering disciplines shall be tested and commissioned in accordance with relevant CIBSE Commissioning Codes and British/European Standards.

The Contractor shall agree a programme for pre-commissioning checks, setting to work, commissioning and performance testing with the Contractor.

Where required, the Contractor shall provide formal Method Statements supported by Risk Assessments detailing all commissioning and testing procedures.

The Contractor shall provide all necessary facilities to enable tests to be witness and inspections carried out on site or at the manufacturer's works.

All required personnel, including manufacturer's representatives shall be present and their activities co-ordinated.

Testing of all equipment and systems shall be undertaken as detailed in this specification. Should an inspection or test fail, the Contractor shall repeat the procedure until a satisfactory result or conclusion is obtained.

The testing of the electrical engineering services shall be completed prior to decoration of the building fabric and before services are concealed about ceilings or within risers. Testing shall be undertaken

during suitable environmental conditions to avoid harmful internal and external conditions affecting the procedure and test instruments.

All test equipment shall be subject to a quality assurance procedure complying with BS EN 30012-1.

Any testing that is to be completed outside of normal working hours shall be included by the Contractor.

Test Certificates shall include the following details as appropriate:

- * Project name and details of system or installation under test;
- * Date and duration of test;
- * Reference of any standard, code of practice or specification delineating applicable parameters;
- * Normal working conditions, e.g. of pressure, voltage, resistance, etc, of element under test;
- * Actual conditions witnessed during the test.

Evidence shall be provided at the request of the Employer's Representative to verify the accuracy and suitability of all instruments and methods of use in tests.

At least seven days notice shall be given of any tests that will require the presence of the Employer's Representative.

The works shall be tested in sections to suit the programme of work and the need for ensuring that all tests are completed before the relevant section is concealed by backfilling, insulation, duct covers, suspended ceilings or any other items that could restrict access. Any means of concealment put in place before testing is carried out shall be removed at the discretion of the Employer's Representative.

Notice of Tests

The Contractor shall provide two weeks notice to the Engineer and Client's Agent of intention to carry out inspection and testing and state any requirements for the attendance and co-operation of others.

The Client's Agent will witness test proceedings, verify results and determine if the specified requirements have been satisfied.

If following a test or inspection any system or part thereof is shown to be defective or not conforming to this specification, the Client's Agent will reject such defective parts by written notice within reasonable time, indicating area of dispute.

Test Records

Whether or not the inspection and tests are witnessed by the Engineer or his representative, the Contractor shall proceed with the inspection and testing of the installation on the agreed dates and shall fully record and certify the results obtained on Forms of Completion and Inspection Certificate as prescribed in the IET Regulations for Electrical Installations.

A copy of all test and commissioning record sheets and certificates shall be issued to the Engineer within 14 days of the completion of inspection and testing.

It should be noted that a Practical Completion Certificate will not be issued until the correct Test Certificates are duly completed and accepted by the Engineer.

2.04.04 Commissioning, User Tuition and Handing Over

General Requirements

All necessary arrangements and facilities shall be made available for the Employer's Representative to witness and approve commissioning.

Detailed records shall be provided of all commissioning procedures. Copies of commissioning records shall be provided initially for approval and subsequently included in the Operating and Maintenance Manuals, together with other completions records.

Inclusion in Programming of Work

Realistic provision for pre-commissioning, commissioning and user instruction shall be included in the programme of work, as described elsewhere in this Specification.

Pre-Commissioning

All necessary installation work, testing and approvals/ witnessing thereof shall be completed before any commissioning procedures are commenced.

Due notice shall be given to the Employer's Representative of the dates for pre-commissioning activities and for relevant approvals/witnessing thereof.

Pre-commissioning activities shall include:

- * The construction, installation and testing of associated installations;
- * All necessary static tests, adjustments and inspections of all elements of the relevant installation;
- * Cleaning of all systems and equipment internally and externally, including strainers and filters;
- * The issuing of relevant certificates in accordance with a format agreed with the Employer's Representative.

Commissioning

Commissioning shall comprise the process of transforming an installed system or item of plant from a state of static completion into full working order, including all necessary measuring, balancing, regulation and adjustments.

All recommendations of appropriate IET Regulations and CIBSE commissioning codes shall be complied with.

All plant, systems and equipment shall be fully commissioned before being offered to the Employer's Representative as being practically complete.

The works shall include all necessary provision for the attendance of the Manufacturer's Representative for the commissioning of each item of plant and specialist systems or equipment.

The works shall include the provision of all tools, instruments and other equipment necessary for commissioning. Evidence shall be provided as required by the Employer's Representative to verify the accuracy and suitability of all instruments and methods used in commissioning.

Commissioning shall be carried out by personnel specialising in such activities.

Commissioning Records

In the course of agreeing the programme of work, a detailed method statement for each commissioning activity shall be submitted to the Employer's Representative for approval.

All commissioning records shall be approved by the Employer's Representative before being included in the completions record documents.

Commissioning records shall include details of initial and final readings of all measurements taken, together with all relevant information to confirm that the installations have been set to work within the operating tolerances specified or otherwise laid down in the commissioning codes.

User Instruction

When the Employer's Representative has confirmed that the works or relative sections thereof have been commissioned and before the works are offered as being practically complete, full instructions shall be given to the Employer's operatives on the correct, safe and efficient operation and maintenance of all associated systems, plant and equipment.

Adequate time shall be allocated to enable the Employer's operatives to understand the complexities of the systems and to learn the necessary procedures for their operation and maintenance.

User instruction shall include an appraisal of all activities recommended in the Operating and Maintenance Manuals.

User instruction shall include an appraisal of the as fitted drawings.

Evidence of user instruction shall be provided to the Employer's Representative in the form of summaries of topics covered and dates of instruction. The summaries of instruction shall include a record of the person(s) instructed and the confirmatory signature of one of these under instruction.

Fuel of Commissioning

The works shall include provision for all necessary fuel and power for commissioning.

Seasonal Commissioning

The Contractor shall include the following seasonal commissioning responsibilities over a minimum 12 month period, once the building becomes occupied:-

1. Building services tested under full load conditions.
2. Testing shall be undertaken during a period of extreme (high or low) occupancy.
3. Interviews with building occupants shall be undertaken to identify problems or concerns relating to the effectiveness of the systems.

4. Recommissioning of systems (following any work needed to serve revised loads) shall be required, incorporating any revisions in operating procedures into the O&M Manual(s).
5. Lighting shall be reviewed at three, six and nine month intervals after initial occupation, either by measurement or occupant feedback.
6. Recommissioning of systems shall be undertaken following the review, incorporating any relevant revisions in operating procedures into the O&M Manual(s).

2.04.05 Builders Work

Builders work shall be excluded from the engineering services installations whenever a particular specification or the Conditions of Contract make provision for builders work to be carried out by the Building Contractor.

Builders work shall include:

- * Concrete and brickwork foundations or bases for plant and machinery;
- * Structural steelwork (excluding supporting steelwork integral with the works);
- * Cutting holes, pockets and chases and making good in walls, floors or ceilings;
- * Building in of rag bolts and other fixings;
- * Cutting and removing floorboards, skirtings and other joinery and making good;
- * The excavation and backfilling of trenches;
- * The formation of services ducts and shafts and the provision of covers thereto;
- * The provision of access panels in walls, floors, ceilings, services ducts/shafts, boxings or elsewhere as necessary.

The works shall include the provision of all information necessary for the execution of the associated builders work. This shall include fully dimensioned working drawings for plant bases, holes or pockets formed in concrete structures, access panels and major holes in brickwork or other masonry structures. It will be acceptable for minor holes and chases in brickwork or other masonry to be marked on site, subject to the agreement of the Employer's Representative.

Proposals for holes through concrete shall be approved by the Employer's Representative before the concrete is cast.

The accuracy of the locations, levelling and dimensions of all builders work shall be verified before subsequent installation of the works. Verification shall not involve the Employer's Representative.

Details of all builders work requirements shall be submitted to the Employers Representative and approved by him before the work commences. Any instructions for builders work shall be confirmed to the builder by the Employer's Representative.

Builders work shall not include the drilling of holes for screw fixing, expanding bolts, etc. Such activities shall be deemed to be included in the works in all circumstances.

2.04.06 Dimensions and Setting Out

Accurate dimensions shall be taken on site as necessary to ensure that works are correctly co-ordinated and integrated with all elements of the site, buildings, other services and any other relevant features.

The works shall be set out in accordance with details on the working drawings.

2.04.07 Drying out the Building

No part of the works shall be used for drying out the building, except under the following conditions:-

Detailed written proposals shall be submitted for approval at least seven days prior to the proposed commencement of the operation.

Such proposals shall designate which sections of the works will be operated and the measures to be implemented to ensure that the works be handed over in good condition.

Any deleterious effects arising from the operation of the system shall be made good before the system is offered for inspection prior to Practical Completion.

No additional costs shall be attributable to the Employer for any work associated with drying out the building.

2.04.08 Programme of Work

A programme of work shall be provided and agreed in good time to enable the progress of the works to be properly incorporated into a co-ordinated programme for the whole project.

The programme of work shall be prepared with due cognizance of all relevant factors, including:

- * Delivery of materials;
- * The need for co-ordination with other services installations and other trades;
- * Required dates for the availability of mains services;
- * The time required for witnessing and inspection of the works;
- * The time required for the preparation and approval of the working drawings;
- * The time required for commissioning;
- * The time required for the preparation of and approval of as fitted drawings and Operating and Maintenance Manuals;
- * The time required for instructing the Employer's operatives in the operation and maintenance of the works.

The programme of work shall be accompanied by sufficient details to enable the Employer's Representative and other interested parties to confirm that the programme is realistic in terms of resources required for co-ordination, inspection, witnessing, certification, etc.

The Employer's Representative shall be notified immediately in the event of any circumstances arising that could jeopardise the progress of the works. Such circumstances would include extended delivery of materials, industrial disputes, etc.

2.04.09 Precautions against Damage or Theft

The works shall be deemed to include all costs associated with all necessary precautions against damage or theft of materials and property used in connection with the works or belonging to persons employed in connection with the works.

2.04.10 Plant and Tools

The works shall include all necessary scaffolding, ladders, hoisting equipment and other apparatus for the supply, delivery, positioning and erection of materials, except where alternative provision is specified in the contract documents.

The works shall include the provision of all necessary plant, tools, transformers, control devices and associated cabling.

All necessary measures shall be employed to ensure that plant, tools, cabling and other apparatus are used in a safe manner and in accordance with appropriate regulations.

No item of plant, machinery or other apparatus shall be retained on site unnecessarily after completion of the activities for which it was required.

2.04.11 Services for the Works

The works shall include provision for the use of water, electricity and any other services necessary in the execution of the works, except where the particular Specification or the Conditions of Contract state otherwise.

2.04.12 Travel and Expenses

The works shall include all associated costs involved in transporting personnel to the site or other place, together with the payment of all relevant expenses or allowances.

2.04.13 Samples

Samples of materials and goods to be incorporated into the works shall be provided as required for approval by the Employer's Representative.

Samples shall be provided when required to suit the programme of work.

2.04.14 Trade Customs and Practice

Local Agreements

All necessary provision shall be included in the works for compliance with any local agreements for additional payments or other compensatory measures that may be attributable to any persons employed to execute any part of the works.

Demarcation

All necessary provision shall be included in the works for compliance with any agreement in effect requiring that any part of the works be carried out by persons qualified or otherwise certified to ply a particular trade.

2.04.15 Overtime

The works shall be deemed to include all overtime working necessary for any of the following reasons:

- * The time allocated in the programme of work;
- * Any requirements of enforcement authorities for large items of plant or other materials to be delivered or erected at a time to suit traffic or other conditions;
- * The need for working outside normal hours in occupied premises;
- * The need for maintaining existing services during normal working hours;
- * Any other foreseeable circumstances.

Prior notification shall be given to the Employer's Representative for any instances of overtime working.

In the event of overtime being necessary, as the result of unforeseeable circumstances, the Employer's Representative shall be requested in writing to issue an instruction to proceed. Any payments for premium time shall be related to records conforming with relevant requirements specified for daywork sheets.

2.04.16 Publicity and Advertisements

No photographs, articles for publication or any advertising material containing references to any part of the works shall be published without the express permission of the Employer's Representative in writing.

No trade signs shall be erected on or adjacent to the site without the prior approval in writing of the design and location.

2.05 General Technical Requirements

2.05.01 Maintenance

The works shall include the provision of comprehensive maintenance and servicing for a period of twelve months from the date of Practical Completion.

During the twelve month maintenance period, all inspections, adjustments, lubrication, replacements and other activities shall be carried out in accordance with the recommendations included in the approved Operating and Maintenance Manuals.

The twelve months maintenance work shall be carried out as a separate contract, following completion of the works.

The cost of the maintenance contract shall be shown as a separate item on the Summary of Tender and included in the Tender Price. The cost of the maintenance work shall be accounted separately from retentions under the Conditions of Contract and shall be payable quarterly.

The maintenance contract shall include the provision of all expendable items not covered by defects liability in the works.

2.05.02 Spares and Accessories

The works shall include the provision of all necessary spare parts and replacements including those listed below:

- * Three sets of keys for each panel, keyswitch, access panel/door/cover, padlock or other lockable item. Where keys are suited, at least one key shall be provided for each lock/switch, etc, plus two spares;
- * Three sets of keys/levers for each size and type of valve, cock, damper or other appropriate isolating or regulating device;
- * Three sets of fuses of each type and rating as appropriate;
- * One complete set of replacements for each air filter;
- * One complete set of belts for each belt drive;
- * One set of spares and expendable items as recommended in the Operating and Maintenance Manuals.
- * Luminaires – The Contractor shall include for the following quantity of luminaires of each type (ref) to act as spares.

Quantity of Luminaires Installed	Quantity of Spares
0-10	3
11-25	5
26-50	5
51-100	10
101-250	10
251+	20

2.05.03 Nameplates and Identification Plates

Nameplates

All items of plant shall be provided with a brass nameplate engraved with the maker's name, serial number, model reference or number, duty, absorbed power/fuel rate, output power, working pressure, test pressure, fuel type, electricity supply and other relevant details as appropriate.

Identification Plates

Each item of plant and equipment shall be provided with an engraved identification plate bearing its reference number, name or other reference as designated in the Specification or on the drawings. Identification plates shall have letters and/or numbers of adequate size as appropriate for each case.

Plate Fixings

Nameplates and identification plates shall be fixed using screws, studs and rivets. Adhesives shall not be used.

Valve Labels

Each valve shall be fitted with an approved engraved label of "Ivorine" or similar laminated plastic. Valve labels shall be secured with a split ring.

Valve labels shall incorporate the relevant number conforming with the valve schedules and as fitted drawings. Each valve label shall clearly indicate the service and function of the valve.

Piped Services Identification

Piped services shall be identified in the manner described in the section of the Specification dealing with insulation and painting.

2.05.04 Electrical Equipment

Provision of Details

Sufficient details shall be provided for approval and to enable all electrical components of the works to be integrated with all other relevant electrical equipment. Such details shall include wiring diagrams, schedules and schematics specifically applicable to the works; 'typical' details shall not be accepted.

Details shall be provided of operating voltage, use/overload ratings, running and starting currents, locked rotor currents, earthing requirements and any other features relevant to the safe and efficient operation of the equipment.

All terminal references and equipment references on wiring diagrams and schematics shall conform with similar references shown on the drawings.

Motors

Except where alternative requirements are specified elsewhere, electric motors shall conform with British Standard requirements for super silent squirrel cage induction type; they shall be totally enclosed ventilated or screen protected and have sealed for life bearings.

Starters

Direct on line starting shall not be employed on any load above 5.5kW. Assisted starting shall be employed above 5.5kW.

Starters shall be metal clad or insulation surface pattern except where located inside a control panel having an integral isolator.

Three phase starters shall be of the three or four pole contactor type with phase failure protection, thermal and/or magnetic overload trips on each phase and no volt release.

Starters shall be suitable for push button operation except where specified elsewhere.

Where remote control is required, auxiliary poles shall be incorporated to ensure complete isolation of the coil circuit.

Colour Coding of Alphanumeric Marking of Electrical Cables

All electrical cables shall carry the new Harmonised colour / alphanumeric coding as defined by BS 7671.

For refurbishment work or where extensions to an installation occur the contractor shall refer to table 7E (appendix 7) of the regulations which specifically addresses the marking at the interface between old and new installations.

Electricity Supply

All electrical equipment shall be suitable for use with a 400 volt, 50Hz, three-phase and neutral alternating current electricity supply, except where difference requirements are specified elsewhere. This requirement does not preclude the use of single phase motors rated at 1.0kW or less.

2.05.05 Interruption of Existing Services

The agreement of the Employer's Representative shall be obtained prior to the commencement of any work requiring the interruption of any existing service.

All necessary liaison shall be carried out with the owners and/or users of existing services and confirmed in writing before any work commences in connection with existing services.

Due compensation shall be paid to the Employer and/or owners/users for any claim arising from damage or disruption caused by failure to observe all necessary precautions in any section of the works involving existing services.

2.06 Site Management

2.06.01 Protection of the Works

All necessary precautions shall be taken during the execution of the works to prevent physical damage, dirt, corrosion, dampness, pollution or other detrimental occurrences to plant, equipment, wiring, pipework or other component parts. Such precautions shall include:

- * Temporary covers as appropriate;
- * The mandatory use of proprietary caps, plugs, blank flanges, glands or terminations or approved purpose made blanking pieces on open ends of pipework, ducts, etc;
- * The retention of factory applied wrappings on radiators, convectors, luminaires, control equipment, items of plant, etc, until other trades work involving potentially deleterious effects has been completed;
- * Storage of delicate components in a safe place until potentially damaging activities have ceased in or adjacent to the final location of such components;

- * The use of adequate storage containers, racks, etc, in the periods between delivery and erection;
- * Protection against frost;
- * Any other reasonable measures as may be considered necessary by the Employer's Representative.

All necessary measures shall be implemented to prevent any element of the works from being misused, e.g. as temporary support, means of access or scaffolding or for any purpose other than that for which it was designed.

The Employer's Representative shall refuse to accept equipment:

- * That has evidence of damage, deterioration or other deleterious effects;
- * That is suspected of having suffered deleterious effects resulting from the absence of suitable protective measures.

If the Employer's Representative has reasonable grounds to believe that adequate protective measures have not been employed, all necessary means shall be implemented to demonstrate that no deleterious effects have occurred. Such means shall include:

- * Rodding, pigging or dismantling of pipework;
- * Additional testing of cables or pipework;
- * Removal of ceilings, duct covers or any other element of the building;
- * Uncovering of services in trenches;
- * Making good to any part of the building, services or external works made necessary as a result of demonstrating that no deleterious effects have occurred;
- * Any other measures as may be required to suit the particular circumstances.

2.06.02 Delivery of Materials

The works shall include all relevant provision for packaging, carriage and delivery of all necessary materials to the site.

Materials shall be delivered to site as required to suit the programme of work.

All surplus or redundant materials and packaging shall be removed from the site immediately.

2.06.03 Unloading and Storage of Materials

The works shall include all costs associated with the unloading, storage, hoisting, distribution and placing in position of the materials used, except when alternative provision is specified in the Contract Documents.

Track laying vehicles shall not be allowed onto any part of the structure without the express written permission of the Employer's Representative.

Written permission shall be obtained from the Employer's Representative before any bulk storage of materials is allowed on any part of the structure.

2.06.04 Site Accommodation

The works shall include provision for site offices, storage sheds, workshops and other accommodation necessary for the execution of the works, except where the Particular Specification or Conditions of Contract state otherwise.

Site accommodation shall be deemed to include any necessary provision for electrical supplies.

Site accommodation shall include toilet and messing facilities appropriate to the number of persons employed in the execution of the works, except where the Conditions of Contract include for alternative provision of such facilities.

2.06.05 Cleanliness of Site

All surplus and redundant materials, scaffolding, packaging and other items shall be removed from the site during the course of or on completion of the works as appropriate.

Care shall be taken throughout the course of the works, to ensure that materials in use, surplus materials and rubbish shall not present any hazard or obstruction to the movement of personnel or plant.

2.07 Quality Management

2.07.01 Materials and Workmanship

Compliance with the Specification

Materials and the standard of workmanship employed in the execution of the works shall comply with good practice and shall comply with all relevant requirements of the Specification, except where the written approval of the Employer's Representative has been given in advance, for compliance with an alternative requirement.

Difference materials from those specified shall be subject to prior approval and shall be accepted only when there are benefits either: to the Employer, in terms of quality or cost; or to the progress of the works. No additional costs shall be attributable to the Contract for any reason in connection with changes made to the Specification, in order to assist in meeting the programme of work.

Deleterious Materials

Without prejudice to the generality of Clause 7.1.1 all reasonable skill and care shall be used to see that, unless authorised by the Employer's Representative in writing or, where such authorisation is given orally, confirmed to the Employer's Representative in writing, none of the following has been or will be used in the construction:-

High alumina cement in structural elements;

Wood wool slabs in permanent formwork to concrete;

Calcium chloride in admixtures for use in reinforced concrete brickwork or blockwork;

Asbestos products;

Naturally occurring aggregates for use in reinforced concrete which do not comply with British Standard 882 : 1983 and/or naturally occurring aggregates for use in concrete which do not comply with British Standard 8110 : 1985;

Urea formaldehyde in cavity wall insulation;

Sand lime brickwork;

Wood preservatives or paints containing pentachlorophenol (PCP);

Insulation materials formed with chlorofluorocarbons (CFC's);

Tropical hardwoods from non-sustainable sources.

Rejection of Materials or Workmanship

All necessary facilities shall be made available to enable the Employer's Representative to inspect any materials and workmanship as required. This shall include inspections of materials at the Manufacturer's works, in store, during the installation or after installation as appropriate.

The Employer's Representative shall be empowered to reject at any time any materials or workmanship that do not comply with all requirements of the Specification.

Any rejected materials or other part of the works shall be removed and replaced in compliance with requirements of the Employer's Representative.

No claims for loss, expense, delay nor any other reason shall be based on failure to complete any section of the works as a result of materials or workmanship having been rejected for non compliance with specified requirements.

Approved Deviations

The works shall include all items as specified except where the Employer's Representative has given written agreement for the acceptance of alternative requirements.

Where the Specification includes such terms as “or equal and approved”, “or equivalent”, “or similar approved type”, such alternatives shall only be deemed appropriate after the approval of the Employer’s Representative has been given. Such approval shall be given in writing either:

- * Where the Conditions of Tender so allow, as acceptance of an offer included in the tender for an adjustment of the tender figure, or;
- * After the tender has been accepted, as an instruction issued in accordance with the Conditions of Contract.

2.07.02 Uniformity

All components having the same function shall be of the same type and interchangeable where relevant.

All components shall conform to relevant requirements of current British Standards and corresponding ISO or CEN standards with respect to sizing and compatibility.

Except where otherwise stated, all screw threads on nuts, bolts, studs and rods shall conform with metric standards.

Names, numeric and alphanumeric identifications of plant and equipment on labels, working drawings, as fitted drawings, schedules, operating instructions and any other location shall be consistent and in accordance with a logical format.

2.07.03 Workmanship and Quality Benchmark Room

The sub-contractor shall supply and install a fully fitted out example area in collaboration with the main contractor which shall act as a quality and installation methodology benchmark for sign off by the client. The area in question shall be agreed with the project design team and the client prior to first fix installation initiation. The client shall then review the installation and sign off the quality aspect for the electrical and mechanical sub-contractors to benchmark installation quality throughout the project. The installation shall align with the requirements specific to the space and include evidence (not limited to) of support and fixing methodologies complete with QR codes associated with the individual products present, and example approved fire -stopping installation in-line with the relevant substrate. The benchmark room will reflect installation methodology and quality with sign off associated with these elements only, wider products utilised shall follow the project technical specification and be subject to a full technical review.

2.07.04 Workmanship and Supervision

All elements of the works shall be carried out in a neat and workmanlike manner.

The works shall be deemed to include all necessary provision for the employment of competent personnel in management, supervisory, skilled and unskilled capacities.

A manager, foreman or other technically qualified and competent persona shall be nominated and be retained on site throughout the course of the works. This manager shall be fully conversant with all aspects of the works and shall be responsible for liaising with an accepting instructions from the Employer’s Representative.

Supervision of the works by the manager/foreman shall include all necessary inspections and ‘snagging’ to ensure that all elements of the works are completed and to an acceptable standard before being offered to the Employer’s Representative for inspection.

2.07.05 Vouchers

Invoices, accounts or other documents as appropriate shall be provided as required by the Employer's Representative as proof that any materials incorporated in the works are in full conformity with specified requirements.

2.07.06 Cleaning

The whole of the works shall be thoroughly cleaned as required by the Employer's Representative before being offered as being practically complete.

Cleaning of the works shall include:

- * Removal of all superfluous plaster, paint, excess jointing material, grout and any other debris;
- * Making good to decorations or other finishes after removal of superfluous materials;
- * Removal of dust/grime from luminaires, diffusers, polished/chrome or other bright metal finishes, gauge glasses, instrument faces, etc.

Cleaning shall include the interiors of all plant, panels and other relevant equipment.

Cleaning shall include the interiors of all services ducts, trunking, shafts or other concealed locations.

2.08 Cost Management

2.08.01 Schedule of Quantities and Rates

Within fourteen days of the issuing of the instruction to proceed with the works, or at such other time as may be required by the invitation to tender or Conditions of Contract, a fully priced schedule of quantities and rates shall be submitted to the Employer's Representative.

The schedule of quantities and rates shall show the quantities of each item of plant and equipment included in the tender together with the installed rate for each, including the cost of the material, labour and expenses, profit and discounts.

The schedule of quantities and rates shall be divided into sections in conformity with the Summary of Tender. The total for each section and the grand total shall conform with the prices shown in the Summary of Tender.

The schedule of quantities and rates shall be used in determining the cost of any variation to the works involving additions or omissions of quantities.

At the discretion of the Employer's Representative, the Schedule of Quantities and Rates may be used in determining interim valuations.

2.08.02 Variations and Additional Information

Instructions

The Employer's Representative may at his discretion issue instructions relating to variations in requirements of the Specification or giving additional information relative to specified requirements. All such instructions shall be issued using a standard form of instruction, e.g. Architect's Instruction and in accordance with the Conditions of Contract.

Circumstances may arise whereby decisions made on site need to be implemented before sufficient time has elapsed to enable a formal instruction to be issued. In such cases, the Employer's Representative shall issue an interim written instruction, e.g. a Site Instruction, at the time of making the decision. Requirements of such instructions shall be implemented on the understanding that a formal instruction will be issued in confirmation.

Adjustment of Costs

Where the requirements of a formal instruction constitute a variation to the scope of the works, any adjustment of costs shall be determined in accordance with Conditions of Contract.

Adjustments to the cost of the works shall be evaluated in accordance with one of the following methods, as appropriate and as directed by the Employer's Representative:

- * Where the variation involves an addition or reduction in the quantities of materials installed, the costs shall be calculated using the Schedule of Quantities and Rates;
- * Where the variation involves the provision of significant quantities of plant and materials of a type not included in the Schedule of Quantities and Rates, a separate quotation shall be submitted;
- * Where the variation involves modifications to existing installations or to materials already installed, the costs shall be either subject to a quotation or measured as daywork and based on the time expended and materials used, as directed by the Employer's Representative.

Quotations

When the Employer's Representative directs that a quotation is applicable, the make up of the quotation shall be fully quantified and a schedule of rates provided to demonstrate that the costs are reasonable and consistent with the level of pricing applicable to the Tender.

Daywork

Daywork shall only be applicable when the Employer's Representative so directs in writing.

Daily records shall be maintained on site of all time, materials and plant used in the execution of dayworks. Weekly records shall be submitted to the Employer's Representative for signature not less than seven working days after the end of the week in question. Copies of signed daywork sheets shall be issued to the Employer's Representative:

- * At the time of signature and;
- * Together with any application for payment in respect of that work.

Daywork sheets shall serve only as a record of the work involved in a particular activity. The signing of a daywork sheet shall not be construed as an instruction nor any indication as to whether the work constitutes a variation to the scope of the works.

Payment of Variations

Any application for payment for additional works shall include a list giving the following information for each variation:

- * Instruction number;
- * Brief description of work;
- * Submitted cost, or failing this, an interim budget cost or, where appropriate, the agreed cost;
- * Percentage of the work completed to date.

In the absence of a fully documented application, any payments for additional work completed shall be entirely at the discretion of the Employer's Representative.

2.09 Building Services Log Book

The Contractor shall, at the completion of the works, provide a Building Log Book to be used by the end user. The log book shall follow the guidance in CIBSE TM31 "Building Log Book Toolkit". It shall be issued to the Engineer in draft form for inspection one month prior to completion and shall be returned by the Engineer no later than five working days following receipt.

Handover will not take place without the final approved document being in place.

3.0 STANDARD ELECTRICAL SPECIFICATION

3.01 Regulations, Standards and Workmanship

The Contractor shall employ fully competent tradesmen of appropriate grades under the direct control of an experienced supervisor.

The whole of the works shall conform to the best principles of modern practice and comply with all relevant regulations and standards current at the date of Tender and in particular the following:-

- a) The Regulations for Electrical Installations, including any amendments, issued by the Institute of Electrical Engineers (the IET Regulations).
- b) The Regulations under the Factories Act and Health and Safety at Work Act, 1978 including the Memorandum on the Electricity Regulations.
- c) The Requirements and Regulations of the Electricity Supply Authority.
- d) The Requirements of any local by laws.
- e) The Requirements of the current editions, including any amendments, of all relevant British Standard Specifications (BSS) and British Standard Codes of Practice (BSCP).
- f) The Requirements of the Employer.
- g) The Requirements of all other applicable statutory, mandatory or advisory standards or regulations.

The Contractor shall include for all material, labour, work, sundry items, etc required to comply with the above regulations and standards.

3.02 Inspection, Testing and Commissioning

The whole of the electrical works shall be inspected, tested and commissioned in an orderly sequence in accordance with this Specification, the IET Regulations, British Standard Codes of Practice, etc. Generally, the inspection, testing and commissioning shall be a continuous process. It shall be progressive as work proceeds with the Engineer carrying out visual inspections and witnessing testing. No work shall be covered up or otherwise concealed until approval has been given by the Engineer.

All equipment, materials, labour, etc required for testing and commissioning shall be provided by the Contractor.

When the Contractor is satisfied that the works, or sections of the works, are complete and ready for testing, he shall notify the Engineer in writing giving a minimum of seven days notice. The works shall then be tested and demonstrated in the presence of the Engineer to show the following:-

- a) Compliance with this Specification and other contract documents.
- b) Compliance with the regulations, standards and workmanship detailed in this Specification.
- c) Ability of the works to perform correctly under all conditions of service.
- d) Correct settings of all controls, overloads, trips, etc.

- e) Correct functioning of equipment.
- f) All visual displays operate correctly.
- g) All interconnections with other systems are complete and functional.

The Contractor shall perform all tests required by the IET Regulations, British Standard Codes of Practice, etc. Completions and Test Certificates, signed by the Contractor, shall be submitted, wherever possible use the format suggested in the IET Regulations (e.g. earth loop impedance, insulation resistance, earthing, Completion Certificate, etc). For other systems, full details of the testing and commissioning results shall be entered on sheets of appropriate format.

Where equipment or materials are routine tested at the manufacturers works, the Contractor shall submit to the Engineer two copies of all routine and type Test Certificates. Faulty materials or workmanship found during inspection, testing or commissioning shall be removed and replaced by the Contractor at his own expense.

3.03 Materials

All materials shall comply fully with the requirements of the appropriate British Standard Specification.

The Engineer reserves the right to inspect materials either on site or at the manufacturer's works at any reasonable time and to reject any material which does not comply with this Specification. The cost of any dismantling, reassembly, removal or retesting as a result of rejection by the Engineer shall be at the Contractor's expense.

The Contractor shall obtain and check all quotations from manufacturers and suppliers to ensure that all incidental work, equipment, accessories and sundry items required for the proper functioning of the equipment are included. If any items are missing from manufacturers or suppliers quotations, the Contractor shall be responsible for supplying such items and for including all necessary costs in his Contract Price.

The Tenderer shall ascertain that all materials, including those specified by the Engineer, can be procured at the proper times to meet the required programme dates. If any material cannot be so procured, the Tenderer shall offer alternative and equal material. The Tenderer shall submit full details, Specifications, brochures, data sheets, etc to enable the Engineer to fully evaluate alternative materials offered.

3.04 Cables

3.04.01 Colour Coding of Alphanumeric Marking of Electrical Cables

All electrical cables shall carry the new Harmonised Colour / Alphanumeric Coding as defined by BS 7671.

For refurbishment works or where extensions to an installation occur the contractor shall refer to table 7E (Appendix 7) of the Regulations which specifically addresses the marking at the interface between old and new installations.

3.04.03 XLPE/SWA/LSF Cables

Cables shall be multicore, copper conductor, XLPE insulated, bedded, steel wire armoured, LSF sheathed overall, 600/1000 volt grade in accordance with BS 6724.

Fixings shall be by means of claw type cleats with plated nuts and bolts suitable for indoor or outdoor use.

Cables shall be terminated using compression type cable sockets and brass glands. All glands shall be fitted with PVC shrouds and be suitable for indoor and outdoor use. All fixings/supports/clips shall be of metallic material.

Earthing between the cable armouring and equipment shall be by means of brass earthing tags fitted to the cable gland. The earthing conductor shall be sized in accordance with the IET Regulations and be connected at the time of cable termination.

The cables shall be installed and terminated in accordance with the IET Regulations and the manufacturer's recommendations. Cables shall not be installed when the ambient temperature is below 1°C. Particular care shall be taken to avoid damage to other services which may run adjacent to or across cable routes. A minimum of 150mm shall be maintained between cables and other services.

Direct buried cables shall be laid at a minimum depth of 500 mm on a 75 mm bed of sand. Cables shall be covered by a further 150 mm layer of sand or sifted soil and protected by interlocking concrete cables tiles embossed "DANGER ELECTRICITY". Yellow plastic warning tape shall be installed 150 mm above the cable tiles.

Where cables pass under roadways or buildings they shall be protected to a minimum heights of 600 mm by galvanised steel channelling.

3.04.04 LSF insulated Cables for Use in Conduit and Trunking

Cables shall be single core, copper conductor, LSF insulated, 450/750 volt grade in accordance with BS 7211.

Conductors up to 2.5 sq mm may be solid. Larger sizes shall be stranded.

The insulation shall be coloured in accordance with the IET Regulations. Additional identification shall be provided where cables are used for specialist systems. LSF insulated cables shall not be routed through fluorescent fittings or near tungsten fittings and other high temperature equipment. In these instances, heat resisting cable shall be used.

3.04.05 MICC Cable

MICC cable shall be LSF sheathed, 1000 V grade, heavy duty type, unless specified otherwise, in accordance with BS 6207. Cable and accessories shall be from the same manufacturer.

Cables shall be made off using cold pot type seals, neoprene sleeving and ring type glands in accordance with the manufacturer's recommendations.

Where cables are surface mounted on walls, etc, or installed on cable trays, they shall be fixed by means of single or multiway PVC coated copper saddles secured with brass screws. All cables shall be neatly dressed in a symmetrical manner and no cable shall be bent to a radius less than six times its overall diameter or the manufacturer's recommendation, whichever is the greater.

The maximum spacing for fixings shall not be greater than the following:

a)	Surface or cable tray installation	:	300 mm
b)	Ceiling voids and other concealed areas	:	600 mm
c)	Buried in plaster work	:	450 mm

Under no circumstances shall cables be run through metal conduit or installed as to be in contact with pipework or other services without written approval of the Engineer.

Cables shall be installed in one length and the individual cores shall be identified by coloured or lettered sleeves.

At cable terminations a sufficient length of straight cable shall be provided before forming any set or bend to facilitate removal of the termination after installation of the cable.

Cables rising from below grade shall be protected to a height of 900 mm by galvanised steel channelling. Where cables are buried in wall finishes, they shall be protected by plastic channelling.

The Contractor shall ensure that all ends of cables are sealed immediately after cutting to prevent the ingress of moisture.

Cables shall be tested before and after installation and readings of "infinity" obtained.

3.04.06 General Pliable Fire Performance Cable Specification Cable Section

a) Pliable Multicore Circuit Integrity Cables-300/500 Volts

All cables shall be Firetuf, manufactured by Delta Crompton Cables in Accordance with BS 7629 and shall be served with an OHLS (Zero Halogen Low Smoke) sheath.

The manufacturer shall hold BASEC approval (British Approvals Service for Cables) for the products they manufacture and supply and in addition, be approved by Quality Assurance standard BS EN ISO 9002.

The manufacturer shall hold LPCB (Loss Prevention Certification Board) approval for the products they manufacture and supply.

The fire performance of cables shall comply with BS 6387 categories C,W,Z.

Pliable cables shall have an outer sheath covering of red for fire alarms and white for emergency lighting, other colours are however available. The overall sheath shall be low smoke and halogen free thermoplastic, unless otherwise specified.

Screening will be achieved by using an aluminium polyester laminated tape which will be in constant contact with a tinned earth conductor.

Fire integrity will be achieved by the combined performance of a close weaved glass binder in conjunction with silicone rubber insulation on the cores. Conductors shall be either solid or stranded plain annealed copper to BS 6360.

Firetuf cables shall have a twisted core configuration comprising of 10 twists per metre to improve signal transmission characteristics.

Pliable cables selected must comply with BS 4066 Part3/IEC60332 Part 3/HD405.3 Categories A,B,C-Flame Propagation.

b) Glands and Fixings

In normal conditions of use, entry to fittings should be through a zero halogen low smoke polymeric or type A2 brass gland. These components must be supplied by the same manufacturer as the cable itself.

Where pliable cables are fixed direct to the building fabric, purpose designed coloured (zero halogen low smoke) OHLS coated copper 'P' clips supplied by the same manufacturer as the cable must be used to ensure the fire survival properties of the installation.

The maximum distance between fixings is dependent on the size of the cable and shall not be greater than that specified in the tables below, unless permission is specifically granted by Delta Crompton Cables:-

Table One - Surface Fixed

Overall Diameter of Cable (mm)	Max. Spacing of Fixings	
	Horizontal (mm)	Vertical (mm)
Not exceeding 9mm	250	400
Exceeding 9mm and not exceeding 15mm	300	400
Exceeding 15mm and not exceeding 20mm	350	450
Exceeding 20mm and not exceeding 40mm	400	500

Table Two - Tray Fixed

Maximum Spacing * depending on installation	Horizontal mm	Vertical mm
Subject to compliance with local regulations	700	900

c) Installation Procedure

The Contractor shall ensure that his workmen are fully conversant with and are skilled in the installation of pliable cable

All bends shall be neat and uniform and their radius shall not be less than six times the diameter of the cable

After both ends of the cable have been made off, the cable shall be tested for continuity and short circuits, in line with the IET Regulations (BS 7671).

Conductors carrying fire alarm power or signals require no segregation from other systems so long as cables meeting BS 7629 are utilised, as referred to in BS 5839:Part 1 Section Two 17.10.

Pliable cables shall be installed according to BS 7671 (IET Regulations) and in conjunction with the manufacturers recommendations.

3.05 Conduit Systems

3.05.01 General

No conduit smaller than 20 mm shall be installed and manufactured elbows, tees or bends will not be permitted. Bends required shall be formed, using a standard conduit bending machine, without unduly deforming the conduit section.

The distance between draw in points shall not exceed 4 metres. The cable capacities of conduits shall be determined in accordance with the IET Regulations. Conduits shall be sized to give easy draw in and withdrawal of cables and the use of French Chalk or other lubricants to ease the installation of cables will not be permitted. Draw wires shall be provided in all conduits left empty for future cabling.

Each section of the conduit system shall be completely erected and swabbed clear before any cables are drawn in.

The conduit system shall be arranged so that cables are drawn in only at lighting points, outlets, switches and easily accessible conduit or adaptable boxes.

Where the ends of conduits have to be left unterminated during building operations, conduit couplers and stop ends shall be fitted to protect the conduit threads. Similarly, temporary lids shall be fitted to all conduit boxes, etc. Wood plugs or packing with paper, rags, etc will not be acceptable.

Where conduits are concealed in plasterwork, screeds and structural concrete, etc, they shall have a suitable depth of cover. The cover shall be at least 12 mm in plasterwork and 32 mm in screeds and concrete unless specified otherwise. Where the top coats of plaster are liable to corrode steel switch or outlet boxes, etc they shall be painted with one coat of red oxide paint before installation.

The lids of draw in boxes concealed in plasterwork or behind ceilings shall be the overlapping type to adequately mask the joint between the box and the surrounding material. Where conduit boxes are concealed, the face of the box shall be flush with or recessed by not more than 6 mm. Extension rings shall be used for conduit boxes recessed by more than 6 mm.

Conduit boxes that are proud of the surrounding material shall be removed and reinstalled, or where practicable, ground down and the metalwork rust proofed as for damaged conduit.

Vertical conduits shall be run parallel to or perpendicular to walls and be erected in such a manner as to reduce mechanical stress to a minimum.

Conduits in concrete which cross expansion joints or similar features shall be wrapped on either side of the joint for a distance of 300 mm with two layers of Denso tape. Where a surface conduit crosses an expansion joint or similar feature, a length of flexible metallic conduit, not less than 300 mm long, shall be installed in the conduit run across the joint or feature. A separate earth continuity conductor, terminated in an approved manner, shall be provided to bond across the flexible connection.

Conduits shall be fixed at intervals via metallic fixings not exceeding those given in the IET Regulations. In addition, fixings shall be provided within 300 mm of each lighting point, outlet, switch or other boxes. All boxes used for supporting lighting fittings, switches, outlets or similar equipment shall be independently fixed. In general two conduit boxes shall be provided for supporting each fluorescent fitting.

Rigid conduit shall not be directly connected to pumps or other equipment liable to vibration. In such cases, the final connections to the equipment shall be made using flexible metallic conduit.

The making good around lighting, switch and outlet boxes shall be carried out before the fixing of accessories or lighting fittings.

The conduit systems shall be arranged so that the conductors of each circuit are installed in the same conduit. All conduit systems shall be arranged so that they are completely rewirable from the spaces served and be accessible in false ceilings, etc.

A separate circuit protective conductor shall be provided for each circuit installed in conduit systems.

3.05.02 Metallic Conduit Systems

Conduit and accessories shall be the galvanised, heavy gauge, welded steel type in metric sizes. All fittings, couplers and accessories shall be the screwed pattern.

Conduit fittings for external or other damp locations shall be weatherproof. Covers shall be fixed by brass screws in blind, tapped holes. The faces and covers of boxes shall be machined and greased.

For normal situations, circular boxes shall be the small pattern with two cover fixing lugs at 50.8 mm centres. Where boxes are to support fittings exceeding 7 Kg in weight, large pattern conduit boxes, with four cover fixing lugs, shall be used.

The interiors of cur conduit ends shall be reamed to remove burrs and sharp edges.

Conduit terminations shall be fitted with a brass male bush and conduit coupler, except where the conduit is terminated into fittings or equipment having tapped spouts. The use of ring bushes and locknuts will not be permitted. On bushed connections, a cadmium plated locknut shall be provided to ensure earth continuity.

Exposed threads shall not be permitted, except where runners are essential. The threads of runners shall be treated as for damaged conduit.

Where the finish of a conduit has been damaged or removed, the conduit shall be protected by two coats of red oxide and one coat of aluminium paint.

Conduit systems are not intended to be gas tight. Provision shall be made for drainage and the expansion and contraction of air. Conduits shall fall to boxes, etc, where provision shall be made for drainage of condensation.

The provision of earthing or bonding conductors installed in the conduit system shall not reduce the requirement for the conduits to be electrically continuous and bonded to the earthing system. The conduit shall be tested for continuity before earthing or bonding conductors are installed.

3.05.03 Non Metallic Conduit Systems

Where approved, conduit shall be circular section, high impact, heavy gauge, rigid PVC type in metric sizes. All fittings, accessories, components, etc shall be obtained from the manufacturer of the conduit.

Joints shall be made using adhesive specially manufactured for jointing non metallic conduit systems. Where conduits are cast in-situ, the joints shall be further protected by two layers of Denso tape to form a rigid, water proof joint.

Allowance shall be made in accordance with the manufacturer's recommendations for expansion in the conduit system.

Non metallic conduit shall be used for internal applications and only where the temperature will not drop below 0°C or rise above 60°C.

Bends in conduit shall be formed using springs. The recommendations of the manufacturer shall be followed in terms of methods, temperature, etc. Inspection bends, tees, etc will not be permitted.

For normal situations, circular conduit boxes with spouts shall be used. Where the weight to the support is greater than can be accommodated by normal conduit boxes, heavy duty boxes with metal straps and clips shall be used. In such cases, additional fixings to the building structure shall be provided as required. High temperature of metallic boxes shall be used where the temperature is likely to exceed 55 degrees centigrade.

The interior of all cut conduit ends shall be reamed or filed to remove burrs or sharp edges. Conduits which terminate at distribution boards or similar enclosures which do not have spouts shall be fitted with adapters and bushes.

3.06 Earthing and Bonding

The main supplies will be the PME type provided by the Electricity Authority. Earthing terminals will be made available by the Electricity Supply Authority.

The Contractor shall supply, install and connect a complete earthing and equipotential bonding system in accordance with the IET Regulations and the Electricity Authority's requirements for PME installations.

Protective conductors shall be covered in green/yellow PVC insulation, except where they are an integral part of a multicore cable, in which case they shall be sleeved in green/yellow insulations at the terminations.

Circuit protective conductors and bonding connections shall be sized in accordance with the IET Regulations. Main bonding connections shall be made directly from the main earthing bar in the LV Switchroom.

All earthing and bonding connections shall be made at accessible positions and be identified by permanently fixed labels embossed "safety electrical earth - do not remove". The labels and 500 mm of wiring shall be free from decorative finishes such as paint, plaster, etc. They shall be protected by tape or similar prior to the application of the decorative finish. The protection shall be removed when painting, plastering etc is completed. Alternatively, the connections shall be made to cleaned surfaces and the labels fixed after decorating, etc is completed.

Connections shall be made using bolted links, removable only by tools for testing purposes as required by the IET Regulations.

3.07 Labelling, Marking and Circuit Lists

In additions to any specific requirements detailed elsewhere, the Sub Contractor shall supply and fix the labelling, marking, circuit lists, etc as described herein:-

Every fuse switch, isolator, distribution board, etc shall be clearly labelled giving its title or designation, source of supply, function, voltage and phases. Labelling shall be in Ivorine letters with characters at least 10 mm high. On main distribution panels, the characters identifying the incoming supply shall be larger to distinguish it from outgoing feeders.

All socket outlets are to be labelled clearly with circuit reference as drawings.

Phase identification shall be clearly marked inside all equipment, including single phase equipment.

Each conductor shall have phase identification by sleeves in either hard plastic or rubber. Numbered or coloured conductors shall be used and whichever system is used shall be maintained throughout the installation.

Warning notices, complying with the IET Regulations, shall be provided on all equipment operating in excess of 250 volts.

Labelling and identification shall be provided on each conductor, at both ends, of all control wiring, contractor controls, time clock circuits, etc using plastic numbered or lettered ferrules.

Special attention to labelling is to be applied to the main switchboard.

3.08 Fixings

All fixings shall be metallic type to BS 7671.

Fixings to wood shall be by means of woodscrews.

Fixings to masonry shall be by means of woodscrews and rawlplugs or other equal and approved methods. Larger fixings shall be by means of rawlbolts or other equal and approved methods.

External fixings and fixings in damp situations or where class 4 conduit is used, shall be made using white bronze rawlplugs and sherdised screws or other equal and approved methods.

Cavity fixings shall be the compressing rubber sleeve or toggle types to suit the particular application.

The minimum size of woodscrew used shall be 3.8 mm No 8.

Fixings to steelwork shall be clamped using minimum 6 mm diameter metal threaded rod, nuts and bolts. For external situations or in damp conditions all fixings shall be galvanised. Drilling of steelwork will not be permitted.

A weight of 14 Kg shall be suspended from each lighting point on conduit systems (7 Kg in the case of other systems) before the fitted is erected. Should any movement occur then the fixing shall be either remade or additional fixings provided.

The Contractor shall supply and fix suitable adapter plates or other items to facilitate the suspension of trunking, cable tray, lighting fittings, etc as required.

3.09 Building Form, Restrictions and Requirements

The basic structure of the building may restrict the Contractor in the positioning and type of fixings. The spacing of fixings, clearances, etc shall be adjusted by the Contractor as required to suit the building structure. The Contractor shall ensure that the maximum spacing of fixings or minimum clearances from other services are in accordance with the requirements of this Specification and the manufacturers recommendations.

The Contractor shall include for all setting, bending, diverting, etc as required to clear all other services and architectural or structural components. This shall include the supply and installation of all extension rings. Extension pieced, brackets, supports or other such items as required.

The Contractor shall include for sufficient fixings or secondary steelwork to cater for the weight of the electrical services being installed.

3.10 Fire Stopping

All engineering services including cables, conduits, cable trunking, cable tray, cable basket, cable busbar, etc. passing through floors or fire compartment walls shall be provided with appropriate fire stopping material (sleeves, collars, blankets, pillows, etc.) built into the building fabric.

Refer to section 1.0 for further details and requirements.

3.11 Rubber Insulating Mats

The Contractor is to allow for the supply and installation of rubber insulating mats. These shall be placed along the full length of the LV switchroom in front of the main switchgear.

3.12 Spares

On completion of the works, the Contractor shall hand over the following:-

- Suitable quantity of spare luminaires – Refer to Section 2.06 and Electrical Schedules for details.
- Spare parts for the fire alarm system as recommended by the system manufacturer.

The Tenderer shall include in his tender a list of the spare parts he proposes to provide.

3.13 Contractor's Responsibilities

The Contractor will be responsible for the installation and correct operation of all the Electrical Engineering Services in accordance with the details of this Specification, Associated Drawings and Client's Fit Out Specification. These documents should be read in conjunction with all relevant Architectural and Structural information.

3.14 Drawings, Specification and Schedules

Drawings of the works specified have been prepared by the Consulting Engineer as a basis for Tendering. It should be understood that they are diagrammatic and that it will be necessary for the Contractor to provide his own working drawings as indicated in the relevant section of this Specification. These working drawings shall be submitted to the Consulting Engineer, Client and Design Team for comment.

The drawings of the works specified are an integral part of this Specification and any work shown on these drawings but not detailed in the Specification and vice versa must be included in the Tender Figure.

The Drawings, Specification and Schedules shall be read together. The Contractor shall include in the Tender for any item or instructions detailed in the Specification and on Schedules attached hereto, whether or not the item or instruction concerned is detailed on the drawings.

The Consulting Engineer and Client reserve the right to effect alterations to the positions of lighting fittings, switches, outlets, diffusers, etc. as required by ceiling and partition layouts and site requirements. Such alterations shall be carried out without extra charge providing there is no additional material involved and the instructions are given before the work proceeds.

3.15 Equal and Approved

The use of alternatives will not be considered without the agreement of the Engineer.

Should it be deemed acceptable for the Contractor to propose alternatives then it will be necessary for the Engineer to be commissioned to analyse and comment on the proposal.

This commission will be quite separate to the original commission and the Consultant will endeavour to analyse and comment on the proposal in an objective manner.

To undertake any assessment the Contractor will provide the Engineer with detailed data to allow an assessment to be undertaken.

For example when alternative luminaires are proposed, the Consultant will request the submission of full photometric characteristics for all alternative luminaires being offered, including the necessary polar curves or equivalent as well as detailed lighting calculations. Such data and calculation should be reviewed to ensure that the alternative luminaires still meet or exceed the scheme parameters and criteria. Any calculations submitted must be made using the same parameters, such as room reflectances and maintenance factors, as the original calculations. Submissions of such calculations must be considered as a legal undertaking by the submitting party, and should be covered by suitable professional indemnity.

The energy consumption of the submitted luminaire must be checked against that of the specified luminaire. If the energy consumption is higher a re-calculation of the overall energy consumption of the luminaires in the building may be required to confirm that the installation still meets the requirements of Part L2 of the Building Regulations. In the case of external public lighting that is un-metered, the energy consumption of the luminaires should be checked to ensure that they comply with the requirements of BSCP250.

The Consultant must be satisfied that the luminaires being offered as alternatives are of equal quality, durability and robustness as the luminaires specified. This may require submission of sample luminaires for both specified and alternative luminaires and any components forming the total luminaire and its support. This is not to say that a luminaire with lesser construction and robustness properties will not be acceptable but does give a measure and yardstick against any declared 'benefits'.

Alternative luminaires must be considered both individually and in relation to other luminaires on the project to ensure aesthetic acceptability. This exercise should be carried out in conjunction with the Architects, Designers, Client and other interested parties who were involved in the selection of the original luminaires. In the case of exterior lighting this assessment should be carried out in conjunction with any fixing system, for instance in road lighting, the bracket and where applicable the lighting column. It is not equitable to subject any alternative luminaire to greater review than the original luminaire.

If the project circumstances had dictated special characteristics for the luminaire that are not covered by normal product or installation standards or directives then the assessment process should assess whether the proposed luminaire meets these special characteristics. Compatibility of components and systems should be checked to ensure safety and performance of the original design is maintained, e.g. any change from the specified control gear may adversely affect the projected lamp life.

Luminaires should only be specified that meet and comply with British Standards or European Standards. Any alternative luminaire should be submitted with full specification and technical detail sheets to show that they meet the same or equivalent standards. Where a proposed luminaire performance in any way differs from the specified luminaire a case should be submitted to support the alternative product and deal with the differences specifically.

The ease and simplicity of maintenance should be considered as part of any assessment of any alternative luminaires submitted. Any alternative luminaires should meet any specific maintenance factor for the installation.

Whatever the benefits, be they financial, ease of installation or time saving on the contract, they should be declared with the submission and request for change of the specified luminaire.

3.16 Co-ordination of Electrical and Mechanical Services

The Contractor is to ensure that all electrical services are fully co-ordinated with the Mechanical Contractor to ensure that there are no 'clashes' of services on site.

Both Electrical and Mechanical Contractors are to undergo a co-ordination process before the installation of services on site.

All Electrical Services including cable containment (tray/basket) both horizontally and vertically, socket outlets, floor-boxes, light fittings, smoke detectors are to be co-ordinated by the Contractor prior to installation to avoid 'clashes' on site.

3.17 Training of Employer's Staff

The Contractor shall allow within his tender price for training of employer' staff in the use of the following systems. The necessary training shall be provided and adopted for laymen at Practical Completion with an accompanying video recorded presentation:-

The following systems shall be included where applicable:-

1. Fire Alarm
2. Emergency Lighting
3. CCTV
4. External Lighting
5. Miscellaneous Services
6. Door Access
7. Security/Intruder
8. Warden Call/Nurse Call
9. Horizon Smart Metering
10. Maintenance Procedures
11. Panic Alarms/Staff Attack
12. Disabled Refuge and Alarms
13. Renewable Technologies
14. Standby Generator
15. UPS
16. Public Address
17. Hard of Hearing Induction Loop.

This training shall demonstrate the purpose, functionality and operation of each discipline listed above and within the Operation & Maintenance Manual(s).

The Contractor shall produce and administer a training acceptance and declaration form for the operator's signature post completion of the demonstration exercise.

3.18 Equipment to be Handed Over at Contract Completion

At Practical Completion, the Contractor shall present the Client's Agent with the following documentation and equipment:-

- a) Record documents as detailed in Section Two.
- b) Operating and Maintenance Manuals for all items of equipment supplied as detailed in Section Two.
- c) Electrical Test Certificates including NICEIC Inspection and completion Certificate in duplicate.
- d) All padlocks and keys for isolators on main LV switchgear.
- e) Keys for MCB distribution boards, isolators, etc.
- f) Manufacturer's Test Certificates for all equipment.
- g) Spare parts as listed within the Schedule of Spares.
- h) Record readings of all water, gas and electricity meters immediately on completion of the works.
- i) Residual Risk Assessment.
- j) Description of required maintenance for each system.
- k) Design Criteria Statement for all services to be 'Design Portioned' to the Contractor, e.g. lightning protection, lifts.
- l) Demolition Statement.
- m) Building Log Book

The Client's Agent will not accept handover until the above documents/items are in the Client's possession.

3.19 Maintenance

The Contractor shall include for the first years maintenance commencing from the date of Practical Completion for total maintenance for all electrical systems installed in accordance with the approved Operation and Maintenance Manuals.

This maintenance shall include all costs for visits by the specialist systems manufacturer's representative to check and maintain the systems in full working order.

These costs are entirely separate from the Contractors obligations in relation to the defects liabilities period detailed elsewhere.

The maintenance shall include, but not be limited to, the following services (where applicable):-

- Ring main unit, transformer, switchgear, LV distribution equipment and cabling
- UPS
- Standby generator
- TV systems
- Audio visual and public address systems

-
- Fire alarm and remote monitoring link
 - Lighting, emergency lighting and controls
 - Access control
 - CCTV
 - Intercoms
 - Security system
 - Lightning protection
 - Renewable technologies.

The Contractor shall include a detailed schedule of maintenance for all installed systems and services, indicating maintenance periods and a summary of the work involved.

4.0 FIRE STOPPING FOR SERVICES PENETRATIONS

4.01 General

The Contractor shall employ the services of a specialist fire penetration seal Contractor who is 3rd party certified by an approved organisation including but not limited to LPCB, BRE, FIRAS, IFC, BM TRADA, to design, specify, install, and certify a complete fire stopping system for all MEP services penetrations.

The specialist shall utilise only proprietary fire stopping and penetration seal products which are 3rd party certified by a UKAS accredited organisation. Firestopping products should be certified, CE marked and tested using the relevant standards.

Wherever practical, one firestopping and sealing system manufacturer shall be utilised throughout the project. In the event this is not possible, it is strictly forbidden to utilise products from different manufacturers within the same penetration opening unless there is clear unambiguous test evidence to verify performance and substantiate their use.

The firestopping details shall be developed in accordance with the requirements of the project specific Fire Strategy report, drawings and digital model and agreed and approved by the Fire Engineer and local Building Control/Fire Officer.

The Contractor shall be responsible for liaising closely with the specialist fire penetration seal Contractor to carefully coordinate the sequencing of installation works to ensure there is sufficient access to install and maintain the services penetration seals.

All firestopping products shall be installed strictly in accordance with the manufacturer's recommendations and guidance to ensure that they perform with their tested capabilities in the situation they are being used.

When sequencing the work, compartment walls with prepared openings should be programmed ahead of the installation of the M&E services to ensure the compartment wall can be installed compliantly above the services.

4.02 Design Standards and Guidance Documents

The penetration seal systems, their certification and installation shall conform to the following standards and guidance documents.

- Approved document Part B of the Building Regulations
- BS 9991 – Fire safety in the design, management, and use of residential buildings. Code of practice.
- BS 9999 - Fire safety in the design, management, and use of buildings. Code of Practice.
- Project specific fire strategy
- BS 1366 series – Fire resistance tests for services installations
- BS 476 series – Fire tests on building materials and structures
- BS EN 13501 series – Fire classification of construction products and building elements.
- Building Bulletin 100: Design for Fire Safety in Schools
- Department of Health Technical Memorandum 05-02: Fire code guidance in support of functional provisions for healthcare premises
- BESA DW/145 Guide to good practice for the installation of fire and smoke dampers

4.03 Spatial Coordination of Services and Fire Protection Seals

The Contractor shall be responsible for the final setting out of all services which shall be coordinated with the specialist sealing services Contractor to ensure sufficient spatial clearances for a compliant installation.

The specialist fire penetration seal Contractor shall design all fire protection seals in coordination with the MEP installation drawings, and the penetration seals shall be;

- Adequate to accommodate the required quantity and type of services passing through the fire separating element.
- Coordinated and certified for use within fire separating element and supporting construction for which it is to be installed.
- Installed only in supporting substrates which are covered by the third-party certification.
- Provide a fire resistance period of equal to or greater than the resistance period of the fire separating element.
- Provide fire resistance to fire penetration (Integrity (E)) and fire resistance to the transfer of excessive heat (insulation (I)) of equal to or greater than the integrity and insulation of the fire separating element.
- Comply with the relevant test standards BS EN 1366 or BS 476 as applicable.
- Complete with any additional properties which may apply to the penetration aside from fire protection, including but not limited to, acoustic performance, air tightness, air pressure, water resistance, smoke seal and even aesthetic requirements where in an exposed location.
- Tested and certified for the opening in which they are installed.
- Provided within framed openings within dry lining systems where required to meet the product testing and certification approvals.
- Coordinated with the supporting construction to ensure the penetration seal size is capable of being formed in the location required.
- Adequately spaced from other penetration seals in the same supporting construction
- Coordinated with any load bearing requirements, and installed according to the load it is designed to carry.
 - Note - Where fire stopping is installed in load bearing situations, they are normally only suitable for load bearing applications in a cold state and not during fire conditions. They are therefore not suitable for manned or storage areas.
- Tested and certified for the type of service passing through.
- Tested and certified for the size of each service passing through.
- Coordinated with any special requirements for movement of the supporting construction which may be lateral, rotational or shear, and tested and certified for the relevant application.
- Coordinated with the insulation type installed to building services, the reaction to fire properties of the insulation, and where this passes through the seal it is tested with the insulation in place as this is considered part of the fire seal.

The MEP services shall be spatially coordinated such that those passing through fire rated elements and constructions are;

- Adequately separated from other services to allow the seals to be installed in accordance with the manufacturers approved details
- Adequately separated from other services within a multi-service seal to allow the seals to be installed in accordance with the manufacturers approved details.
- Adequately positioned with distances between the penetration seal edge and services in accordance with the manufacturers approved details
- Adequately positioned to maintain minimum distances between penetration seals and supporting constructions.
- Adequately supported on either side of the penetration seal at a distance of no greater than the distance covered by the approved test certification.
- Readily accessible for future inspection, testing and maintenance requirements.

4.04 Technical Submittals

The Contractor shall provide technical submittals for all proposed fire protection sealing products, which shall include but not be limited to;

- Product datasheets and brochures
- Product test certificates and third party approvals
- Product CE mark and Declaration of Performance (DoP)
- Manufacturers installation instructions and approved installation details

The Contractor shall also provide working installation drawings, including for all fire penetration sealing requirements, from which a comprehensive set of builders work drawings shall be prepared by the Contractor.

All documents shall be submitted to the client, fire engineer, building control, architect, structural engineer, and consultant engineer for approval prior to commencement of works.

4.05 Site Quality Management

The Contractor shall employ the FIS “PPP” quality framework to record the fire sealing installation:

Product	Keep records of the specification, test evidence, purchase orders and delivery notes.
Process	Keep dated site images of the installation, particularly elements which get closed up prior to completion of the build.
People	Keep records of the skills, attitude, knowledge and experience of any person who installed the system.

The records from the process shall be recorded within the O&M manuals upon completion and be available for inspection at all times on site.

4.07 Benchmarking and Samples

The Contractor shall include for the preparation of sample wall and fire penetration sealing constructions as a benchmark for each type of wall type and fire sealing product combination, to provide an approved quality control benchmark for use across the project.

The benchmarks shall be signed off by all relevant parties including the client, fire engineer, building control and consultant engineer for approval prior to commencement of works.

4.08 Inspections and Photographic logs

The fire protection sealing installation shall undergo a thorough inspection regime to ensure all seals are installed compliantly, and as a minimum this should follow the guidance of ASFP Technical Guidance Note 17.

The penetration works must be inspected by someone within the same company, other than the installing operative, who has responsibility for checking and signing off the work including the placing of labels to demonstrate this.

An electronic system shall be employed for monitoring and managing the fire penetration sealing installation.

The Contractor shall complete a photographic evidence log, which shall be reference against each unique fire protection seal number, which shall be held on file to form part of the O&M manual at handover. Photographs should be taken before, during and after installation of the seal.

4.09 Labelling of Service Penetration Seals

Service penetration seals should be clearly labelled by the specialist contractor on completion with the following information:

- Unique reference number of the penetration and the seal
- Installation date
- Name of the operative who installed the seal
- Name of the supervisor who inspected the seal
- Name and contact details of the manufacturer
- Name and contact details of the specialist contractor
- Date of next inspection

4.10 Maintenance

The manufacturers maintenance requirements for all fire penetration seals shall be clearly detailed and included within the O&M's at handover.

4.11 Operation and Maintenance Manuals (O&M's)

The Contractor shall provide a digital O&M manual on completion of the works which shall include but not be limited to;

- Details of penetration seals installed within project including all accreditations and 3rd party certifications.
- Details of the specialist penetration seal Contractor
- Details of the penetration seal manufacturer(s)

- Full performance requirements of the penetration seals including integrity and insulation
- As built Plans and models showing the location and unique reference of all fire stopping seals, the finished size and construction details
- Photo log cross referenced with the plans/model using the unique ref number, logged with details of penetration seal
- Quality check records
- Future inspection and maintenance requirements

5.0 DEMOLITION AND ENABLING WORKS

5.01 Removal of existing Switchboard

The site is currently served from an existing obsolete switchboard. The contractor shall undertake isolation, disconnection, removal and disposal of this switchboard and associated required sub panel and distribution boards. As required to complete the required works.

The contractor shall note that due to the age of the main switchboard asbestos may be present and all health and safety precautions should be taken in accordance with the CDM and HSE requirement.

5.02 Provision of temporary Electrical Supplies

The contractor shall provide all necessary temporary power provisions to enable safe undertaking of the works within the required timeframe. This shall include lighting to the access and egress points and power for all relevant tools necessary for the works.

The contractor shall supply a temporary single phase 3kVA generator and connection to the on-site foul drainage pump located within the workshop area.

6.0 INCOMING SERVICES

6.01 Electricity

The site is currently served via an underground supply terminating into the main switch of the switch board. Contact has been made with National Grid to arrange for the existing supply to be isolated during the period of the works. A technician is due to visit site to assess and confirm the isolation, disconnection and reconnection procedures.

It shall be the responsibility of Contractor to co-ordinate with National Grid to arrange all works to ensure that the works program and key shutdown dates are achieved.

The metering arrangement shall be located within a dedicated section of the switchboard. Disconnection and reconnection of the meter shall be undertaken by National Grid.

The Contractor shall ensure that this work is carried out in a timely manner so that no delay to the Client's completion programmes is incurred.

The Contractor shall liaise with the DNO to confirm the characteristics upon which the electrical installation design and testing is based:-

1. Prospective short circuit
2. Over current protection device
3. Type of earthing arrangements
4. Source impedance
5. Nominal voltage and frequency

The Contractor shall provide all necessary on-site civil works associated with the DNO works and shall be responsible for the co-ordination of the installation to meet the programme of works. This shall include where required clearing of the current incoming cable pit and breaking out any necessary masonry to allow the installation of the new switchboard.

7.0 CABLING & WIRING REQUIREMENTS

7.01 General

The installation shall generally be wired as follows:-

Item	Cable Type	Containment Method
2. <i>Lighting & Small Power</i>	<i>LSF single core stranded copper cables (6491B)</i>	<i>Galvanised steel trunking within ceiling voids for main cable runs. Individual cable runs to be installed in galvanised steel trunking in ceiling voids and enclosed in conduit within walls/partitions. All fixings/clips/supports shall be of metallic material.</i>
3. <i>Final Circuit Cabling for Life Safety and Firefighting Applications</i>	<i>BS8519 Category 3, Multi-core, copper cable, fire rated to 120 minutes</i>	<i>Installed within dedicated cable basket/tray concealed within the ceiling void and installed as the upper tier to prevent premature collapse. All fixings and supports must have a fire survival time equal to the rating of the cables supported. Metal conduits shall be used for all drops within walls/partitions. Mechanical protection to be afforded where recommended by manufacturer.</i>
4. Main and Sub-Main Distribution	XLPE, steel wired armoured, LSF stranded copper cables (XLPE/SWA/LSF). All main and sub-main distribution shall have a separate CPC cable.	Heavy duty cable tray shall be provided to accommodate all sub-main cabling. Cables to be fixed to tray via round band and proprietary cable cleats. Where cables run singularly, they may be fixed direct to the building fabric via proprietary cable cleats. All fixings/clips/supports shall be of metallic material.

7.02 General Requirements

All cables and wiring systems shall be supported with fire resistant fixings without exception, to prevent premature collapse during fire conditions. Plastic, nylon and aluminium fixings are not acceptable.

Where surface installations are unavoidable, cables shall be dressed flat, free from twists, kinks, strain and aligned parallel to building elements. Where glands and clamps are not required, the Contractor shall extend the cable sheath through to the associated accessory boxes and equipment. Potential cable abrasion shall be overcome through the use of grommets or similar sharp edge protection.

Where vertical conduit is installed, cable clamps shall be provided in conduit boxes at 10m intervals.

All cabling shall be installed in an orderly fashion, capable of being withdrawn without affecting the local construction finishes.

The Contractor shall allow for full range of movement at building construction movement joints. All joints to wiring shall be made at terminal blocks within conduit boxes.

The Contractor shall ensure that the capacity of all primary cable containment is sufficiently sized accommodate all cabling proposed with a further 25% provision for future extension.

It shall be the responsibility of the Contractor to protect all apertures through fire compartmentation lines. Fire prevention shall be achieved through approved techniques at positions coordinated with the containment installations and the building's Fire Strategy Layouts.

7.03 Cable Jointing

It is anticipated that the existing cabling will be of insufficient length to re-terminate into the new switchgear and as such require jointing to allow connection to be made.

The contractor shall allow for jointing of all existing cabling onto new cable legs sized to match the existing cable.

All joints shall be maintenance free type and be clearly labelled as to the load connected.

All joints shall be supported on Cable tray or Ladder Rack supplied and installed by the contractor.

7.04 Sub Main Cabling

Sub main cables shall be supported on cable rack, cable tray, uni-channel or monopoint fixings as appropriate to the particular cables concerned. The support system shall be designed with economy, durability and strength as paramount requirements. All cable tray supports shall be galvanised and installed at centres such as to prevent deflection in the tray and where necessary, galvanised mild steel angle supports shall be installed along the length of the tray.

The primary cable tray shall emanate from the building's main switchgear panel and run horizontally along the corridor voids and rise vertically within designated risers to the floors above.

Multiple cable runs shall be supported on cable tray/basket of adequate strength for the number and size of cables concerned, plus minimum of 25% spare capacity. Cable tray/basket shall be affixed to the building fabric within designated service voids, risers or zones. Cabling shall be dressed in such a manner that crossovers are eliminated.

Subsidiary minor routes of cables shall be supported by medium duty return flanged cable tray or uni-channel as appropriate.

All sub-main cabling shall be laid side by side, individually fixed using cleats or cable ties. Metallic cable ties shall be used on all fire performance rated cables.

7.06 Sub-Circuit Cabling

The installation of general LSF lighting and power cabling shall be via galvanised basket, trunking or cable tray installed at high level or above suspended ceilings with secondary conduits to final outlets positions concealed within the building structure (refer to the Containment Layouts for exact details of the main sub-circuit containment specification).

The cable basket or trunking shall emanate from floor distribution boards and shall generally run horizontally along circulation routes and above ceilings.

Where vertical trunking is proposed, pin racks at 3m intervals shall be provided. Cable ties shall be employed at 2m intervals for all wires of the same circuit reference. Ties shall be marked with the respective circuit reference number at 10m intervals.

The Contractor may consider the use of multi-compartment trunking for the installation of ELV systems wiring and/or fire alarm system wiring. Where cable basket is proposed, proprietary divider plates shall be installed to segregate the respective LV and ELV cabling accordingly.

Sub-circuit cabling containment shall be supported along its entire length with all sections of the basket/trunking and associated fittings efficiently and adequately bonded as required in Section 8. Fixings shall be adequate to carry the containment (at full load) without deflection, with due consideration for appearance, access and rigidity.

Where brackets are required to support cable containment, they shall be constructed in steel using flat angle or channel sections such as to ensure strength and rigidity for the particular duty. Where brackets are fixed to the building or structure or steelwork, these shall be affected by the use of patent type of special fittings as appropriate, but permission obtained from the Contract Administrator before any such work is carried out. All fixing brackets shall be given two coats of red oxide paint after erection.

All cable containment shall be securely fixed to brackets by means of plated, round head bolts, nuts and lock washers with bolt heads to avoid damage to cables.

Where cable containment passes through structural apertures, a cover plate shall be fixed to the containment before installation. This shall be arranged to project at least 50mm beyond the finished surface of the wall or floor. Fireproof barriers shall be fitted at these positions.

Cable Trunking Requirements

Steel conduit connections to cable trunking shall be undertaken by means of smooth bore brass bushes and couplings. The trunking shall be cleared of all paint at the point of contact and repainted immediately upon completion of the conduit installation.

Where vertical runs of trunking exceed 5m in length, the cables shall be supported in an approved manner and internal barriers fitted every 3m to prevent excessive rise in air temperature at top of trunking.

All removable covers, which shall be of the screw fixing type, shall be securely fixed after completion of the works.

Where trunking contains single core cables are installed, respective circuit cables shall be bound together through the means of insulating tape at 2m intervals.

Regardless of the trunking size, the containment shall be attached to the building framework or fabric at intervals of not more than that recommended by the manufacturer.

Any proprietary joints in the trunking shall be arranged to not overhang fixing points by more than 700mm.

All trunking fittings (i.e. bends, tees etc.) shall leave the main trough completely clear of obstruction and the cover shall be completely accessible except through walls and floors at which points suitable fire resisting barriers shall be provided. All fittings shall be compatible with the main body of the trunking.

Trunking shall not be installed with the cover on the underside.

Where trunking is used to connect switchgear or distribution boards such connections shall be made by trunking fittings manufactured for this purpose and not be multiple conduit couplings.

All trunking shall be electrically continuous by means of 30mm x 5mm copper links across each joint in the system. Connection shall be made by means of electro-tinned bolts (heat inside trough), nuts (6mm diameter minimum), flat washers and spring washers and where trunking is galvanised, the galvanising shall be removed within 6mm of the joint strap and painted after to prevent rusting.

Wherever in the building it is possible for the Contractor to provide a concealed and recessed installation a galvanised steel conduit system shall complete the installation from the trunking to the lighting point, lighting switch, socket outlet, etc.

Where there is no provision of suspended ceilings in rooms, the final connection to the accessory from the corridor ceiling trunking shall be carried out using steel galvanised conduit installed on the surface.

8.0 MAIN DISTRIBUTION AND SWITCHGEAR

8.01 Main Switchboard

The Contractor shall supply and install a factory built fully type tested cubical type Switchboard complete with a dedicated section within the incoming cubicle to house the incoming DNO termination point and facility to accommodate the connection of a third party DNO metering unit.

The switchboard shall accept the incoming underground electrical supply and distribute outgoing moulded case circuit breaker circuits to primary sub-distribution equipment including but not limited to; composite split load power and lighting MCB distribution boards, general SPN and TPN MCB distribution boards, fire alarm control and indicating equipment, mechanical services control panels and sustainable technologies.

The Main Switchboard shall be manufactured by an approved panel builder and be complete with Protective devices and equipment manufactured by **Schneider Electric**. All Sub-Distribution Boards shall be manufactured by **Schneider Electric** or equal and approved. The Contractor shall refer to the electrical schedules for associated details. Any alternative manufacturers suggested by the Contractor shall be presented to the Engineer and Client for approval prior to any orders being placed, however

The Main Switchboard has been sized based on the existing site constraints, Where the Contractor is considering offering an alternative, full co-ordination with the existing switchroom shall be conducted in advance of the offer of an alternative. Where an alternative solution is being offered, it will be the Contractor's responsibility to fully co-ordinate this in accordance with the internal building constraints. Separate switchboards/propriety equipment will not be accepted when fulfilling this requirement.

The Contractor should refer to the Mains Distribution Schematic for a comprehensive summary of the proposed LV philosophy for the development.

8.02 Design Standard

The switchboard shall be designed, manufactured and tested to comply with the requirements of BS EN 61439 and meet the requirements for Form 4 Type **2 separation**.

8.03 Panel Manufacturer

The contractor shall employ a specialist panel manufacturer / builder to provide a floor mounted type tested switchboard of modular construction complying with BS EN 61439-1+2:2011.

Due to the project time constraints, a specialist has been approached to provide a technical proposal and quotation for the supply and manufacture of the switchboard to suit the site constraints and distribution requirements.

The contractor shall confirm the delivery lead in time from point of order for the switchboard and ensure an order is placed with the manufacturer for it's construction in a timely manner to ensure completion of the works is achieved by the required key dates as indicated in the contract documents.

The contact details for the switchboard's supplier is:-

Chris Gooding
Contracts Engineer
Harries Automation and Control Ltd
Systems House, Unit 8,
Trostre Business Park,
Llanelli,
Camarthenshire,
SA14 9UU

Tel: 01554 777460

Mob: 07442 797794

Chris.gooding@hacltd-group.com

Quotation Ref Q.0985576.1.01

8.04 Panel Specification

The new main LV switch panel shall replace the existing obsolete unit located within Plantroom 1 on the ground floor labelled DB-16 within the Electrical record information.

The manufacturer of all devices/equipment shall be Schneider Electric.

The LV Switch panel shall be constructed to the following specifications –

- Construction: Form 4 Type 2 to BS EN 60439
- IP Rating: IP31
- Material: 1.5mm steel
- Paint Finish: RAL7035
- Cubicle
- Fault Rating: 80kA 1 sec
- Equipped with Transient Voltage Surge Suppressor,
- Incoming Bottom
- Outgoing Top
- Metering as per schematic
- Spare Capacity as indicated on the associated LV schematic
- TMD Devices \leq 250A
- Electronic Trip Unit \geq 250A

All outgoing devices will be moulded case circuit breakers, suitably sized and set for the appropriate protection level using thermal-magnetic as well as microprocessor logic trip units where required as specified above and as indicated on the associated schematic drawing/s.

The main switch panel will have a minimum fault capacity of 80kA for 1 second, based on the calculated prospective short circuit condition and manufactured to IEC 61439 Parts 1 and 2.

The switchboard shall be provided with inter panel gas tight barriers and ASTA type tested as a composite assembly.

All incoming and outgoing cables shall be installed with watertight glands with all minor control cables in glanded and watertight conduit.

Where single core armoured cables are to be terminated into a gland plate, it shall be of a suitable non-ferrous material.

The switchboard shall be provided with Integral busbars rated to a minimum of 970A, with a minimum of 25% spare capacity for future expansion. Each bus bar shall be rated to short circuit strength of 80kA (minimum) for 1 second.

Busbars shall be separated from all functional units and their terminals by metal enclosures. Metalwork shall be finished to withstand local climatic conditions. Doors, lids and removable panels shall be fitted with suitable gaskets to prevent ingress of moisture and insects. All units shall be provided with locking devices.

8.05 Construction

The switchboard structure shall be of bolted design and comprise Zintec sheet steel, 2mm for main framework and 1.6mm for cladding. It shall meet the degree of protection requirements of BS.5420 (IEC.144) IP31, this is to be achieved without the use of gaskets.

The switchboard shall be capable of being broken down into sections to facilitate handling if required. If this is the case, this facility should be available along the length of the board and also the depth, where the board is deeper than 600mm nominal. The Manufacturer shall assist the Contractor with the assembly of the switchboard sections on site.

Contractor shall ensure that this is allowed for within the tender sum.

The switchboard shall be complete with a section specifically required for the storage of any special tools and spare HRC fuselinks, six of each size utilised in the design. This section shall be provided with door access.

The switchboard shall also include an area for transient surge suppression and a supply to the existing external power factor correction equipment.

The main incoming supply, and outgoing ways shall be provided with multi-function metering in accordance with the requirements of the Building Regulations.

All metering will be provided with provision for connection to a future BMS and or dedicated site metering hardware/software, to allow central monitoring.

8.06 Cabling

Access for cabling shall be from the rear with cable entry from either top or bottom to suit the Contractor's requirements.

Cabling compartments shall be provided for cables from the protective devices. These compartments shall be continuous throughout the switchboard. It shall be possible to gain access to these compartments without isolating the switchboard.

8.07 Busbars

The busbars are to be 4 pole air insulated mounted within DMC insulators supported by sheet steel brackets and manufactured from HD/HC rectangular section copper with bolted connections between horizontal and vertical busbars and clamp type connections to all outgoing circuits. All busbar

connections to utilise maintenance free fixtures of the 'Precote 80' type. Busbars shall be capable of being mounted at the top, in the middle or at the bottom of the assemble to suit design requirements.

The horizontal and vertical busbars are to be enclosed within a segregated sheet steel compartment to comply with BS EN 61439

Main interconnections between protective devices and the busbars are to be carried out in copper strip, run within a fault free zone and fault rated to satisfy the rating of the devices to which they are connected.

The busbar system to be rated to suit the required electrical demand and independently tested in a LOVAG test station. Certified to 50KA for 1 second, 80KA for 1 second and 100 KA for 1 second duration.

The neutral busbar shall be of the same cross-sectional area as the phase busbars.

8.08 Functional Devices

All, MCCB's are to be selected from a single manufacturers range and provided with door interlocks to isolate live components when the door is opened. Any accessible parts which remain live when the door is opened are to be shrouded to meet a minimum of IP2X requirements. Shrouding to be labelled advising that live parts would be exposed if the shrouding were to be removed.

The mains incoming disconnecter shall be Four pole 800A MCCB Isolator.

Moulded case circuit breakers shall be manufactured in accordance with IEC 947-2. The breakers shall be complete with trip-free mechanisms to allow operation when padlocked on or when closed onto a fault.

The switchboard shall be complete with spare ways as indicated on the associated schematic drawing

The outgoing way protection shall be by moulded case circuit breakers (MCCB) Internal Switchboard Wiring

Small wiring is to be carried out in a minimum of 1.5mm sq LSF insulated 450/750v grade to BS 7211, class 2, single core cable and fitted with up to 4 digit cable markers. BMS communication wiring shall be in twisted and screened cable, earthed one end.

Power cabling shall be carried out in PVC insulated 450/750v grade to BS 6004, class 2, single core cable with crimp compression terminals or clamp type terminals, colour flashed in phase colours.

8.09 Earthing

A full width extendable copper earth bar is to be provided in each section with a connection point at each end and with a main incoming earth terminal in the incoming section. The steel framework is to be mechanically and electrically bonded with the earth bar extended to each gland position to facilitate cable armour earthing.

8.10 Doors

All doors to have a hinge assembly that permits opening greater than 90°.

8.12 Labels

All panel designation labels are to be white/black/white manufactured from plastic laminate giving black lettering on a white background secured by plastic rivets or screws with all circuit designations labels engraved.

8.13 Paint Finish

The process to involve passing through a 2-stage process of chemical degreasing, and automatically electro-static epoxy polyester film application before being cured at a high temperature. The depth of paint to be 40/60 microns to the manufacturer's standard colour.

8.14 Testing

The completed switchboard is to be electrically and mechanically inspected and tested throughout its manufacture. Final testing and inspection to include dielectric in accordance with BS EN 61439 and an insulation resistance test. Auxiliary equipment susceptible to damage by such tests is to be excluded from the tests. Operating procedure tests to be carried out on all equipment.

8.15 Power Factor Correction

The existing external Power factor correction unit shall be re-used and re-supplied via a dedicated way within the main switchboard.

8.16 Metering

All meters shall be of the same manufacturer throughout and be connected to the automatic metering and targeting system and building management system (BMS)

The Contractor shall ensure that each meter is installed to the face of the main panel and the total quantity of meters are presented to the building management system specialist for inclusion within the points list.

8.16.01 Main switchboard – Incoming Metering

A main incoming meter shall be provided compliant to IEC 61000-4-30 Class S.

The meter shall be capable of measuring the following parameters:

- Energy
- Voltage (Phase to Phase, and Phase to Neutral)
- Current
- Frequency
- Active, reactive, apparent power (total and per phase)
- Power factor (total and per phase)
- Current and voltage harmonic distortion to the 63rd, waveform capture, detection of voltage sags and swells

The meter shall detect the direction of disturbances. The meter shall be 0.1% for current and voltage accuracy and 0.2 Class for Active energy as per IEC 62053-22 (active energy).

The meter shall support Modbus, ION, DNP3, IEC61850 with dual port ethernet for daisy chaining, and be connected to the automatic monitoring and targeting system and BMS.

The meter shall be capable of acting as a Modbus Master connecting downstream serial Modbus devices.

The power meters shall be compliant to EN50470-1. The meter shall also be MID approved and certified (Annex B+F or Annex H1).

8.16.02 Main switchboard – Outgoing Metering

Outgoing metering shall be provided to all sub-main circuits emanating from the main switchboard.

The power meters shall measure the following parameters:

- Energy
- Active, Reactive and apparent power (total and per phase)
- Voltage (Phase to Phase, and Phase to Neutral)
- Current
- Frequency
- Power Factor (total and per phase)
- THD to the 15th harmonic.

The power meter devices shall comply with IEC 61557-12 Class 0.5 for revenue meters.

Accuracy for active energy of the power meters shall be class 0.5S as per IEC 62053-22 (active energy). The power meter shall use four-quadrant metering.

The meters shall be equipped with Modbus serial ports and be connected to the automatic monitoring and targeting system and BMS.

The power meters shall be compliant to EN50470-1. The meter shall also be MID approved and certified (Annex B+F or Annex H1).

8.17 Transient Surge Suppression

Protection shall be provided to the main incoming supply via provision of Type 1 & 2 Integral SPD unit within a dedicated module.

9.0 LOW VOLTAGE DISTRIBUTION

9.01 General

To facilitate the replacement of the current switchboard a new Panelboard shall be installed to allow connection of the sub-main and circuits that are unable to be re-terminated into the new switchboard due to physical size limitations within the existing space, The circuits to be installed on to the new panelboards are indicated on the associated schematic drawings.

As part of the works the existing LV distribution system is to be upgraded, these upgrade works consist of the replacing obsolete distribution boards for new Type A or B units. The distribution boards to be replaced are indicated on the associated drawings and schedules.

It should be noted that the information on the existing sub-circuits and connected loads has been determined using the available record information, this record information is to be verified on site to ensure the correct number and type of protective devices are installed.

Where sub-circuits supply sockets outlets, RCBO's rated at 30mA shall be provided.

9.02 Panel and Distribution Boards

All main and sub-main low voltage distribution equipment shall be procured and installed by Contractor generally as indicated on the Main Distribution Schematic and associated schedules.

All distribution boards shall be provided with lockable, hinged covers and relevant circuit protection for outgoing ways as detailed in the Electrical Schedules.

All main and sub main distribution boards shall be fitted with engraved warning and identification labels stating the reference of the board, phasing details and its supply orientation.

Distribution boards (as shown on Main Distribution Schematic) serving both lighting and power sub circuits shall be split and provided with CT's, digital meter and all other necessary equipment to enable the recording of lighting energy usage simultaneously and independently.

Distribution boards within the residential areas are to be manufactured by Fusebox to allow the installation of single module AFFD's

All panel/distribution boards shall be provided with a typewritten circuit list which shall be attached to the inside of the hinged lid in a heavy duty, transparent plastic envelope. The circuit list shall include the following information:-

- DB Reference
- Supply Point
- Circuit Numbers and Phases
- Circuit Designation
- MCB Rating
- RCBO Rating
- Cable Type and Size.

All panel/distribution boards shall be of the same manufacture throughout.

General Performances

All MCB distribution boards shall comply with the relevant parts of BS EN 61439 and phase identification to BS 7671.

All MCB distribution boards shall be fabricated from rust protected sheet steel and be coated with epoxy powder paint, the finished colour to be RAL 9001.

All MCB distribution boards shall include a fully shrouded main busbar assembly which shall include integral provision for the electrical connection and isolation of an unused outgoing ways and the live side terminals of outgoing MCB ways. Where boots or similar devices are supplied to cover live parts of spare ways the board will be deemed not to comply with this requirement.

All MCB distribution boards will be supplied with a manufacturer's 5 year guarantee.

All MCB distribution board neutral bars shall be supplied complete with insulating cover requiring the use of a tool to facilitate its removal on B type boards.

All 3 phase MCB distribution boards shall accept 3 or 4 pole incoming devices to enable switching of incoming neutral.

All MCB distribution boards outgoing ways shall be capable of conversion, through the use of a kit, to facilitate neutral switching through the use of 2 or 4 pole devices.

All MCB distribution boards shall accept 1, 2, 3 and 4 pole (3 or 4 pole on B type boards) MCB's as outgoing units, be capable of accepting the following outgoers.

- a) Combined MCB/RCD's (RCBO's) of single phase type having the following characteristics:-
- Manufactured and tested to BS EN 61009
 - A breaking capacity of 10kA to BS EN 60898
 - A or AC classification
 - 10, 30 or 100mA sensitivities
 - Permanent non-adjustable and non-removable earth fault protection
 - A width of no more than one outgoing way where the neutral is unswitched
 - Automatic protection against reverse polarity
 - Automatic disconnection in the event of a lost neutral
 - Be able to accept auxiliary contacts, under voltage release or shunt trip.
- b) Combined MCB/RCD's (RCBO's) of three phase type providing protection, disconnection and isolation of all live conductors including the neutral.
- c) MCB's combined with a full range of electrical auxiliary devices:-
- Shunt trips
 - Undervoltage releases
 - Auxiliary switches
 - Alarm switches
 - Emergency stop release.
- d) Any combination of a), b) and c) above.

General Installation

All MCB distribution boards shall be suitable for surface mounting or flush through the use of a separate kit.

All MCB distribution boards shall make ample provision for cabling. In particular cable space must be available to the rear of the pan assembly, furthermore the pan assembly shall be removable to further ease cabling and to avoid the ingress of foreign bodies during the preparation of cable entry points. The Contractor shall ensure that all outgoing phase cables are afforded circuit identification tags.

All MCB distribution boards shall be supplied from the distributor without the incoming device fitted. Incoming device including terminal blocks, switch disconnectors, MCCB's and RCD's shall be available separately such that the maximum flexibility is maintained.

All MCB distribution boards shall facilitate the protection, connection and isolation of all incoming and outgoing live conductors including the neutral, such that routine tests can be performed with the minimum of effort.

Type 'B' MCB distribution boards may be required to be associated into neat and tidy groups as specified in the schedules. Units shall therefore be of modular dimensions, and it should be possible to mechanically join boards both vertically and horizontally with the use of a manufacturer supplied kit.

Single phase 'A' type MCB distribution boards shall be also available in modular dimensions for similar association.

Range of Manufacture

To allow for all installation requirements to be met using the same manufacturer's equipment, the manufacturer shall provide a complete service as follows:-

- Provide a complete range of 'A' type and 'B' type distribution boards and accessories,
- Provide a complete range of 'A' type and 'B' type multi-service units enabling the inclusion of both MCB's and control devices such as contactors, push buttons, signal lamps, etc. in the same enclosure grouping,
- Provide a complete range of metal-clad and all-insulated individual enclosures,
- Provide a complete range 10kA to BS EN 60898 (15kA to BS EN 60947-2) MCB's with current rating up to 63A,
- All MCB's shall be panel mounted with or without DIN-rail by preference, this requirement shall be met as standard however an accessory is an acceptable solution,
- Be capable of providing 'specials' by manufacturing prefabricated assemblies in their own workshop.

9.03 Miniature and Moulded Case Circuit Breakers

Miniature and moulded case circuit breakers shall comply with BS EN 60898 and BS EN 60947-2 respectively and shall be installed with due regard to the environmental conditions prevalent on site. All breakers shall be selected in accordance with the British Standards with due regard to operating characteristics, current rating, calibration and discrimination. Adequate backup protection by mccb's shall be provided. Miniature circuit breakers shall be unconditionally rated at a category of duty M9 or higher. The effect of ambient temperatures, operating duty, and application, shall be fully considered in applying derating factors for application at site.

Multi-phase miniature and moulded case circuit breakers shall have means for preventing any one pole of a multi pole circuit breaker being operated or tripping independently of the other poles.

Miniature and moulded case circuit breakers shall have locking facilities and be supplied with all keys, or shall be enclosed in cases with locking facilities which shall be provided with keys.

Miniature and moulded case circuit breakers shall be of the same type throughout the Contract.

All MCCB's and MCB's shall be mounted on a removable din rail. The neutral bars shall be drilled for at least one connection per circuit way.

MCCB and MCB banks in cubicle panels shall be of a similar pattern to those enclosed in distribution boards.

All MCCB's and MCB's used in Distribution Boards shall have a minimum fault rating of not less than 14,000 amps breaking capacity.

9.04 Residual Current Devices

All residual current devices, with or without integral overcurrent protection, shall in all instances confirm with BS EN 62423, Type 'B' and be suitable for residual sinusoidal AC current, pulsating DC current including superimposed smooth direct current, AC current with mixed frequencies and smooth direct current.

Residual current operated devices are to be either 3-phase and neutral or 1-phase and neutral. Either type must isolate all poles and neutral and be complete with a test button marked "PUSH TO TEST". The unit must be of robust construction and be mounted in an enclosure of pressed steel.

9.05 ARC Fault Detection Devices (AFDD's)

In accordance with BS 7671, AFDD's conforming to BS EN 62606 are recommended as a means of providing additional protection against fire caused by ARC faults in AC circuits.

AFDD's shall be installed within all consumer units within the residential accommodation serving single-phase AC final circuits supplying socket-outlets not exceeding 32A.

The AFDD shall not replace any MCB or RCBO, but is to operate as well as the circuit MCB/RCBO.

All AFDD's to include integral isolator so can be isolated from the circuit.

All AFDD's to be DIN Rail mounted.

For use in Distribution Boards:

Where single module Arc Fault Detection Devices (AFDD) are unavailable from the selected manufacturer, the Contractor shall wire an AFDD in series with the circuit protective MCB or RCBO, and house within a dedicated din-rail enclosure mounted above the respective distribution board. Without exception, the AFDD and enclosure shall be procured from the same manufacturer supplying the distribution board and its circuit protective devices.

The Contractor shall identify the purpose of the equipment by affixing suitable labelling to the front of the DIN rail enclosure. A dedicated circuit chart shall be contained within the distribution board which highlights the topology arrangement installed including confirmation that a separate AFDD is wired in series from the corresponding circuit.

For use in Consumer Units:

The AFDD can be installed directly onto the DIN rail within the consumer unit.

Alternatively, an additional amendment 3 DIN rail enclosure/consumer unit shall be provided.

Each AFDD requires 2 No. 36mm modules within each distribution board/consumer unit.

AFDD's shall not be provided to circuits requiring protection higher than 32A.

All AFDD's shall be single phase type.

9.06 Meters

The Contractor shall supply, install, test and commission an automatic Energy metering system to the low voltage distribution equipment as detailed herein, on the LV distribution schematic, and to satisfy the requirements of Approved Document Part L, CIBSE TM:39, BREEAM, and other environmental criteria including but not limited to NABERS and other net zero carbon emission reporting policies.

All meters shall be of the same manufacturer throughout and be connected to the automatic metering and targeting system and building management system (BMS)

The Contractor shall ensure that each meter is installed to the face of the panelboards and distribution boards and the total quantity of meters are presented to the building management system specialist for inclusion within the points list.

Refer to Section **Error! Reference source not found.** of this specification for the building metering strategy and general requirements.

9.06.01 Panelboard – Outgoing Metering

Outgoing metering shall be provided to all sub-main circuits emanating from the main switchboard

The power meters shall measure the following parameters:

- Energy
- Active, Reactive and apparent power (total and per phase)
- Voltage (Phase to Phase, and Phase to Neutral)
- Current
- Frequency
- Power Factor (total and per phase)
- THD to the 15th harmonic.

The power meter devices shall comply with IEC 61557-12 Class 0.5 for revenue meters.

Accuracy for active energy of the power meters shall be class 0.5S as per IEC 62053-22 (active energy). The power meter shall use four-quadrant metering.

The meters shall be equipped with Modbus serial ports and be connected to the automatic monitoring and targeting system and BMS.

The power meters shall be compliant to EN50470-1. The meter shall also be MID approved and certified (Annex B+F or Annex H1).

9.06.02 Distribution Boards – Incoming Metering

Distribution boards shall be suitable for tariff/sub-metering applications and shall be assembled from standard manufacturer components either to fully meter the total load or separately lighting and power loads, or lighting, power and air conditioning loads. The meters shall monitor the following parameters:

- Energy
- Voltage (Phase to Phase, and Phase to Neutral)
- Frequency
- Current – present and maximum
- Power - active, reactive, apparent (total and per phase)
- Power factor (Total and per phase)
- THD to the 15th harmonic.

The power meter devices shall comply with IEC 61557-12 Class 0.5 for revenue meters.

Accuracy for active energy of the power meters shall be class 0.5S as per IEC 62053-22 (active energy). The power meter shall use four-quadrant metering.

The meter shall be compliant to EN50470-1. The meter shall also be MID approved and certified (Annex B+F or Annex H1).

The meters shall be equipped with Modbus serial ports and be connected to the automatic monitoring and targeting system and BMS.

10.0 EARTHING

10.01 General

The Contractor shall supply and install a new main earthing bar adjacent to the new main switchboards.

The contractor shall supply and install new main bonding conductors from the incoming main services in line with BS:7671 to the new main earth bar.

Earthing network for the purpose of earthing each item of electrical equipment or control gear whether supplied under this contract or by others, in accordance but not limited to the requirements of the following standards and recommendations.

10.02 Design Parameters

- All relevant British Standards
- BS 7430
- BS 7671 18th Edition
- Engineering Recommendations G.12/3
- BS 9999
- Engineering Recommendations 5.5/1
- District Network Operator requirements.

10.03 System Description

Provide a supply system earthing network as outlined below:-

The contractor shall supply and install a new dedicated main earth bar of HDHC tinned copper mounted on insulated bobbins adjacent to the new switchboard.

The Contractor shall connect equipotential bonding conductors to the main earthing terminal as listed in Section 9.05 below.

All sections of metal cable trunking, busbar chambers, items of switchgear, and other similar metal cased units forming parts of the new switchboard and Panelboard shall be suitably bonded together with suitable copper strip, secured by brass machine screws with heavy brass washers, nuts and locknuts. The copper bonding strip shall have a cross sectional areas as required by Regulation, but in no case shall it be less than 25mm x 2.5mm in section.

Main bonding conductors and supplementary bonding conductors shall be connected to pipework etc. using approved earth clamps which be of heavy, cast, tinned brass each having brass set screws, nuts and lock nuts.

Cables shall be secured to the earth clamps using crimped or soldering sockets which shall be secured to the clamps by separate screws independent of the fastening of the clamps.

Approved earth clamps shall be similar to the Elmo type, as manufactured by Messrs M Mole & Son Ltd, or other well established manufacturer approved by the Engineer. Earth clips of the copper or galvanised iron strip type will not be accepted.

All earth clamps must be readily accessible and be complete with the following label "Electrical Earth Connection – Do Not Remove".

Earth clamps in damp situations shall have phosphor bronze bolts, nuts and washers shall be given two coats of bitumastic paint after installation and after earthing tests have been completed.

An earthing terminal shall be provided on each piece of equipment necessary or apparatus supplied to the Contractor. The terminal shall consist of a substantial brass set screw, brass nut and washer.

All earthing conductors shall (unless otherwise stated) shall be enclosed in galvanised steel conduit or trunking.

Additional protective conductors shall be run alongside steel wire armour cables as indicated on the Drawings.

Care shall be taken to ensure that the earth clamp of socket outlets is efficiently connected to the conduit boxes. The metalwork of all lighting fittings and other current using equipment switches shall also be efficiently earthed.

Care shall be taken to ensure that all joints are properly made and bonded to ensure continuity. The earth system shall be connected to the earth bar.

At completion, the Contractor shall provide internal fire stopping of all cable trunkings as they pass through fire compartment walls/floors, in compliance with Regulations 527.2.

Protective conductors shall be installed in all flexible connections. The metalwork of all lighting fittings and other current using equipment shall be earthed.

Each individual fuseswitch, distribution board, tray and trunking shall be bonded. Sizes of conductors shall be as indicated on the Drawings.

The earth terminal of each socket outlet and its conduit box shall be connected by a circuit protective conductor or supplementary bonding conductor. Every conduit box serving an electrical output point of any type shall be provided with a properly screwed and tapped earthed terminal.

All local lighting and small power circuits shall be provided with a separate CPC.

Provide earthing systems for standby/firefighting generators in accordance with this specification and drawings.

10.04 Main Earth Terminal

The Contractor shall supply and install a suitably sized earth terminal at the incoming electrical service position, for connection to the adjacent switchboard(s). The following works shall be undertaken by the Contractor:

- Install main protective bonding conductors as stated in Section 8.05 below.
- The main earth terminal shall be mounted on insulated bobbins/supports located at clearance of 30mm centres for a 25mm bar and 450mm centres for a 50mm bar. A minimum clearance of 30mm shall be afforded at rear of bar.
- Clearance holes shall be drilled, one for each cable plus 30% spare holes (two minimum) at 50mm minimum centres through the bar for connection of cable lugs. Clearance holes shall be the minimum size necessary to maintain adequate lug/bar contact.

10.05 Main Earth Terminal Connections

The Contractor shall supply, install and terminate main protective bonding conductors to the main earth terminal(s) as detailed herein.

The Contractor shall install compression type lugs suitable for bolting copper cables direct to the main earth terminal(s) sized in accordance with the requirements of BS 7671 and in relation to the CSA of the main supply neutral where PME conditions apply.

- The incoming mains supply cable gland/terminal enclosure
- Primary LV switchboard/switch panel internal earth bar
- The incoming gas supply pipework
- The incoming water supply pipework
- Extraneous-conductive-parts (e.g. exposed structural metalwork and cladding)
- Lightning protection system
- New Cable Containment systems

A dedicated clean earth bar shall be installed within the Communications Room for earthing of the structured cabling equipment cabinets.

10.06 Earth Marshalling Bars

Where an installation provides more than one building with remote buildings supplied from the same incoming supply provide Earth Marshalling bars in each of the remote buildings to meet the requirements of the latest version of BS 7671. A bonding conductor is to be provided from the main earth bar to the Earth Marshalling Bars in the remote buildings to meet the requirements of the latest version of BS 7671.

In each of the remote buildings provide main equipotential bonding conductors connected to the Earth Marshalling Bars to meet the requirements of the latest version of BS 7671.

10.07 Supplementary Bonding

The Contractor shall provide additional protection in the form of supplementary equipotential bonding in accordance with BS 7671. For all new works.

The Contractor shall assess the requirements for additional protection in the form of supplementary equipotential bonding for all special locations listed in Part 7 of BS 7671. These include:-

- Swimming pools and other basins
- Rooms and cabins containing sauna heaters
- Construction and demolition site installations
- Conducting locations with restricted movement
- Operating and maintenance gangways

The Contractor will supply, install and commission additional supplementary equipotential bonding where the automatic disconnection cannot be fulfilled to BS 7671 Section 411.3.2.6.

11.0 LIGHTING, EMERGENCY LIGHTING AND EXTERNAL LIGHTING INSTALLATION

11.01 General

The contractor shall supply and install a new lighting installation within the main switchroom, consisting of new IP65 400K Industrial LED Linear luminaires complete with integral 3hr emergency Non-maintained battery pack as indicated on the associated drawings

The lighting installation shall be in accordance with the current CIBSE Code for Lighting, CIBSE LG7 and BS EN 12464-1.

The Contractor shall ensure that the installation and location of all luminaires is provided as depicted on the lighting and emergency lighting drawings. Luminaires shall be erected in exact locations to ensure the task, immediate and background illumination levels set out in BS EN 12464-1 are achieved.

All new lighting shall be controlled via local manual switches and key switches for emergency luminaires.

11.02 Switches

All lighting switches shall be 20 amp rating and positioned in relation to the luminaires to comply with Part L of the Building Regulations.

Lighting switches shall be of the grid type. Lighting switches of a single pole type shall be connected to the phase conductor. Where grouped, switches shall be of the multi-gang type.

Lighting switches of the grid switch pattern shall comprise switch; cover plate adjustable grid and box, all components being part of a single manufacturers grid assembly system. The switches shall be 20 amp rating and comply with BS 3676 and BS EN 60669-1.

All grids shall be provided with terminal earthing tag connecting the grid to the metal box. The metal box shall be provided with an earthing terminal and shall be connected to the protective conductor of the installation. The solid terminal screw connection within the back-box will not be accepted as a suitable earth.

11.03 Luminaires

Luminaires in congested Plant Rooms or roof areas shall be located with particular emphasis to the maintenance access under CDM Regulations.

No conductors less than 1.5mm² size shall be used for the installations hard wiring and all conduit systems steel or PVC must carry an earth continuity conductor of suitable capacity. This requirement also applies to flexible conduit connections and cable trunking systems.

Where the Contractor has selected alternate and equal and approved luminaires it shall be their responsibility to ensure not only the performance of the luminaire matches that specified but also the installation including efficacy values and cable sizing are not adversely affected.

All luminaires shall be independently supported from the building structure unless they are fixed directly to a load bearing surface.

The Contractor shall ensure all luminaires and their control devices are under warranty for a minimum of twelve months from the date of handover. Where luminaires have been installed prior to handover

they shall remain the responsibility of the Contractor thus the warranty period not commencing until the handover date.

Where fire rated ceilings are employed, the Contractor shall ensure that all penetrations through the finished ceiling are suitable protected via intumescent fire hoods.

11.04 Lighting Controls

11.04.01 Controls Philosophy

All luminaires unless otherwise noted shall be provided with local manual control.

11.05 EMERGENCY LIGHTING

The Contractor shall supply, install and connect a complete emergency lighting system throughout the building. The system shall be in accordance with the requirements of Building Control and the Fire Officer and fully comply with BS 5266, EN50172.

The emergency lighting luminaires shall be self-contained, non-maintained or maintained type as detailed in the Schedules attached to this Specification.

All emergency lighting luminaires shall comply with the requirements of the appropriate ICEL Specification, BS 5266 and EN50172.

In the event of a mains failure, the lamp shall remain illuminated for a minimum period of three hours. On return of the mains supply the battery shall be automatically recharged.

The emergency lighting fittings shall include a highly efficient solid state, 220/240 volt inverter module having the following functions:-

- a) To convert the dc supply to an ac supply required for the lamp.
- b) To provide a charging current for the battery pack from the mains supply.
- c) To energise the fitting on mains failure.

The Contractor shall ensure all batteries are sourced from a reputable supplier who adopt strict rotation system in storage. Where NIMH or lead acid batteries are utilised the Contractor shall ensure they have been electrically charged at a minimum of 6-monthly periods throughout their life. The operating temperature shall not exceed 55°C. All batteries shall comply with ICEL 1010.

Once the site electricity supply is energised (resulting in illumination of the emergency fittings), the Contractor shall ensure that the supply is not intermittently isolated thus allowing the batteries to extinguish fully and maintain life expectancy hours quoted by the manufacturer.

The Contractor shall ensure the emergency luminaires maintain an initial charge duration of 24 hours. Where continuous site isolation at site occurs, the Contractor shall refrain from connecting the emergency luminaires until a time where a permanent mains supply is established.

All surface mounted emergency luminaires shall be capable of withstanding the 850°C hot wire test.

The emergency lighting fittings shall be fed from the normal lighting circuit or in some cases dedicated circuits and connected to the unswitched supply so that the fitting is activated on failure of the local lighting circuit.

All luminaires shall be capable of withstanding the hot wire test and shall match the general luminaires in each particular area.

11.06 Testing of Emergency Lighting

*** Key Test Switches**

All emergency lighting luminaires to be tested via dedicated key test switches positioned locally within the room. Key test switches shall be installed to match the profile and colour finish of the general light switches.

12.0 TESTING AND INSPECTION

12.01 Main Switchboard & Panel Boards

The contractor shall undertake a complete EICR on the existing sub-main and sub-circuit cabling from the current Main Switchboard DB-16 in accordance with the requirements of BS: 7671 including all latest amendments.

As the power is to be disconnected from the site the contractor shall ensure that testing of all conductors is undertaken including insulation resistance and R1+R2 values.

No limitations will be accepted on the test certificate without notification to the engineer and approval of the reason for such limitation.

13.0 RECORD INFORMATION

13.01 Record Drawings

The contractor shall update the main LV distribution schematic provided as part of this project to reflect the actual on-site layout and distribution strategy.

The contractor shall provide a copy of the drawing for review by the engineer and on receipt of any comments amend the drawing accordingly and provide a full-sized framed version for mounting within the Main switchroom.

13.02 Labelling

The contractor shall update the labelling on all existing Distribution boards to indicate the following;

- DB Reference
- Supply Point

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