KGA (UK) Ltd

Chartered Building Services Consulting Engineers

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Electrical Services Performance Specification

Project:-

National Museums Liverpool Sea Galleries – Second Floor

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Date: July 2019

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SECTION 1.0 PRELIMINARIES

1.01 GENERAL

Tenders are invited for the design (where applicable), supply, delivery, erection and setting to work of the equipment, apparatus and materials detailed in the specification and on the associated drawings, all subject to the following conditions -

1. The submission of a Tender will be regarded as the acceptance by the Tenderer of the General Conditions of Contract.

2. The Employer/Client will not examine or consider any Tender which does not comply in every respect with these Conditions of Tendering.

3. The Tenderer will be deemed to have carefully examined the Specification and Drawings supplied to him and to have fully acquainted himself with all requirements and on any detail or matter which may be obscure to him, as no allowance or claim will be considered for any alleged deficiency of material or description contained in the Specification or on the Drawings once the Tender has been submitted.

The Drawings may be inspected by appointment at the Consulting Engineer's Office.

The following definitions shall apply:-

Client shall mean	**National Museums Liverpool** 127 Dale Street, Liverpool, L2 2JH
Consulting Engineer shall mean	**KGA (UK) Ltd** Trinity Chambers, 10 Ivy Street, Birkenhead Merseyside, CH41 5EF
Contract shall mean	the Engineering Contract or - Contract
Electrical Services Sub Contractor shall mean	the Electrical Services Sub Contractor to whom the contract is awarded
Contract Works shall mean	the design (where applicable), supply to site, installation, testing, commissioning and handing over of a complete and working installation.

1.02 FORM OF CONTRACT

The work to be carried out under this Sub-Contract is included as a Fixed Cost Item in the Main Building Contract made between the Client of the one part and the Main Contractor of the other part, which said Main Building Contract is subject to the Form of Agreement and Schedule of Conditions for Building Contracts published by the Royal Institute of British Architects, as amended between the Employer and the Main Contractor, (hereinafter referred to as the RIBA Conditions of Contract), and the successful Tenderer shall stand in relation to the Main Contractor as a "Domestic Electrical Services Sub Contractor" in accordance with the full meaning of the said Form of Agreement and Schedule of Conditions.

Under no circumstances will the Electrical Services Sub Contractor's or any Suppliers own printed Conditions of Sale or Tender be applicable to the execution of the Sub-Contract Works.

1.03 SUB CONTRACT PRICE BASIS

The attention of Tenderers is drawn to the Conditions in the Contract whereby the price basis is to be FIXED.

1.04 MAINTENANCE

See Section 2.0

1.05 DAMAGE

The Electrical Services Sub Contractor shall take all necessary and reasonable precautions to prevent damage to buildings, fittings, equipment etc, provided under the Contract and shall bear the cost of making good any such damage to the satisfaction of the Employer.

1.06 CERTIFICATE OF PAYMENT

All Invoices shall be forwarded to the Consulting Engineer for approval.

Under no circumstances shall any invoice be issued direct to the Client.

The Electrical Services Sub Contractor will receive payment to the extent of the amount claimed less retention and less any amount previously paid.

The amounts so retained will be released against Certificates of Payment issued in accordance with the Conditions of Contract.

1.07 OVERTIME

Where, owing to the default of the Electrical Services Sub Contractor, it may be necessary for the work to be carried on at other than normal working hours, he shall carry on the work without additional payment but otherwise shall not be required to work at other than normal workings hours without receiving payment for the extra cost involved.

If the Electrical Services Sub Contractor is ordered, in writing, to work at other than normal working hours, he will be allowed the nett additional cost incurred in respect of the wages of tradesmen and labourers so employed.

1.08 FINAL CONTRACT VALUATION

On completion of the Contract Works the Electrical Services Sub Contractor shall agree with the Consulting Engineer, the value of any Contract variations outstanding and as soon as possible thereafter, submit to the Consulting Engineer his final statement of account showing the total value of the Contract Works claimed for approval.

1.09 TENDER PRICE DETAILS

Where called for in the Tender Documents, Tenderers shall provide, in addition to the Total Tender Price, such other detail Tender information, section and individual item prices as indicated, to be used as may be required.

1.10 PRICED SCHEDULES OF QUANTITIES

In addition to the details to be given at the time of Tendering, any Tenderer, upon being advised that his Tender is receiving consideration, shall prepare, within seven days of being called upon to do so, and submit, in triplicate, detailed Priced Schedules of Quantities, showing the make-up of the total Tender Price.

These Schedules are to be sub-divided in Sections as the Lump Sum Tender Form to provide a unit rate for each item to be supplied. It is understood that in no case more than two Tenderers will be required to fulfil this condition.

1.11 DAYWORKS

No work shall be carried out on a day work basis or at day work rates until the Clients Representative has given his written permission via the Main Contractor to do so. When day work is permitted, day work sheets must be produced to verify the extent of work and these sheets must be signed by a person authorised by the Client.

The signed day work sheets, which shall be completed at the time that the extra work has been carried out, shall be forwarded to the Engineer for his consideration and approval that the claim is a bona-fidé extra to Tender.

SECTION 2.0 GENERAL REQUIREMENTS

2.01 GENERAL

This section of the Specification covers the general requirements relating to the Works, as detailed in Section 4.0 Particular Works. The parts shall be integrated together with Sections 1.0 and 3.0 to be read as a complete contract requirement.

The specification and any drawings provided shall form a single entity and be complementary to each other. All materials specified, required and/or indicated on the drawings shall be procured, supplied, delivered, off-loaded and installed by the Electrical Services Sub Contractor.

The specification shall be read in conjunction with any drawings provided. Any items of plant and equipment shown on the drawings but not described in the specification or described in the specification but not shown on the drawings, shall be provided as part of this section of the works, and be deemed to be included in the Contract price. If there is a difference between the requirements of the specification and the drawings, the difference shall be clarified before tendering and ordering.

Where 'shall' is used to give instructions in respect of a part of this section of the works, all costs arising from such instructions shall be deemed to be included within the Contract price.

The Works shall be carried out under the direction and to the entire satisfaction of the Client and/or his representative. Whilst undertaking the works it is essential that duty of 'care' is maintained at all times.

Since the tender or architectural drawings (where provided) are only representative of the work to be undertaken, they may not fully indicate every change of direction, bend, or offset, required in the services for their complete installation and co-ordination with other services and the building structure. It shall be deemed that all aspects of the works have been examined and this section of the works shall include for all labour and materials necessary to achieve a full and co-ordinated installation of the work covered by this specification.

It shall be deemed that the site, the Conditions of Contract, Specification, Schedules, Associated Architectural and Structural Drawings and Plans have been examined. If all the particulars required cannot be obtained from this examination, application to the Clients Representative for further information shall be made.

Any claims because of want of knowledge in respect of the section of the Works included in this Specification will not be considered.

2.02 ELECTRICAL SERVICES SUB CONTRACTOR COMPETENCE

To maintain a standard of competency for all Electrical Services Sub Contractors the following shall be noted:

- The Electrical Services Sub Contractor shall ensure that 'all' safety and welfare measures required under or by virtue of any enactment or regulation on the working rules of the industry are strictly complied with.

- To ensure a standard of competency for any Electrical Services Sub Contractor engaged on this project, details shall be furnished, upon request by the Clients Representative, of the competence of all their installation operatives.

- The Electrical Services Sub Contractor shall be fully registered with the NICEIC as an approved Contractor.

2.03 DELIVERY AND CONSTRUCTION PROGRAMME

A comprehensive and detailed delivery and construction programme shall be issued to the Client as part of the Tender Proposal.

The programme shall be of the simple bar chart type, suitably broken down into services elements covering each main area or floor level, indicating dates for the commencement and completion of all sections of work.

The programme shall make an allowance for, and indicate separately, all work including preparation of drawings, comments on drawings, first fix items, second fix items, pre-commissioning checks, pressure testing, setting systems to work, commissioning and performance testing, witnessing of tests by the Client or his representative, and demonstration of plant and equipment. The programme shall clearly indicate what are considered to be first and second fix items, and also show the required delivery dates of all goods and materials vital to the programme. Evidence shall be provided that such goods and materials can be made available at the required time.

Whilst long delivery items must be ordered early, care must be taken to ensure that items, which may deteriorate under site conditions, are not delivered to site too early (even if there should be slippage in the Construction Programme). Such items, if ready for delivery too early, must be warehoused at the Electrical Services Sub Contractors cost.

The programme shall also show:-

- The periods allowed for the proving and setting of work of plant and equipment.
- The periods allowed for diversion and/or re-provision and/or special protection of existing services that are affected by the new construction. In particular, any such work that has to be carried out in advance to enable the Electrical Services Sub Contractor to begin work must be clearly shown.
- Projected dates for breaking-in to existing services. In arriving at these dates, the particular operating conditions of the service concerned shall be borne in mind (i.e. whether it operates 24 hours/day, 7 days/week or only weekday office hours; whether it operates only through the winter months and is shut-off through the summer months; or whether there are specific peak demand/loading times), and programme break-ins organised to minimise disruption.

It should be noted that the Client and/or his representative shall only witness performance tests when all elements of building works have been completed, and due allowance for this shall be made when the programme is being prepared.

Should the agreed programme for the works require to be modified, a revised programme covering this section of the works shall be prepared and issued.

2.04 INSTALLATION LIAISON

The Electrical Services Sub Contractor is responsible for the co-ordination of all his Sub Contractors and their installation work on site. All Sub Contractors appointed for the Works by the Electrical Services Sub Contractor will be required to co-operate with all other trades before the work is commenced to ensure the correct design intent during the course of construction.

This shall include all necessary liaison prior to the preparation of the installation drawings, to ensure that the final detailed installation drawing layouts prepared under this section of the works are compatible with all other aspects of the works i.e. structure, and other services, being installed in the same vicinity. Any work that has to be re-done due to negligence in this respect will not constitute an extra.

Particular care shall be taken to prevent obstruction of electrical service positions, cable routes, switch positions, access positions and obstruction of sanitary engineering services, rodding positions etc. Services installed in ducts shall be so arranged to permit maximum access along the ducts and all services, equipment and plant shall be readily accessible for maintenance.

Where the work includes the installation of large items of equipment the access required shall be arranged in good time.

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

- Two or more items of equipment, whether electrical or mechanical or both, which are to be erected on the same wall or ceiling, or which will be otherwise visually close to each other, shall be arranged in a neat and symmetrical group. Symmetry of arrangement shall be obtained by horizontal and vertical alignment through the centre lines (or bottom for sockets etc above worktops) and not the edges of the equipment and for this purpose any mounting heights stated in the general specification or on drawings may be varied slightly.

- Particular care shall be taken to ensure that the neatest fittings are used on surface pipe work / conduit / trunking with a neat and tidy pipe work / conduit / trunking arrangement installed. Work, which is required to be re-done due to negligence in this respect, shall not be charged to the Contract. This also applies to surface conduit installations.

All concerned will be required to co-operate in planning these arrangements.

2.05 QUALITY ASSURANCE

Where the Electrical Services Sub Contractor is left to select products, the BSI Buyers Guide shall be consulted to ensure that products that are manufactured or stocked under the following schemes are always given priority.

- BSI KITEMARK Scheme
- BSI SAFETY MARK Scheme
- Firms of Assessed Capability.
- Stockists of Assessed Capability.

The Client shall be notified of any instances where these schemes could be, but are not, used.

2.06 MISCELLANEOUS STANDARDS

The works shall conform as applicable to the following;

- Health and Safety at Work Regulations
- Construction (Design and Management) Regulations
- The Building Regulations
- Local Authority Building Control Requirements
- COSHH Regulations

- Water Regulations
- HSE Document L8
- Local Authority Environmental Health Department
- HVCA Guides
- IEE Regulations (Current Edition)
- Recommendations as published by the Chartered Institution of Building Services Engineers.

  CIBSE Guides A, B, C and F
  CIBSE Technical Memoranda
  CIBSE Application Guides

- BSRIA Technical Memoranda and Manuals
- Electricity at Work Act
- Electromagnetic Compatibility Regulations
- Electricity Supply Regulations
- Electrical Equipment (Safety) Regulations
- Requirements of the Fire Authority
- Relevant current British Standard Specification and Codes of Practice
- The Gas Safety Installation and Use Regulations
- Clean Air Acts

2.07 INDUCTION

All personnel, directly, indirectly or sub-contract employed must be given a course or period of site induction when attending site for the first time. This shall comply with the Clients standards and shall include but not be limited to.

- All aspects of Health and Safety
- Fire Precautions and Procedures
- Awareness and Topography
- Communication
- Rules and Regulations
- Plant Equipment and Location
- Logging and Recording Requirements
- All aspects of Security
- Disruption and Intrusion
- First aid

2.08 HEALTH & SAFETY

All work undertaken and completed as part of this section of the works shall be carried out fully in compliance with the Health and Safety at Work Act and the Construction, Design and Management Regulations.

Where works are 'notifiable' under the Construction, Design and Management Regulations full assistance and co-operation shall be given to the CDM Co-ordinator to ensure complete and accurate Health & Safety documentation is provided throughout the course of the contract and ultimately at completion of the works.

Notification shall be made in writing of the intention to use on site any equipment, liquids, gases or other articles or materials which may endanger life or property. It shall be ensured that safe methods of working are followed at all times. All necessary precautions shall be taken to safeguard against damage by fire or explosion where the execution of work may involve the presence of flame or sparks.

Petroleum products and other flammable or vaporising liquids shall only be used in accordance with the regulations applicable to the storage and use of these products.

When equipment and vessels that contain flammable liquids or gases are not in use they shall be removed together with any stored liquids or gas, to a safe place of storage.

Work involving asbestos materials shall be carried out in strict accordance with current legislation

It shall be ensured that all safety and welfare measures required under or by virtue of any Act or Regulation on the working rules of the industry are strictly complied with.

All portable electric apparatus and tools used by the Electrical Services Sub Contractor shall be complete with certification and be operated at 110 volts A/C.

2.09 PPE

The provision and wearing of the relevant PPE on site shall be mandatory and strictly enforced under this section of the works.

2.10 CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS

All elements of the scheme shall comply with the Construction Design Management Regulations whether 'notifiable' or not.

2.11 RISK ASSESSMENT

Throughout the cycle of the Project the Electrical Services Sub Contractor shall continuously assess the risk of the proposed Works upon the continued operation of construction works. Where the Electrical Services Sub Contractor considers there to be a potential risk or effect, the Electrical Services Sub Contractor shall advise the Client / Project Manager of all details and demonstrate his proposals for minimising such risk or effect. The Electrical Services Sub Contractor shall produce written statements to this effect in the format contained within the Project Plan (or equal /approved method). The Project Manager shall assess such information with the Client and instruct the Electrical Services Sub Contractor accordingly prior to execution of that element of works.

2.12 OFF LOADING AND INSTALLATION

The supply, delivery, off-loading, positioning and installation of all equipment and materials detailed in this specification, indicated on the drawings or required for the contract works shall form part of this section.

This shall include the provision of all necessary craneage, hard standing for same, lifting tackle, trolleys, skids, tools, ladders, temporary workshops, gangways, fences, scaffolding other than that already erected, etc. and the subsequent removal.

Timely indication shall be given of any difficulties likely to be encountered in accommodating plant or equipment in the spaces available.

The strength of floors across which heavy loads are to be moved shall be checked in good time before the load is applied so that if the strength of any floor is found to be inadequate, arrangements for supporting the load can be made without delaying its movement.

This section of the works shall include the responsibility for any damage caused by the off-loading and movement of this material.

Plant equipment and materials shall not be deposited on roadways, footpaths, in corridors or rooms other than the occupied site for the works unless prior permission has been obtained in writing.

The Electrical Services Sub Contractor shall be responsible for any damage caused by the off-loading and movement of his materials, plant or equipment.

Any materials and fittings not required for the purpose of the contract works shall be removed from site from time to time and at any time within 48 hours of being instructed
in writing to do so by the Client.

2.13 STORAGE OF MATERIALS

The Electrical Services Sub Contractor shall note that adequate space is available external to the proposed works for their storage of materials on site. Materials stored on site shall be at the sole risk of the Electrical Services Sub Contractor.

2.14 SUPERVISION OF LABOUR

A qualified representative shall constantly be kept upon the Works with a thorough experience of the class of work covered by the specification. So far as possible, this representative shall not be changed during the course of the Works.

Trade custom in the employment of the appropriate grades of work people shall be followed. Work people shall not trespass beyond the limits of their work.

2.15 PROTECTION OF MATERIALS AND WORK

The following shall be provided, during storage and installation.

- Adequate and safe storage for all material, plant and equipment necessary for the Engineering Services works, including suitable protection against the weather, and ingress of dirt or moisture into working parts.
- Purpose made racks for storage of conduits, pipes and similar materials to prevent bending and distortion, and to support them clear of the ground.
- Purpose made end caps to protect pipes, threads, nozzles and support system.
- Protection by means of paint, tallow or grease for bright and machined surfaces, which immediately before handover shall be cleaned and polished.
- Precautions and protection against frost, building works, or operations by others, including mechanical damage by other trades.

- Suitable racks and storage for plant, equipment, pipe work and other materials unable to be stored in huts or buildings.

- Protection for electrical cables and seal cable ends using methods and materials recommended by cable manufacturers.

- Leaving plant and equipment in a condition ready for finish painting where specified as part of the work or by others.

- Painting of parts liable to corrosion immediately after removal of temporary protection.

- Replacement material, plant or equipment where deterioration or damage has occurred prior to handover.

2.16 DESIGN DRAWINGS AND INSTALLATION DRAWINGS

Where the Specification requests the provision of design drawings by the Electrical Services Sub Contractor these shall not be schematic but are to be fully representative of the work to be carried out and detailed as to the positions and physical dimensions of all components in the systems.

Design/Tender Drawings issued with the Specification show design intent only. This section of the Works shall also include the responsibility by the Electrical Services Sub Contractor for providing installation drawings necessary for the construction of the whole of the works covered by the contract requirements, together with the additional drawings required as work progresses.

The Electrical Services Sub Contractor shall include for all the work necessary for, and all costs and charges arising from the provision of drawings.

All drawings shall be provided in good time to meet the agreed programme for the Works.

Apart from those drawings which must be issued for construction purposes before the Contract is let, drawings of builder's work, wiring diagrams, and drawings of work to be done by other trades required for the purposes of the complete installation, shall be provided as part of this section.

Unless stated elsewhere in subsequent sections of this specification, design, installation and as-installed drawings shall be prepared in a detailed and legible manner, to a suitable scale and on A1 or AO paper sheets (AutoCAD or AutoCAD LT latest version). All drawings shall be single service drawings, i.e. separate drawings shall be provided for each service, e.g., Heating, Air Conditioning, Ventilation, Pipe work Services, Power, Lighting, Fire Alarms etc.,

Approval of Design Drawings;

In the matter of any design by the Electrical Services Sub Contractor it shall be understood that any review/approval of any of the drawings, calculations and installation drawings by the Client and/or his representative shall under no circumstances relieve the Electrical Services Sub Contractor of his full responsibility for the design of the installation.

To this end the Electrical Services Sub Contractor shall issue a full warranty to the Client and/or his representative stating that the design complies fully with all aspects of this specification, the full extent of works required by the Client, current standards, CIBSE and IEE recommendations and that the Electrical Services Sub Contractor further indemnifies the Client and/or his representative against any failures attributable to any errors in design.

The Electrical Services Sub Contractor shall forward to the Client or his representative two (2) copies of each drawing, marked 'for comment'. The Client or his representative will examine the drawings and return one copy of each to the Electrical Services Sub Contractor marked:

- 'Approved', or
- 'Approved subject to' (followed by the qualification of the approval) , or
- 'Not Approved'

For 'Approved' drawings, the Electrical Services Sub Contractor shall issue two copies of each to the Client, Architect, Project Manager and Electrical Services Sub Contractor.

For the drawings 'Approved subject to' the Electrical Services Sub Contractor shall modify the drawings as necessary and issue two copies of each to the above.

For drawings 'Not Approved' the Electrical Services Sub Contractor shall prepare new drawings and re-submit them for approval as before.

2.17 RECORD DRAWINGS

During the progress of the Works, the information necessary for preparing the installation record drawings shall be recorded on drawings in an approved manner. The marked-up drawings shall be made available for inspection and checking upon request.

All record drawings shall be single service drawings, i.e. separate drawings shall be provided for each service, e.g., Air Conditioning, Ventilation, Pipe work Services, Power, Lighting, Fire Alarms etc., and shall indicate the following :-

- The locations and positions of all apparatus.
- The sizes, types and routes of all tray work and trunking.
- The reference numbers of all associated boards and fixed items.
- The exact positions of any fire dampers.
- The sizes, types and routes of all cables and conduits.
- The exact routes and invert levels and the sizes, types, makes and dates of laying of any underground cables.
- The exact positions and descriptions of all underground joint boxes and earth electrodes and the name of the jointers responsible.
- The lengths of all underground cables between joint boxes and terminations.
- The locations of any other services or obstructions in the routes of underground cables.
- The reference numbers of all electrical circuits. Each circuit reference number shall be carefully checked against the installation and updated distribution diagrams produced compatible with the record drawings.
- Record drawings shall also include diagrams of connections of mains distribution, mains switch gear with protective equipment, plant, control systems, alarm systems and call systems. Diagrams of connections shall show identification of terminal and cable ends, size and type of cables, rating of switch fuses and circuit breakers, and overloads in motor starters.

Record drawings shall also be provided for all plant and equipment, which, together with the printed instructions provided, shall be sufficient to enable the plant and equipment to be operated, maintained, dismantled, re-assembled and adjusted.

All record drawings shall be submitted for examination. On receipt of final comments, the following sets of record drawings shall be provided as part of the Operation and Maintenance details:-

(1) Two complete sets of prints on paper.
(2) One complete set of all record drawings on CD Rom, suitable for transferring into an AutoCAD program in either, DWG or DXF file format.

2.18 DRAWINGS OF BUILDERSWORK

Builderswork drawings shall show;

All openings required through bases, structural elements and floors; all openings having a dimension greater than 100mm through walls, partitions, ceilings, ducts and trenches; all chases and recesses; and details of built in fittings.

The drawings shall be complete with comprehensive dimensions to enable the position of each item to be located accurately.

The Electrical Services Sub Contractor will not be required to provide drawings showing the location of small holes, other than those previously stated, or positions of miscellaneous built-in pipe brackets etc. For such cases he shall mark out on site all such positions for approval prior to cutting away or building in and shall state all necessary requirements therewith.

The Electrical Services Sub Contractor shall be responsible for checking that builders work has been carried out in accordance with his instructions.

2.19 BUILDERSWORK

The main elements of builderswork associated with the contract shall be detailed by the Electrical Services Sub Contractor.

Unless stated otherwise in subsequent sections of the Specification all excavation, chasing, cutting away and making good will be done by the Electrical Services Sub Contractor, in accordance with the information provided the Electrical Services Sub Contractor.

The Electrical Services Sub Contractor shall be responsible for the drilling and provision of fixings in floor, walls and ceilings for securing services and equipment requiring screw or bolt fixing.

The Electrical Services Sub Contractor shall inform the Client of any difficulties likely to be encountered in accommodating and maintaining the contract works within the structure of the building e.g. ducts, ceiling spaces, under floor spaces, openings, fire stopping etc.

2.20 INSPECTION OF SITE

It shall be the responsibility of the Electrical Services Sub Contractor to request inspection of any related documents at the Offices of the, Client or Consulting Engineers showing information in support of the Scope of the Project.

In addition, it is the responsibility of the Tenderer to visit the site of the works to familiarise himself of the Buildings and structures and to undertake the necessary Survey Work to satisfy himself in respect of local conditions affecting the works and relating to removal of and connection to existing equipment and all necessary access arrangements.

The Electrical Services Sub Contractor shall be responsible for all cost and programme implications resulting from a failure to undertake such inspections and surveys. No claims shall be allowed in this regard.

2.21 ORDERING OF MATERIALS AND EQUIPMENT

The Electrical Services Sub Contractor shall:-

To avoid delays due to late or non-delivery, consider placing orders immediately when instructions have been issued for the work to proceed.

Make every effort to obtain materials and delivery to accord with the work programme.

2.22 MATERIALS AND WORKMANSHIP

The Electrical Services Sub Contractor shall:-

Ensure that all plant and material is new, undamaged, free from corrosion, not sub-standard and conforms to the requirements of the specification.

Where quality or standard of materials are not specified, ensure that they are of adequate quality and equivalent standard to specified items.

Ensure that the work is carried out be competent staff in an expeditious and workmanlike manner under skilled supervision.

2.23 MEASUREMENT OF WORK

The Electrical Services Sub Contractor shall:-

Give all assistance necessary to enable the Client to examine or measure the Works.

Not cover, conceal or insulate any section of the Works before completion of a witnessed satisfactory test.

Give due notice when Works which are to covered or concealed are ready for examination and / or measurement which will then be carried out by the Client without undue delay.

2.24 EXISTING ENGINEERING MATERIALS

The Electrical Services Sub Contractor shall

- Include in the Tender for stripping out redundant material as detailed in Section 4.0 or on the tender drawings and removing from the site to a place of storage.

- Not deviate from this clause unless specified in Section 4.0 or on the tender drawings or given further written instructions.

2.25 DIMENSIONS

The Electrical Services Sub Contractor will have been deemed to have taken advantage of the facilities available to visit the site prior to tendering to ascertain and check:

- Means of access.
- Buildings and structures involved in the works.
- Dimensions where plant or equipment is to be installed within or close to existing buildings or structures. Immediately any discrepancy is found it shall be drawn to the immediate attention of the Client.

2.26 POSITION OF PLANT

The Electrical Services Sub Contractor shall

Notwithstanding the provision of the drawings be responsible for taking dimensions and particulars from site for the work specified.

Submit design drawings for the Clients consideration at a reasonable time before work is commenced and based on the latest available information.

Provide contractual distribution all information and drawings necessary to achieve and complete co-ordination.

Give due regard to the needs of inspection, efficient maintenance and replacement.

2.27 CLEAN AND TIDY WORKING

The Electrical Services Sub Contractor shall in respect of his own Works keep the site clean, tidy, free from waste and superfluous material and take all necessary precautions to avoid damage to the building structure or its contents.

2.28 CONNECTIONS TO APPLIANCES

The Electrical Services Sub Contractor shall ensure technical co-ordination for connections to all plant and equipment provided by him and disconnecting and re-connecting all items moved by him.

2.29 BREAKING INTO EXISTING SERVICES

The Maintenance of continuity of essential services e.g. electricity, hot and cold water, drainage etc., is of prime importance and interruption of these services will not be permitted without prior consultation with the Client. If the breaking into these services cannot be carried out during normal working hours, the Electrical Services Sub Contractors shall agree with the Client the times during which the work can be completed.

2.30 RESTRICTIONS WITHIN PREMISES

It shall be the duty of the Electrical Services Sub Contractor to prevent his employees from visiting any part of the premises for purposes other than in the performance of the Contract or purposes necessarily incidental thereto.

The Client reserves the right to require the Electrical Services Sub Contractor to prevent or secure the prevention from further employment in connection with the Contract of any employee of the Electrical Services Sub Contractor who visits any part of premises otherwise than the purpose aforesaid.

All ladders shall be protected and secured to prevent unauthorised use.

2.31 SITE MEETINGS

Site meetings will be held at regular intervals and the Contract Tender must allow for responsible representatives to attend as and when requested to do so by the Client.

2.32 PROJECT MANAGER / CLIENT'S REPRESENTATIVE

If deemed necessary, the Client shall appoint a Project Manager or Clients Representative. The Main function of the Project Manager/ Clients Representative will be to ensure that all aspects of the work are carried out and installed in accordance with the specification and drawings and to witness tests that must be approved by the Project Manager or Clients Representative or the Client.

The Electrical Services Sub Contractor shall work closely with the Client / Project Manager/ Clients Representative in arranging inspection and tests.

Should the Electrical Services Sub Contractor have any queries regarding the Project during the tender stage these shall be furnished in 'writing only' to the Client and/or Project Manager for his comments.

2.33 SAFETY PRECAUTIONS

The Electrical Services Sub Contractor shall notify the Client in writing of his intention to use on site any equipment utilising substances of a type that may injure or endanger life or property. At all times he should ensure that safe methods of working are followed when using such equipment and shall take all necessary precautions to safeguard against damage by fire or explosion where the execution of the work may involve the presence of flames or sparks.

Petroleum and other flammable or vaporising fluids shall only be used in accordance with the relevant regulations applicable to the storage and use of such products.

When equipment and vessels containing flammable or dangerous substances are not in use they shall be removed to a safe place or storage in accordance with the regulations appertaining.

2.34 FIRE & SMOKE STOP BARRIERS

Where cables, conduits, trunking, pipe work or ductwork, pass through fire or smoke stop barriers, such as walls or floors so designated on the Architectural and Structural drawings or drawings forming a part of this section of the works, the opening shall be permanently sealed by the Electrical Contractor to maintain the integrity of the compartment barrier, in compliance with the Building Regulations Approved Document B, using products tested in accordance with BS 476 20 and 22 1987. All products shall be suitable for the temperature of the service on which they are being used.

Where cables, pipes or trunking are installed inside channel ducts or sleeves which pass through fire or smoke stop barriers, internal barriers shall be provided, equal to rock wool materials or fire resisting compound to maintain the integrity of the compartment barrier.

Ventilation ducts passing through fire or smoke stop barriers shall be fitted with dampers as allowed for in the design.

2.35 MATERIALS, PLANT AND EQUIPMENT

Unless otherwise specified, all materials, plant and equipment shall comply with the current edition of the British Standard Specifications and statutory requirements where applicable.

All materials, components and goods to be incorporated in the Works are to be new and of best of quality of their respective grades, unless distinctly stated.

2.36 BACTERIA FREE MATERIALS

The Electrical Services Sub Contractor shall ensure that all materials shall be of a type that will not support bacteria. No acoustic insulation or sound deadening material shall be manufactured with any form of animal hair.

2.37 PROTECTION

The Electrical Services Sub Contractor will be deemed to have allowed in his Tender for all expenses in connection with the protection of the works and the provision of special plant, materials and equipment necessary to maintain continuous working throughout periods of cold and exceptionally inclement weather and shall if necessary and without the approval of the Client re-programme the sequence of his operations with this object in view.

2.38 ADVERTISEMENTS

The right of advertising on boarding or around the site are reserved by the Client and the display of name boards by the Electrical Services Sub Contractor shall be limited to identification of site huts, direction signs and one composite name board, the size and design of which shall be approved by the Client and in respect of which the Electrical Services Sub Contractor shall obtain all necessary statutory consents at his own cost.

2.39 STAFF TRAINING

The Electrical Services Sub Contractor shall allow in his tender for the attendance of appropriately qualified personnel for the full training of the Clients staff in the operation and maintenance of the new installation.

The training period shall be spread over a period of two half day sessions per system discipline and be at a time (or times) agreed with the Client. As part of this section of works the Electrical Services Sub Contractor shall provide suitably bound training manuals.

These shall be user friendly (non-technical), suitable and concise in content for their purpose and will be used at a later date as a source of reference to the staff.

2.40 ELECTRICAL INTERFERENCE AND SUPPRESSION

The Electrical Services Sub Contractor shall:

Suppress all equipment supplied or used by him to the requirement of BS 800 to eliminate interference with radio and television equipment and be responsible for locating and rectifying faults.

2.41 NOISE ATTENUATION

The Electrical Services Sub Contractor shall provide sound attenuation equipment and materials to prevent transmission of sound through ducts, pipe work and structures.

2.42 WATER AND ELECTRICITY

Provided that they are available to the Client and, in the absence of other agreements, supplies of water, electricity and drainage connections will be made available free of charge to specific points on the site for use in connection with the works provided that the Electrical Services Sub Contractor installs at his own expense all necessary temporary means of connecting to and distributing such services by arrangement with the Client and that due economy and care is exercised. Removal of such temporary work shall also be at the Electrical Services Sub Contractor's expense.

The Electrical Services Sub Contractor shall allow in his rates and percentages for the provision of all necessary temporary transformers and equipment for the reduction of voltage for electrical tools which shall be used as detailed below:-

Portable Electrical Equipment;

Portable Electrical tools and apparatus used on the site by the Electrical Services Sub Contractor shall have an operating voltage with alternating current supplies of not exceeding 110 volts (55 volts to earth) except that the Client may on application by the Electrical Services Sub Contractor give written permission for the use by the Electrical Services Sub Contractor of portable electric tools and apparatus with an operating voltage higher than 110 volts alternating current (55 volts to earth) in which case tools and apparatus may be used by the Electrical Services Sub Contractor at the Electrical Services Sub Contractor's risk and provided all appropriate safeguards which the Client may require are provided at the Electrical Services Sub Contractor's expense. The Electrical Services Sub Contractor shall submit for the Client's approval the types of plugs sockets and cable it is proposed to employ at any other voltage that may have been agreed with the Client, Architect or Project Manager.

The Electrical Services Sub Contractor shall take adequate steps to define and bring to the attention of his own employees the areas where tools and apparatus exceeding 110 volts operating voltage on alternating current supplies are permitted and shall mark all socket points in the said areas with the appropriate voltage.

Portable Electrical equipment is equipment which can be carried by the person operating it while in normal use.

Site Electrical Tests;

The Electrical Services Sub Contractor shall comply with equipment test and inspection procedures as required by the Client, Architect or Services Consultant and must submit equipment for test upon request or as part of an ongoing regime to the Client before any use on site.

2.43 TRANSPORTABLE ELECTRICAL EQUIPMENT

The Electrical Services Sub Contractor shall obtain from the Client written approval of all types of transportable electrical equipment including sockets and cable which it is intended to use on the site. Such equipment is used at the Electrical Services Sub Contractor's risk and appropriate safeguards which the Client may require shall be provided at the Electrical Services Sub Contractor's expense.

Transportable electrical equipment is equipment which can be moved to a new position while connected to the same source of electrical supply.

2.44 MEDICAL FACILITIES AND FIRST AID

The Electrical Services Sub Contractor shall be responsible for all aspects of safety on his works and will provide First Aid Facilities for his own personnel. All accidents on site involving any of the Electrical Services Sub Contractor's employees and all reportable accidents under the Factories Act shall be reported to the Electrical Services Sub Contractor and the Client/Project Manager with a copy of the completed Factory Inspectorate Form in the case of a reportable accident.

All personnel directly, indirectly or sub-contracted by the Electrical Services Sub Contractor shall be trained in the basic principles of First Aid, in particular:

- the treatment of electric shock and associated precautions
- treatment of falls from ladders or heights
- the effects of asphyxiation, gas or choking
- cuts and flesh injuries
- broken limbs

2.45 FIRE PRECAUTIONS

There will be in existence severe restrictions covering the use of flame or flame-producing equipment. The Electrical Services Sub Contractor is to obtain permission and certification from the Client before such work is commenced and the Client shall instruct the Electrical Services Sub Contractor as to whether the work may be carried out adjacent to or removed from the actual plant area in which the work would normally otherwise be carried out.

In recognition of the existence of high fire risk areas within the site, the burning of waste paper or other waste materials on or near the site is strictly prohibited.

The Electrical Services Sub Contractors personnel must be aware of all fire precautions and safety procedures for the site.

2.46 PROTECTIVE CLOTHING

The Electrical Services Sub Contractor shall provide his employees with all industrial and weather protective clothing to comply with any working rule agreement for the various categories of employees to be engaged on the works, together with safety helmets, goggles, earmuffs, gloves and footwear as approved for the use in the works. The Electrical Services Sub Contractor shall provide the relevant PPE and clothing which will be of a self-identifiable colour.

2.47 FENCING, LIGHTING AND GUARDING

Overall responsibility for fencing, lighting and guarding shall rest with the Electrical Services Sub Contractor. The Electrical Services Sub Contractor with the Electrical Services Sub Contractor shall be responsible for the safe keeping of the Client's materials issued to him for incorporation in the works. The Electrical Services Sub Contractor is required to ensure that upon termination of work for the day shift all works are rendered safe before leaving the works.

2.48 GENERAL DISCIPLINE

Every Electrical Services Sub Contractor's employee must obey the instructions of those in Authority and is required to work in any part of the site for which he is detailed. Should a doubt arise, about any instruction given, attention should be drawn to the Project Manager.

Except in the fulfilment of his duties Electrical Services Sub Contractor's employees shall not use or interfere with anything in the site including buildings or their fittings, plant, machinery, tools, implements, stores and materials in any state of use or manufacture.

Electrical Services Sub Contractor's employees are not permitted to enter any part of a building or of the site other that in which they are employed, without the permission of the Client.

Electrical Services Sub Contractor's employees guilty of disorderly conduct or horseplay of any kind render themselves liable to immediate eviction from the site.

Electrical Services Sub Contractor's Employees shall not engage in private trading in the site.

2.49 BREACH OF RULES AND REGULATIONS

Electrical Services Sub Contractor's employees guilty of breach or disregard of any of these Rules and Regulations or any other rules and regulations imposed by Act of Parliament or otherwise now in force or which may be imposed later or of negligence of disobeying the instructions of the management or of improper conduct may be summarily dismissed from the site. Such suspensions or dismissal shall be without prejudice to any proceeding, which may be brought against employees in any Civil or Criminal Court.

2.50 PATENTED ARTICLES

The Electrical Services Sub Contractor shall save and indemnify the Client against all claims, costs or expenses in connection with any patented, copyrighted or protected articles supplied by him or any Sub Contractor and used on or in connection with the works and any payments or royalties payable in one sum or by instalments shall be included in the contract price and be paid by the Electrical Services Sub Contractor to whomsoever they may become due.

2.51 SCHEDULE OF RATES

Three copies of a Schedule of Quantities and Rates upon which the Electrical Services Sub Contractors Scheme is based, shall be submitted to the Clients Representative. The Schedule shall be forwarded to ensure it reaches the Client by return of request.

The Schedule shall fully detail quantities and rates for all works in accordance with the Standard Method of Measurement current edition, authorised by agreement between the Royal Institution of Chartered Surveyors and the Building Employers Confederation.

The Schedule shall be fully priced and broken down to reflect the various sections of work included. The total price of each section of the Schedule shall equate to the price included for that particular section of work indicated. The total of the various sections of the Schedule shall equate to the original price. This shall be used only for the pricing of variations.

In the event of any discrepancy in the Schedule, the quantities and/or rates shall be corrected as necessary, but the total sum shall not be amended as a result.

Where it is necessary to agree a rate for an item that is not included in the Schedule of Quantities & Rates, this shall be calculated in a manner similar to comparable items. All additional rates shall be calculated using prices applicable at date of tender. Where applicable, price fluctuation will be valued in accordance with the Conditions of Contract.

If additional works are authorised, these will be valued in accordance with the items and rates included in the Schedule of Quantities, irrespective of whether more complex fittings and labours are actually required, unless it can be shown to the satisfaction of the Client and/or his representative that the additional work is significantly more complex than the general level of complexity of installations on this project.

2.52 INTERIM APPLICATIONS FOR PAYMENT

Interim applications shall be submitted seven days before the date when an application is to be made for an interim payment, showing itemised breakdowns of the total values only of work done and unfixed materials securely stored on site. Applications shall only include goods or materials owned by the applicant, and this shall be confirmed on each interim application submitted. Interim applications not confirming titlement of goods will not be accepted.

Where fluctuations are allowed under this Contract these shall be included in a separate document and submitted monthly with the interim application. The document shall provide all supporting information including time sheets signed by the Clerk of Works, supplier's invoices, price lists, index calculations, as applicable.

2.53 INSTRUCTIONS AND VARIATIONS

No variation shall be undertaken without written authorisation. The price of each authorised variation shall be submitted within seven days of such authorisation or on the completion of the variation when carried out as day work.

When materials and equipment which are not included in the Schedule of Rates are required to be provided under a variation, included with the estimate for the variation shall be a copy of any quotation received from suppliers and shall show separately the allowance required for overheads and profit. If a price list is used in place of a quotation the date and reference of the price list shall be stated.

Should it be considered that the regular progress of the Works or of any part thereof has been or is likely to be so materially affected by the variation, written notice shall be given.

2.54 DAYWORK

Day work sheets shall be signed by a nominated employee of the Client, and these sheets shall be submitted in triplicate with detailed schedules supporting the claim the week following the week in which the work is executed.

The signing of day work sheets by the authorised person shall not of itself constitute authorisation of work.

The cost of authorised day work shall be calculated in accordance with the rates issued to the Client.

2.55 DEFECTS LIABILITY PERIOD

Any item that is replaced or renewed due to defective operation shall be considered to be under the defect's liability period until expiration of 12 months from the date of the replacement or renewal and certification.

2.56 TESTING AND INSPECTION

The Electrical Services Sub Contractor shall be responsible for providing adequate experienced supervision and thorough inspection and checking of the works including any materials and components supplied by the Client.

2.57 RETENTION OF TIME SHEETS AND WAGES BOOKS

Time sheets, wages books, vehicle, and driver's log books shall be kept by the Electrical Services Sub Contractor and, with any records that the Electrical Services Sub Contractor may keep for the purpose of compiling his account under the Contract, shall be carefully preserved by the Electrical Services Sub Contractor throughout the period of the contract and for a further period until the final settlement of accounts between the Electrical Services Sub Contractor and the Client shall have been made.

The Electrical Services Sub Contractor shall produce such time sheets, wages books, vehicle and driver's log books and other records for the inspection of the Client at such reasonable times as he may require.

2.58 REMOVAL OF RUBBISH

The site shall at all times be kept free from obstruction and rubbish generated by the Electrical Services Sub Contractor. All surplus materials, temporary works, packing cases etc. shall be removed from the site as soon as they are no longer required. On completion of any maintenance procedures the site shall be left in a thoroughly clean and tidy condition to the entire satisfaction of the Client.

For the purpose of this Clause, the word "Site" shall mean each and every building of the site, yards, passageways and any other means of access to or egress from the site.

2.59 PLANT BASES AND ANTI-VIBRATION MOUNTINGS

The Electrical Services Sub Contractor shall:

Ensure that any concrete bases for plant and machinery have a minimum perimeter clearance of 150mm with each item of plant adequately fixed, supported and aligned in accordance with the Manufacturers recommendations.

Provide holding down bolts, for all items of plant including anti-vibration materials and mountings have rotating or moving machinery. Anti-Vibration material which is to be cast into plinths shall have a waterproof membrane on both bearing surfaces and be handed to the building Electrical Services Sub Contractor before casting commences.

2.60 BONDING AND EARTHING

The Electrical Services Sub Contractor shall:

Provide all necessary materials and make connections to ensure that all installations and equipment are efficiently and continuously bonded to an earthing system at all times in accordance with the IEE Regulations for electrical installations.

2.61 OPERATION AND MAINTENANCE MANUALS

Two weeks prior to Practical Completion, or Partial Possession of the Works, one copy of a 'Draft Operation and Maintenance Manual' shall be submitted to the Client for examination and comment by his representative. Manufacturer's literature shall not be required at this stage.

Following receipt of final comments from the Clients Representative and upon Practical Completion of the Works, three copies of the approved Maintenance Manual shall be provided and handed to the Clients Representative.

Each manual shall be of the loose leaf A4 size type, having a rigid cover, sub-divisions for each section, a ready means of reference and a detailed index.

Each manual shall contain full operating and maintenance instructions for each system and item of equipment included in the Works.

The paper used in the final documents shall be of good quality high white 100 g/m^2 min., and the re-production method shall be laser print, dry photocopy or equal.

The arrangement of the Maintenance Manual shall be as follows:-

Simple User Guide

This shall be provided at the front of each manual and shall consist of 'quick reference and simple operating instruction' for the installations, together with telephone numbers in the case of emergencies or breakdowns.

Section 1 - General Index and Introduction

This section shall contain the Index, for the entire content of the manual together with a general introduction to the manual.

Section 2 - Systems Operation and Automatic Controls Installation

This section shall contain a detailed description of each system, its operational intent, operating instructions and procedures together with a schedule of the parameters used as a basis for the design of that particular system.

This section shall be fully cross referenced to the particular Record Drawings

A concise description of the Automatic Controls Installation shall also be provided together with a full schedule of Control Equipment, Circuit Diagrams and Software details.

Section 3 - Schedule of Plant & Equipment

This section shall contain a full schedule of all plant and equipment, including duty, electrical load, flow rates, etc.

Section 4 - Manufacturers Literature and Directory

This section shall contain Manufacturer names, addresses, telephone numbers and literature. Any literature that contains descriptions of equipment that is of no concern to the end user, shall not be included. Relevant equipment data only shall be extracted from the manufacturer's literature and included within these documents.

Where equipment is non-standard, information for the Maintenance Manual shall be obtained from the manufacturer.

Section 5 - Planned Maintenance Instructions

This section shall contain a detailed description of Planned Maintenance instructions, for all systems and each item of plant and equipment. These shall be in HVCA schedule form.

Section 6 - Emergency and First Aid Procedures

This section shall describe actions to be undertaken in the event of an emergency, and shall include a full directory of names, addresses and telephone numbers of individuals, or organisations to be contacted.

This section shall also include a description of the basic principles of First Aid.

Section 7 - Commissioning Results

This section shall contain a full set of the commissioning results for each system. These shall be presented in a format which is easily understandable, and which contain equipment references, which

relate exactly to that which is noted on the installation and record drawings. Originals of the following documentation shall be provided:-

Main Plant and Testing Commissioning Sheets
Manufacturers Test Certificates for Specialist Equipment

Section 8 - Record Drawings

This section shall contain all Record Drawings as detailed earlier in this section and in DXF/DWG Format. The drawing CD Rom shall also be provided in this section.

2.62 BUILDING LOG BOOK

For all new Buildings and those refurbishment projects designated as requiring compliance with the Building Regulations 2000 Approved Document L2, the Electrical Services Sub Contractor shall provide a Building Log Book in compliance with CIBSE TM31, with guidance from Action Energy Good Practice Guide 348.

The Log Book shall be provided using the template format set out in TM31.

The Log Book shall be between 20 and 50 pages (5-10 pages for premises less than 200 m^2). Note that the Log Book is not to be confused with the Operation and Maintenance Manual.

The Log Book will typically consist of the following minimum requirements, presented in a fully indexed lever-arch A4 file, with cover and spine file descriptions:

- Internal Cover Sheet - to indicate presentation date and acceptance name following induction of Building Manager.
- Updates and Annual Review Section/Index.
- Purpose and Responsibilities.
- Links to other key documents, e.g. Operating and Maintenance Manuals, As Installed Drawings, Plant Log Books and their location for easy access/recovery.
- Main Contracts - emergency, statutory authorities, maintenance.
- Commissioning, Handover and Compliance.
- Overall Building Design - simple conceptual diagrams and text.
- Summary of Areas/Occupancy - simple floor plans and occupancy types.
- Summary of Main Building Services Plant (main plant locations, meter locations)
- Overview of Controls/BMS.
- Occupant Information (staff awareness of simple good housekeeping for energy use)
- Metering, Monitoring and Energy Targeting Strategy - including calculated energy consumption data from the Designers.
- Building Energy Performance Records.
- Maintenance Reviews.

- Schedule of Major Alterations - for Building users post practical completion.
- Results of In-Use Investigations.

The Log Book shall be available at the point of Handover.

In the scenario of multi-tenanted Buildings, a central Log Book shall be procured for retention by the Landlord, with "sub" Log Books provided for each tenancy. The Tenant Log Books will be abridged versions of the main Log Book, but will still provide all the necessary information to all Tenants to log their energy performance, track alterations etc.

Where multi-tenanted Buildings are provided the Central Landlords Log Book will also include a Schedule of Tenant Log Books and their designated Managers and Log Book locations. Likewise, the Tenant Log Books should show the Landlords details and location of the Central Log Book.

2.63 FAILURE TO PRODUCE DAWINGS, MANUALS, LOG BOOK AND STAFF TRAINING

Should the Electrical Services Sub Contractor fail to produce to the Clients approval any of the following:

- The Marked Up Drawings, as required during the progress of the works.
- The Record Drawings at Handover.
- Operation and Maintenance Manuals.
- Building Log Books.
- Staff training/Training Manuals.

The Client may provide the above with whatever assistance the Client deems necessary and the cost of preparing such documents or providing training will be deducted from moneys or retention's due to the Electrical Services Sub Contractor.

2.64 TENDER DOCUMENTS

The specification, documents and any drawings associated therewith shall remain the property of the Client. They shall 'under no circumstances' be reproduced in whole or part, except for the specific requirements of this contract, without the express permission, in writing, of the Client.

The Electrical Services Sub Contractor when submitting his Tender for the Works shall qualify any discrepancies or divergences between the Tender Documents.

The Electrical Services Sub Contractor shall be deemed to have:

- Thoroughly examined all contract documents
- Visited site and made himself fully acquainted by his own independent observations and enquiries as to the nature, extent and practicability of the works, means of access, space for storage of materials, the positions relative thereto of buildings, structures and any underground or existing services and all other points in relation to the works which can in any way affect the price.

Any monetary or other claim made against or by the Electrical Services Sub Contractor on the grounds of want of knowledge of any or all the aforesaid matters will not, under any circumstances, be considered or entertained by the Client.

2.65 STATUTORY OBLIGATIONS

The Electrical Services Sub Contractor shall comply with and give notices required by, any rule or order or any Regulation of Byelaw of any Local Authority, Statutory Undertaker or of any Public Utility which has any jurisdiction with regards to the works.

The Electrical Services Sub Contractor shall provide attendance to any Local Authority, Statutory Undertaker or Public Utility when they carry out any works on site and shall make due allowance in the Tender for any assistance required, advise of the final requirements and programme.

The Electrical Services Sub Contractor shall provide any information required in the form of drawings and obtain written approval from the relevant Authority or Utility prior to commencement of the work on site and for paying all fees and charges arising there from.

2.66 INCOMING UTILITY SERVICES

As part of the works the Electrical Services Sub Contractor shall make all necessary arrangements where applicable, be responsible and include for

- A new electrical service and meters.
- A new service shall be installed into the Building in accordance with Supply Authority Details and Regulations.

As required and detailed in the Tender Drawings or Specification

The electric meter locations shall be as agreed with the Client.

For the gas service an automatic gas safety shut off valves shall be installed an interfaced to the Building Control System where applicable. Gas cocks shall be installed at the meter and at every appliance.

The Electrical Services Sub Contractor shall allow for all adequate time and expense required for liaison with the Utility Services, where required, for and on behalf of the Client, to ensure a complete installation

2.67 PERFORMANCE EVALUATION

Before offering the installations to the Client for acceptance, the Electrical Services Sub Contractor shall satisfy himself that the systems are achieving the design intent by carrying out such performance tests as he may deem necessary.

The Electrical Services Sub Contractor shall provide all necessary test instruments, measuring point adaptors, and equipment required in carrying out regulation, calibration and performance tests. Performance testing shall be deemed to include any tests which are requested by the Consulting Engineers, to demonstrate compliance with the Specification and in particular that the materials used throughout comply with the requirements of the Local Fire Office.

The performance of the systems shall be monitored under normal winter and summer weather conditions and with the Building in normal occupation.

Following winter and summer performance monitoring the Electrical Services Sub Contractor shall submit a written report to the Client recording all measurements taken against appropriate design values. The Electrical Services Sub Contractor must allow in his Tender for returning to site to comply with this requirement.

2.68 ACCEPTANCE CHECKS

On completion of the commissioning process the Electrical Services Sub Contractor will be required to demonstrate to the Consulting Engineer that the systems are operating in accordance with the design intent.

The Electrical Services Sub Contractor shall give the Consulting Engineer at least ten days' notice in writing when requesting acceptance tests on any portion of the works. The application must certify that the agreed commissioning procedures and performance tests have been carried out.

The application must be accompanied by a complete set of records which shall include all plant settings, fluid flow rates, temperatures and pressures, space conditions and noise levels as adjusted by the Building Electrical Services Sub Contractor, related to the respective design values and all pump and fan characteristics.

Any application that is not accompanied by the test records will be rejected.

The precise nature, methods of measurement and presentation of commissioning record information shall be the subject of prior agreement between the Electrical Services Sub Contractor and the Consulting Engineer.

The Electrical Services Sub Contractor shall demonstrate to the Consulting Engineer the satisfactory operation of all systems. This shall include (not by way of limitation) all automatic control systems, safety indication and warning devices. He shall also demonstrate that adequate access for inspection and maintenance has been provided.

When all demonstrations have been completed and accepted by the Consulting Engineer the commissioning record information shall be updated as necessary and such records shall form part of the manual of Operating and Maintenance Instructions, called for elsewhere in this Specification.

2.69 ATTENDANCE ON THE ENGINEER

Whilst acceptance checks are in progress the Electrical Services Sub Contractor shall have staff available (including representatives of Specialist Suppliers as necessary) to operate and adjust the systems as may be required by the Consulting Engineer. The Staff available shall be fully conversant with the installations and the commissioning and testing procedures. The period during which staff must be available shall include that required for any preliminary operation of the plant in preparation for demonstrating the installation to the Consulting Engineer.

2.70 SNAGGING

Following handover/completion, the Consulting Engineer shall prepare and send a Snagging List to the Electrical Services Sub Contractor. The Electrical Services Sub Contractor shall ensure that all snagging items are cleared within two weeks of receipt of the Snagging List. Where the Electrical Services Sub Contractor fails to do this, the Consulting Engineer reserves the right to organise for another Mechanical Services Contractor to complete the snagging and for this to be contra-charged to the Electrical Services Sub Contractor.

2.71 MAINTENANCE

The Electrical Services Sub Contractor shall include a separate price in the Tender for providing a fully comprehensive twelve months maintenance contract for the complete installation as set out in the maintenance manuals or recommended by the manufacturer. The maintenance should be based on the HVCA "Standard Maintenance Specification for Building Services in Buildings" Volumes 1, 2, 3, 4 and 5 and shall include but not be limited to:-

- Replacement of consumables.
- Call out over the twelve months.
- Response time of less than twenty four hours or shorter as required for critical plant.
- Minimum of four site visits (each quarter) to visually inspect the equipment and plant and to carryout routine maintenance.
- Carryout all statutory obligations in respect of checks. Testing of plant and equipment to meet Health and Safety Requirements.

The Electrical Services Sub Contractor shall provide Maintenance Log Book(s) for the respective installations. The Maintenance Log Book(s) shall cover all items of equipment which require regular maintenance, in accordance with the Operating and Maintenance Manuals. Items of equipment as indicated in Maintenance Log Book(s) shall be categorised under system headings in accordance with BSRIA "Operating and Maintenance Manuals for Building Services Installations" Application Guide 1/82 Appendix 2, or as in the agreed format to accord with the approved Operating and Maintenance Manuals.

The Maintenance Log Book (a) shall contain the following, applicable to each item of equipment:-

- Nature of item.
- Item reference (in accordance with the Operating and Maintenance Manual(s), their page numbering and Drawings.
- Location of item (with reference to "As Fitted" Drawings and their numbers).
- Spaces for Maintenance Engineer to fill in (hand written) details of check, maintenance and repairs carried out, plus comments, signatures and dates.
- Spaces to record details of any break down of equipment and repairs outside the schedule planned maintenance.

The Sub-Electrical Services Sub Contractor shall be aware that the Maintenance Log Book (s) is/are part of the necessary handover documentation, and hence its submission shall be carried out at the same time as that for the Operating and Maintenance Manual(s).

2.72 SELECTION AND INSTALLATION OF EQUIPMENT

The Electrical Services Sub Contractor shall for Performance Specifications, as part of his Contract:-

Ensure that selection and installation of equipment and services fit within the plant and service ducts shown and comply with spatial restraints as outlined on relevant Drawings and descriptions in this Specification.

Guarantee and ensure satisfactory access for maintenance of Mechanical and Electrical Services Installation under this Contract and shall not obstruct access for maintenance of other services provided under separate contract (s).

Ensure that installation and selection of equipment and services are done to the satisfaction of the Client and/or Clients Representative.

Provide a list of all equipment and ancillaries selected for this Contract in the form of schedules.

Schedule shall include:-

- Reference
- No. of
- Location
- Equipment composition
- Area to be served
- Equipment make and model
- Physical size (mm x mm x m)
- Weight (kg)
- Motor output (if appropriate)
- Duty (kW)
- Number of phases (if appropriate)
- Starting method (if appropriate)
- Electrical load (kW)
- Volume handled (litre/sec or m^3/sec)
- Resistance (Pa or KPa or ohm)
- Anticipated time of delivery
- Running cost of control plant
- Remarks

Highlight all equipment with delivery periods longer than three weeks.

Be aware that details of equipment to be selected are as outlined in the Engineering Specification.

Ensure that the services penetrate structural elements only in those locations where the Structural Engineer has detailed Builders work openings. Where other holes are required which affect the structure, the Electrical Services Sub Contractor shall bear all costs for the Consultants works and any programme implications resulting from redesign and checking.

Allow for fortnightly co-ordination Meetings throughout the design to explain design progress and to go through Drawings and Calculations.

2.73 CALCULATIONS

The Electrical Services Sub Contractor shall for Performance Specifications, as part of the contract, prepare three copies of all Technical calculations for review by the Consulting Engineer.

Notwithstanding the review of the Electrical Services Sub Contractors calculations by the Consulting Engineer, the Electrical Services Sub Contractor shall remain fully responsible for the calculations used to size equipment and systems.

All calculations shall be carried out using industry recognised computer software programmes. copies of calculations shall be provided on disk. The use of Manufacturers software is not permitted without prior agreement.

The calculations shall be prepared prior to the commencement of installation work and shall in all cases demonstrate that the design criteria scheduled in this Specification will be fulfilled.

The Electrical Services Sub Contractor shall, before the relevant work proceeds, and allowing fifteen working days for examination of the calculations by the Consulting Engineer, issue the required number of copies of calculations to the Architect and Consulting Engineer. The Electrical Services Sub Contractor shall also allow within his programme for any modifications to the calculations that the Architect or Consulting Engineer may require as a result of the calculation examination process.

Failure of the Electrical Services Sub Contractor to submit his calculations in a timely fashion related to the contract programme and the information above shall not relieve him of his contractual responsibilities.

The Electrical Services Sub Contractor shall submit three copies of all final full data input and output calculations; the calculations being contained in a separate loose leaf folder all duly indexed and cross reference, with a document amendment record sheet.

Calculations as below, as applicable but not limited to, shall be submitted or reviewed by the Consulting Engineer. Calculations shall be prepared on A4 sheets, with easily justifiable summaries of the calculation output.

- Prospective Short Circuit Current
- Prospective Fault Current
- Discrimination Check
- Supply Load Sizing
- Earth Loop Impedance
- Over Voltage and Over Current
- Thermal Performance of Cables
- Volt Drop Calculations

2.74 SUB LETTING

Should the Tenderer propose to sub-let any portion of the Sub Contract Works, he /she shall nominate in his Tender the elements of the Sub-Contract Works to be sub-let and also the name of the firm, for approval by the Consulting Engineer, who he proposes to undertake such works. Where sub-let work is not shown, it shall be assumed that the Electrical Services Sub Contractor's own workforce is carrying out those elements of work.

The approval of the Consulting Engineer shall be gained for changes to or additions to Works to be sub-let. The Consulting Engineer reserves the right to reject such changes or additions to sub-let work.

SECTION 3.0 INSTALLATION STANDARDS

The whole of the installation shall be carried out in strict accordance with the 18th Edition of the Regulations for Electrical Installations, BS 7671, as issued by the Institution of Electrical Engineers (hereinafter referred to as the IEE Regulations) and requirements of Sections 1.0, 2.0 and 4.0 of the Specification.

3.01 MATERIALS

All materials and components shall be supplied and installed in accordance with the manufacturer's recommendations.

Materials shall comply fully with the relevant British Standard Specification, unless otherwise described in the specification.

The Client reserves the right to inspect materials on site and to reject any materials not complying with the specification and/or not marked with an acceptable British Standard or European Approval CE mark. The cost of any dismantling and re-erection of the installation occasioned by the removal of rejected materials shall be borne by the Electrical Services Sub Contractor concerned.

3.02 NOMINAL VOLTAGE

This specification generally refers to low voltage and extra low voltage as defined in the current IEE Regulations. The actual voltage in the installation may differ from the nominal value by a quantity within normal tolerances.

3.03 LOAD BALANCING

The electrical installation shall be designed to provide balanced loads across the phases as far as possible. Where additional load is introduced during the contract period, this shall be connected by the Electrical Services Sub Contractor so as to maintain the balance, having due regard to phasing and safety within the premises.

3.04 VOLTAGE DROP

Conductors shall be sized in accordance with the IEE Regulations Sections 6 Table 4Ab to ensure that a voltage drop of 3% is not exceeded between the origins of the installation and any point in a lighting installation, and 5% on general circuits when the conductors are carrying their full load current but disregarding starting currents.

3.05 EARTHING

The whole of the metallic portion of the installation, other than current carrying parts, shall be electrically and mechanically bonded to the consumers main earth terminal and also, if applicable to the lightning protection system or other points specified, and shall comply with the following:-

a) British Standard BS 7671, 18th Edition of the IEE Regulations.

b) British Standard Code of Practice BS 7430: Earthing.

c) British Standard Code of Practice BS EN 62305: Protection of structures against lightning.

A main earth terminal shall be supplied and installed adjacent to the electricity supply cable termination. The terminal shall be of ample size and capacity to suit the installation. All items of equipment, switchgear etc., shall be bonded to this earth terminal, using PVC sheathed cables, coloured green and yellow and sized in accordance with section 413 of the IEE Regulations.

An Ivorine Label reading

'SAFETY ELECTRICAL CONNECTION -DO NOT REMOVE'

in engraved uppercase characters not less than 4.75mm high, shall be permanently fixed immediately adjacent to or on the earth terminal.

A main earthing (protective) conductor shall be supplied and installed between the earth terminal, and the incoming electricity supply cable using PVC insulated cables, coloured green and yellow, and sized in accordance with Table 54.7 and Section 543 of the IEE Regulations. A heavy duty copper clamp, complying with BS 951 shall be used to bond the main protective conductor to the electricity supply cable, armouring or metallic sheath (where applicable the armouring and sheath shall be bonded together) and shall be provided with an embossed metal label reading

'SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE'

Complying with the IEE Regulations section 514.

In those instances, where earthing rods and/or earth leakage protection devices are to be used, these will be as detailed elsewhere in the specification.

All protective conductors shall, where possible, be enclosed within metal trunking or conduit serving switchgear, distribution boards etc., so as to provide mechanical protection. Where protective conductors are run on building surfaces, they shall be properly fixed and supported by means of PVC coated metal saddles along selected routes.

Earth continuity between separate items of switchgear, distribution boards etc., mounted adjacent to one another shall be effected by means of high conductivity, continuous copper tape, or PVC sheathed cable, coloured green and yellow and sized in accordance with section 54.3 / table 54.8 of the IEE Regulations, connecting all items to the earth terminal.

All items of switchgear, accessories, luminaires, conduit and the outer sheaths of MICS cables, the armouring of PVC/SWA/PVC cables, together with all other items of electrical plant and equipment shall be effectively earthed by means of a protective conductor, in accordance with Section 54.3/ table 54.8 of the IEE Regulations.

At every terminal point on the fixed wiring system, an integral earth terminal shall be provided, e.g. B.E.S.A. boxes, accessory boxes etc. A protective conductor shall be provided and installed between this terminal and the earth terminal on the associated switched socket outlet, luminaire etc.

Each circuit protective conductor shall be connected to multiway earth terminals provided and fixed within each distribution board. The earth terminal shall be provided with an adequate number of ways, such that not more than one conductor per terminal shall be installed and the earthing conductors shall be connected in the same sequence as the phase conductors.

All metal piped services e.g. heating, water and gas services, metal wastes and piped services at sinks, showers etc., shall be bonded to the earth terminal in accordance with the IEE Regulations section 543.

A 50mm section of each gas and water pipe, at positions close to their entry into the building, shall be cleaned and made smooth. A copper earthing clamp designed to permit the connection of protective conductors shall be provided and sized in accordance with Section 543/ table 54G of the IEE Regulations.

The clamp shall be a proprietary type or shall be fabricated from high conductivity copper strip, minimum size 40mm x 4mm which shall encircle the cleaned sections of the pipe. 40mm x 10mm brass bolts shall pass through 10mm holes, drilled in the end return sections of each clamp and a brass bolt, washer and nut shall tighten the clamp on to the pipe.
A permanent label, indelibly marked with

'SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE'

in legible type, sized as shown in section 514, shall be permanently fixed at the points of connection.

Connection between each clamp and the consumer's main earthing terminal shall be made by PVC insulated stranded copper cables, sized in accordance with section 413 and Section 543/ table 54.8 of the IEE Regulations. Each end shall be terminated in a sweated or crimped cable socket, and connection to pipe clamps and earthing terminals shall be made on to the stud or bolts, using brass nuts, washers and locknuts.

Connections between dissimilar metals are to be avoided, if unavoidable they shall have the faces coated with petroleum jelly or similar neutral grease and in the event of copper being present, it shall be tinned.

The final connection of bonding conductors from gas, water pipes and other services to the earthing terminal, shall not be completed until earth electrode and/or earth impedance tests have been satisfactorily completed

Bonding connections to pipework shall be as unobtrusive as possible and where practicable shall be made in service ducts or accessible voids and shall be readily accessible. Their positions shall be indicated on the Record Drawings.

The metal waste of all sinks and basins shall be bonded to the hot and cold water pipes. The cables shall be run so as to be as inconspicuous as possible.

All equipment located in kitchens e.g. cookers, hotplates etc., shall have an additional supplementary protective conductor, interconnecting all pipework and the main earth terminal.

All earth bonding connections and safety earth labels shall be clearly visible at all times and shall not be covered by paint or lagging or otherwise obscured.

Connections to lightning conductors shall be as detailed in BS EN 61305 and as described elsewhere in the specification.

The provision of protective multiple earthing shall be in accordance with the Electricity Supply Authority and as detailed elsewhere in the specification, where applicable.

All materials and sundry items shall be provided whether or not specifically mentioned, necessary to completely and effectively earth the installation. The installation shall be fully protected against dampness and corrosion and the effects of electrolytic action between dissimilar materials. A completely permanent installation shall be provided, which shall be fully accessible for regular testing and inspection.

3.06 MAIN SWITCHGEAR BOARDS

Meter connections enclosed in steel trunking shall be provided between the switch panel and the Supply Authorities metering equipment, unless specified to the contrary.

When required, elsewhere in this specification, suitable provision shall be made on the main switchgear panel to accept the Supply Authorities metering equipment and all interconnecting wiring within the panel shall be provided.

In instances where no meter cubicle is to be provided by the Authority, the Authority's meters shall be mounted directly on to a section of trunking, so arranged to interconnect meters, cut-outs, and main switchgear board, and enclose meter connections.

Switchgear boards shall be fixed to the wall/floor by rawl bolts or other approved fixings.

When cable entry into switchgear boards is from floor cable trenches, vermin plates are to be provided to seal all cable entries.

Provision is to be made for a minimum 25% spare capacity for future fitting of distribution fuse switches. Any larger requirements shall be specified elsewhere in this specification.

No building alteration shall be allowed when moving the switchboard into position, the switchboard being supplied in sections if so required to be built in position. Switchgear shall be delivered to site when required to suit the progress of the works. Care shall be taken to preserve the manufacturers paint finish. Any refurbishing etc, shall be carried out using paint, obtained from the switchgear board manufacturer to the original standard of finish.

All cables connecting to switchgear shall be installed without reduction in cross-sectional area, appropriately sized cable lugs and terminals shall be provided, or equipment shall be modified by the manufacturer to accept larger cables than standard.

Industrial Type Switchgear Board (Employing Fusegear);

These shall consist of a frame of mild steel angle, having minimum dimensions of 40mm x 40mm x 5mm and shall be arranged for securely fixing to walls and/or floors as required. On the frame shall be mounted the items of equipment as detailed in the specification and shown on the drawings.

Bus-bars shall be high conductivity hard drawn copper, having suitable phase colouring and mounted on stout insulated supports. The bus-bars shall be of 200 amp minimum rating for main switches up to 200 amp rating. Where the main switch exceeds 200 amps, the rating of the bus bars shall be higher than current rating of the main switch.

All connections to the bus-bars shall be made by mechanical clamps of the pinching bolt or shell type. The internal wiring within the switchgear board shall be of ample cross sectional area and be suitably insulated.

The completed switchgear board shall be designed so as to be capable of successfully withstanding, through fault current equivalent to a minimum of 31MVA at 400 volts or as indicated elsewhere in this specification.

Cubicle Type Switchgear Board (Employing Fusegear);

The details specified in the previous Sub-Clause for industrial type switchgear boards, shall apply as far as fused switches, bus-bars and ratings etc., are concerned. They shall be designed to give front access for maintenance and future extension.

The components of the switchgear board shall comply with the above, inclusive of the specification.

Cubicles shall be constructed from rolled steel channel minimum sized 60mm x 30mm deep x 5mm or equivalent angle section, clad with sheet steel of 3mm metric gauge minimum for large panels and 2mm metric gauge for lids and small panels. The panels shall be finished in a 'Light Admiralty Grey' cellulose finish or other equal and approved colour, inside and out, after two coats of rust proofing have been applied to the panel. Cubicle shall comply with BS EN 61439.

3.07 CONTROL PANELS AND CUBICLES

The details specified in the main switchgear distribution centres shall apply as far as fused switches, bus-bars and ratings etc, are concerned.

The panels shall be constructed from rolled steel channel minimum size 60mm x 30mm deep x 5mm or equivalent angle section clad with sheet steel of 3mm gauge, 2mm gauge may be used for covers and doors of not more than 1 metre square.

Terminals shall be of the standard rail-mounted feed-through type, or equal and approved. All terminals shall be identified by means of numbered or lettered marking tags, which shall be identical to the numbers or letters applied to the cables. Cables shall be identified at terminations by means of cable markers. 25% spare terminal capacity shall be included in the control panel for future usage.

Multiple runs of minor flexible cords within panels, shall be neatly loomed on doors and contained in BETA ducts PVC ducting, or equal and approved. Elsewhere in the equipment 50% spare capacity within wiring ducts shall be provided. All components, motor starters, relays, timers etc., shall be labelled showing their reference and function and these shall relate to the panel's schematic wiring diagrams provided with the record drawings and manuals.

All control panels shall be fitted with multi-pole isolating switches through which all electricity supplies shall pass. The door/doors of the control panel shall not open unless the isolating switch is in the 'off' position. A facility to lock the control panel isolating switch in the 'off' position shall be included.

Components used in Control Panels shall comply with the following British Standards;

Busbars and Busbar Connections	BS159 and BS EN 61439
Motor Starters and Controllers	BS EN 60947-4-1, BS EN IEC 62271 and BS EN 61439
Contactors	BS EN 60947 & BS 5424
Air Break Switches and Isolators	BS EN 60497-3
Heavy Duty Composite Units of Air Break Switches/Units	BS EN 60497-3
Colours of Indicator Lights And Push Buttons	BS EN 60073
The Performance of AC motor control gear equipment up to 1000v AC	BS 5486 and BS EN 61439
For use on high prospective fault systems	BS EN 6094

3.08 DISTRIBUTION BOARDS

All distribution boards, unless stated otherwise, shall be RCBO Metal Clad Distribution Boards, and shall be surface or flush type as specified, and of the sizes as detailed on the drawings. Facilities for local isolating of the distribution boards shall be provided by either a local fused switch unit or an integral isolating switch, whichever is indicated on the drawings.

Where surface mounted on to a flush installation, all conductors shall terminate behind the board in an adaptable box. For surface mounting, trunking shall be fixed between the board and ceiling level, or conduit run directly into the board. Full earth continuity connection shall be made between the various components.

Miniature Circuit Breaker Distribution Boards;

MCB distribution boards shall comply with BS EN 61439 'Particular Requirements for Miniature Circuit Breaker Boards'. The cases shall be constructed of heavy gauge sheet steel in such a manner as to afford rigidity and maximum ease of wiring for full size circuit and main cables. The cover shall be provided with an efficient gasket or alternatively designed with generous overlapping edges to prevent the ingress of dust.

Components shall not be manufactured from zinc alloy in conjunction with sheet steel where they are relied upon for earth continuity.

All distribution boards are required to be lockable, cylinder type locks shall be provided, having two keys per lock. All locked distribution boards shall be operated by a master key, six such keys shall be handed to the Client upon completion of the Contract.

The cases shall be provided with detachable cable/conduit terminating plates, which shall be reversible and interchangeable from top to bottom.

All screws and nuts used in the construction of the case shall be fitted with shake proof washers and care taken to ensure efficient earth continuity. An external earthing terminal with cable sockets shall be fitted.

The cases shall be stove enameled inside and out, the exterior being finished in grey or silver enamel, applied after two coats of rust proofing.

All MCB blanks shall be fitted to frames with robust locking plates provided to secure the frame rigidly in the fixed positions. The blanks shall be so spaced to obviate the necessity for insulating barriers, but protection shall be provided by means of insulating shields to prevent accidental contact with the main bus-bars and incoming main cable.

Bus-bars shall be of a high conductivity, hard drawn copper conductors, connected to the MCB contacts by means of spring washered screws or bolts, unless plug in type MCB's are specified.

Where a main integral isolating switch is provided in an MCB case, it shall be arranged to isolate incoming live and neutral main cables from the bus-bars. The isolator switch shall be rated at 500 volts and of the quick 'make or break' pattern, with positive action. Incoming and outgoing terminals shall be fitted with two clamping screws, and outgoing conductors to the bus-bars shall be high conductivity hard drawn copper.

Isolating switches shall comply with IEE Regulations and shall be capable of carrying their full rated load continuously and shall 'make or break' their full rated load without undue burning of the contacts.

The isolating distances between contacts when in the open position, shall not be less than those specified for isolators in BS 5419 / BS EN 60947 - 3

Neutral bars shall be similar to the main bus-bars and shall have two screw terminals per way for ratings of 30 amps or over. Single screw connections will be allowed for capacities up to 32 amps. The neutral bars shall have one terminal for each MCB within the board, and connection of conductors to the neutral bar shall be in the same order as the phase connections.

Where installations are carried out with cables with protective conductors, all distribution boards shall also contain internal earthing bars similar to the neutral bars detailed above, with one terminal for each MCB within the board. Earthing conductors shall be connected in the manner described for neutral conductors.

Fused Distribution Boards;

All fuseboards shall be of 500 volt rating to BS EN 61439 'Particular Requirements for Fuseboards'. The details specified in the previous clauses shall apply as far as cabinet and cover construction cabling arrangements, bus bars, neutral bars, earthing and isolating switches are concerned.

Fuse carriers and bases shall be manufactured from high quality vitreous porcelain or phenolic moulded construction. Fuse contacts shall be designed to give adequate and even pressure between the base contacts and carrier clips, by means of phosphor bronze springs, and shall be of such cross section as to be capable of carrying the full load rating continuously without undue temperature rise.

Fusebanks shall be fitted to detachable frames with robust locking plates, provided to secure the frame rigidly in the fixed position.

Fusebanks shall be so spaced as to obviate the necessity for insulating barriers, but protection shall be provided by means of insulating shields to prevent accidental contact with the main bus-bars and connections.

All fuses in lighting and heating circuits shall be of the HRC cartridge type, ASTA certified for compliance with BS 88 - 1 Category of Duty 440V AC 5 Class Q1.

3.09 FUSED-SWITCH, SWITCHFUSES, SWITCHES AND FUSED UNITS,

The above units shall comply with BS EN 60947 - 3 and shall be 500 volt type and installed where specified and as detailed on the distribution diagram.

All switchgear shall be provided with suitable locks for padlocking the switches in the 'off' position. The cover shall be interlocked with the operating mechanism to prevent it from being opened in the 'on' position. This interlocking shall also prevent the switch from being closed with the cover open, unless the mechanism is operated by an authorised person for examination and maintenance purposes. The cover shall be gasketed to prevent ingress of dust.

The switch action mechanism shall be of the parallel operation (double break type, having cartridge fuses mounted on an insulated bar forming the plate assembly for fused switches) and shall be ASTA certified to adequately meet all required duties specified.

The operating mechanism of the quick 'make and break' pattern, shall be controlled by powerful springs which shall be in tension only during the operation of the switch. The blades shall enter clips of heavy gauge copper, shrouded with insulated shields which also protect the cable terminals. All current carrying components shall be electro-tinned, and ferrous parts shall be rust proofed.

The glanding plates shall be removable for drilling for conduit or cable entry and shall be fitted with additional distance pieces where necessary.

Fuses for Fused-Switch Units and Switch Fuses;

All fuses in switchgear shall be HRC, sized and specified as detailed on the drawings for the fused-switch units or switch fuses etc., in which they are incorporated unless different ratings are shown on the drawings.

They shall be ASTA certified for compliance with BS 88 - 1 / BS EN 60269 - 1: 2014 Category of Duty 400V AC 5 Class Q1.

In all cases, fuse links shall be selected to provide correct circuit discrimination. Fuses 'backing-up' MCB's or MCCB's shall have their characteristics closely matched to avoid overload and short circuit operation of the fuse within the capacity of the circuit breakers but ensuring that the maximum short circuit capacity of the circuit breaker is within the protection afforded by the fuse.

Cartridge Fuses;

All fuses installed within 13 amp plug tops, fused spurs, clock connectors etc., shall be cartridge fuse links rated at 240 volts ASTA certified for compliance with BS 1362 'General Purpose Fuse Links for Domestic and Similar Purposes' or BS 646 'Cartridge Fuse Links (rated up to 5 ampere) for ac and dc Service' or BS 2950 'Cartridge Fuse Links for Telecommunications and Light Electrical Apparatus'.

All equipment connected under this contract which is locally fused, shall have fitted fuses with characteristics which are recommended by the manufacturer of the equipment.

If any appliance or equipment suffers due to incorrect fusing of the appliance, this shall be repaired or replaced at no extra cost to the contract.

3.10 MOULDED CASE CIRCUIT BREAKER (MCCB's)

Where specified, MCCB's shall be of the thermal/magnetic type, having a quick 'make or break' trip free mechanism which prevents the MCCB from being closed or held in against short circuits or overloads. Tripping of every multi-pole MCCB shall be such that operation ensures simultaneous action in all phases.

Clear indication shall be provided for the three positions of operation of the mechanism 'on', 'off' and 'tripped'. The operation shall be such that the MCCB shall trip automatically under fault conditions and to reset, the dolly shall require first moving through the 'off' position. All MCCB's shall be provided with facilities for locking the breaker in the 'off' position.

All MCCB's shall be rated at 500 volts minimum, be ASTA certified for this operational duty, and comply with BS EN 60947 - 2.

3.11 MINIATURE CIRCUIT BREAKERS (MCB's) (RCBO's)

All MCB's shall have movements which are positive in both directions (make and break) so as to enable units to be closed decisively by the operation of the handle, and to be able to be opened under any circumstances. The handles shall not be able to assume the 'off' position unless the contacts are definitely separated, to safeguard against false indication. The handle shall be trip free to make it impossible for the operator to hold the breaker in the closed position under faulty conditions. The operating mechanism and arc chambers of the circuit breaker shall be separated from the terminals and fixing screws.

Terminal identification shall be readily discernible as viewed from the front of the board with automatic and clear signal identification for both 'on' and 'off' positions.

Miniature circuit breakers protecting two or three phase circuits shall be ganged type. Individual MCB's shall not be allowed. Multiphase circuit breakers shall not be employed in single phase circuits.

Where the full capacity of a distribution board is not required, the Electrical Services Sub Contractor shall allow for fixing blanking plates in the vacant MCB housings.

All MCB's shall be rated at 500 volts minimum and comply to BS EN 60898 and RCBO's BS EN 61009.

3.12 LABELLING

All fused-switch units, switch fuses, switches, bus-bar, chambers, distribution boards etc., and all items of equipment on the main panel shall be identified in accordance with Section 514 of the IEE Regulations and shall have securely fitted, externally, a white 'Formica' or 'Traffolyte' label engraved with 40mm black letters detailing the function of the equipment, any reference number and the size of incoming and outgoing cable and types.

Red, yellow, blue 'Formica' phase buttons shall be fixed inside all switchgear and distribution boards to indicate to which phase of the supply the various circuits are connected. The colouring shall comply with section 514 of the IEE Regulations Table 51.

Each distribution board shall be fitted internally with a Type Written list, giving details of all MCB or fuse ratings, supply phase, equipment served and size and type of all circuit conductors. Each list shall be mounted in an envelope formed from 0.5mm thick clear non-inflammable materials.

The envelope shall be open at one end and fitted to the inside of the distribution board with 5mm diameter rivets passing through eyelet's in the envelope.

An additional Typed copy of each circuit card shall be incorporated in the maintenance manuals and handed to the Client.

Each T P & N item of switchgear shall have fitted on the cover, a white 'Formica' or 'Traffolyte' label having 'CAUTION - 400 VOLTS' engraved in 10mm high red lettering.

No manufacturers or installers name plates whatsoever shall appear on the work unless written permission is obtained from the Client.

3.13 ENGRAVING

The Electrical Services Sub Contractor shall allow for engraving of all switched fused spurs, double pole switch accessories and any other accessories which are required under this specification.
The accessory plate shall be engraved in either black or red as appropriate, capital letters 5mm high, detailing the appliance or equipment being supplied by the accessory, e.g. extract fan, fan convector, and external lighting etc. Glued Traffolyte labels will not be accepted.

3.14 CABLE TRAYS

Cable trays shall comply with BS EN 10346 and be formed from perforated steel of not less than 0.9mm thickness up to an including 100mm width; 1.25mm thickness from 150mm up to an including 300mm width; and 2.00mm thickness above 300mm width. They shall be galvanised unless otherwise indicated elsewhere in the specification, and schedules or drawings.

Earth continuity shall be maintained throughout the tray installation via the installation of bonding cables between lengths of the tray not directly connected in close proximity to each other.
Power & Data cabling shall be installed on separate cable tray.

Trays shall be adequately sized to support the cables without bunching. Support shall be by means of steel brackets, installed at intervals necessary to provide a rigid fixing, and ensure that no undue deflection occurs in the complete installation. The brackets shall be galvanised prior to fixing. Dome headed bolts, nuts and washers of finish suitable to the tray, shall be used between tray and brackets.

Fixing to the fabric of the building shall be by means of expansion type masonry plugs or bolts. Fixings shall be galvanised unless otherwise stated.

Trays shall be installed with a space between the structure and tray as given in the following table.

TRAY	**SPACE**
Up to 100mm wide	50mm minimum
Above 100mm wide	75mm minimum

Cable trays shall be installed using factory formed bends, elbows, tees, couplers and risers etc. Where cut sections are used for sets, they shall be free from sharp edges and jointed by means of fish plates, bolted to each section. Site fabrication of elbows etc., will only be permitted with the prior approval of the Client and where it is not possible to obtain the necessary factory made item.

Where cuts have been made, the tray shall be painted with zinc paint.

Holes that have been cut to allow cables to pass through, shall be suitably bushed.

All routes must be chosen to allow ease of access to all cables when installed.

Suspension sets shall comprise threaded M12 cadmium plated hanger rods, together with nuts and locking washers, vertical hanger brackets, support channel, tray hold-down clips etc., all of which shall have a galvanised finish.

All cables shall be securely fixed to tray work, and the complete installations must be carried out in a neat and workmanlike manner without crossovers. A 25% reserve margin in size and weight shall be allowed for all cable tray works.

Cables of 30mm diameter and above, shall be fixed using the appropriate size cable cleat, as supplied by BICC Ltd or of equal and approved type and manufacture.

On multi-light duty cable runs, cable straps of plastic coated metal shall be used to secure cables.

Bunching of cables will not be allowed.

Cables shall be clipped by means of copper or brass saddles and clips, where high temperature or humid conditions are likely to be experienced. In all cases, saddles, clips, straps etc., shall be fixed to the tray by means of brass screws bolts and nuts.

Tray work shall be light duty Admiralty pattern for office ceiling voids supporting twin & earth type cables. Tray work shall be heavy duty for supporting PVC SWA PVC or XPLE SWA PVC type cables.

Tray work installed in exposed areas shall be galvanized finish to BS EN ISO 1461 or BS EN ISO 12944: Section 2 dependent upon application.

3.15 CABLE TRUNKING

Trunking shall only be installed in situations which will remain readily accessible throughout the life of the building. No cable trunking shall be installed behind a plastered ceiling or in other inaccessible situations.

3.16 SHEET STEEL CABLE TRUNKING

Steel cable trunking shall comply with BS EN 50085, BS EN 61386 and BS EN 10346 steel surface trunking.

Where communications, extra low voltage circuits (Band 1) etc., are contained in a trunking, the requisite number of separate compartments shall be provided to segregate the wiring. Where conduits are taken off such trunking, they shall not pass through other compartments unless prior permission is obtained from the Client.

The Electrical Services Sub Contractors attention is drawn to Chapter 52 of the IEE Regulations.

The entire trunking system shall be electrically and mechanically continuous throughout.

Where trunking is required to be recessed in the structure of the building, the finished edge of the trunking is to be installed flush with the plaster work.

Trunking runs shall be so arranged that the lid or cover plate is always on the top, or side, and not underneath, unless this cannot be avoided in which case the Client's permission shall be obtained.

Wherever trunking passes through walls, vertical partitions etc., a fixed piece of trunking lid shall be fitted to the trunking, extending 75mm either side of the wall or other barrier, this is to allow removal of the adjacent lid without disturbing the building fabric. Care shall be taken to see that no orifice is left between the trunking and the building structure through which fire might spread. In addition, a suitable barrier of incombustible material shall be provided and fitted inside the trunking, in accordance with the IEE Regulations.

All fixing screws within the trunking shall be of the 'round head' type. The trunking shall have an overlapping, well fitted lid, securely fixed to the trunking by approved means, that will avoid damage to the cables. Self-tapping screws shall not be used.

All necessary accessories, including long sleeve couplings, end pieces, bends, sets, tees, reducers, branches, fillets, pin racks, cable retainers etc., shall be allowed for in the tender and shall be purpose made units rather than being fabricated on site.

Where a change in direction of a trunking run occurs, the deviation should be effected by a purpose made unit, manufactured on similar lines to the bends and tee pieces described above. Where this is not practical, changes in direction shall be fabricated in a neat and workmanlike manner. All joints shall fit closely, and gaps will not be permitted.

All burrs and sharp edges shall be removed, and no screw shall protrude into the trunking.

Trunking shall be firmly attached to its associated equipment, either by bolted flanges or by male bushes and couplings.

Where trunking is connected to equipment by means of flange connectors, the entry into the equipment shall be of the same cross-section as the trunking.

Where trunking does not terminate in equipment, the otherwise open end shall be capped with a cover suitably bolted in position.

Sheet steel cable trunking may be used on installations, employing steel conduits for connecting two or more switchboards together, or where several conduits would otherwise have to be run alongside each other. The Electrical Services Sub Contractor must make proper allowance for the de-rating of cables installed, where together. The cables must be capable of carrying the current imposed by the equipment connected. The Electrical Services Sub Contractor's attention is drawn to Chapter 52 of the IEE Regulations. The Client must be consulted as to precise details concerning trunking routes and applications.

Trunking shall be heavy gauge, zinc coated steel enamelled to an approved colour, and fixings shall be arranged in pairs across the back of the trunking at 1 metre intervals.

Where trunking is used for connections between switchgear and any equipment apparatus, the trunking shall be secured by means of flanged couplings, screwed conduit couplers with smooth bore bush or fixed insulated 'paxoline' type spacer pieces with fixed grommets. Direct attachment of the trunking to equipment or apparatus without couplings or involving the need to cut the return edge of the trunking shall not be permitted.

All lengths of trunking shall be connected together by internally fitted rectangular couplings of sufficient bearing face of 25mm to which the lengths shall be bolted on site or welded at the factory.

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

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

On vertical runs of trunking, internal incombustible barriers shall be fitted at the distance between floors or 5m whichever is the less, in accordance with the IEE Regulations.

All vertical runs of trunking which pass through floors, shall be fitted with fire barriers in accordance with the IEE Regulations.

All trunking shall be fixed so as to drain off any condensed moisture.

Where underfloor trunking is to be installed, reference shall be made to other parts of the specification. Steel underfloor trunking shall be in accordance with BS EN 10142 and 3 steel underfloor (duct) trunking.

All necessary trunking support work, hangers, brackets and fixing requirements shall be provided by the Electrical Services Sub Contractor.

Earth links of the appropriate size and type shall be installed at every jointing coupling, manufactured bend, tee etc., throughout the entire trunking system. The Electrical Services Sub Contractor shall install separate protective conductors in the trunking to comply with Section 543 of the IEE Regulations.

In cases where sheet steel trunking is installed on wooden floor joists or similar applications, and there is a danger of movement, a flexible earth conductor shall be installed, bonding all joints in the trunking. This shall be fitted in addition to the standard earth links.

Cable retaining strips shall be fitted at 1 metre intervals, unless trunking is installed with the cover on the top side.

Insulated cable support pins shall be fitted at intervals of 4 metres in vertical runs of trunking and at the top of the vertical trunking.

3.17 INSULATED CABLE TRUNKING

Insulated trunking and accessories shall comply (where applicable) to the physical tests contained in BS 4607 'Non Metallic Conduits and Fittings for Electrical installations'.

The insulated trunking shall only be used where an insulated conduit system is being installed, unless specifically stated otherwise. The trunking shall be fixed by means of wood screws at intervals not exceeding 1 metre. Fixing holes shall be slotted to allow for any subsequent expansion due to temperature variations. Insulated trunking temperatures are expected to exceed + 60° C or fall below – 5° C. Care shall be taken to ensure that the trunking is not deformed by fixings, this applies particularly when trunking is fixed to an uneven surface. Packing pieces shall be introduced in order that the trunking shall be securely fixed, level and plumb without being deformed.

Insulated cable trunking shall be smooth inside and outside and free from imperfection and manufactured by an approved manufacturer.

Insulated cable trunking shall be of the high impact resisting heavy gauge type, fitted with well-fitting lids of an approved type and size , or as indicated in the specification or schedule of drawings.

Cable retaining strips shall be fitted at 1 metre intervals unless trunking is installed with the cover on the top side.

Insulated cable support pins shall be fitted at intervals of 4 metres in vertical runs of trunking and at the top of the vertical trunking.

The Electrical Services Sub Contractors attention is drawn to Chapter 52 of the IEE Regulations.

Internal fire barriers shall be fitted where vertical trunking passes through floors.

Overlapping cover plates shall be fitted where installed flush with the building fabric. The finished edge of the trunking shall finish flush with the finished surface.

Insulated trunking shall be fitted with manufacturers standard tees, off-sets and other fittings where changes of direction occur.

Where trunking terminates, manufacturers standard end plates and flanges shall be fitted to connect to items of equipment.

Joints shall be effected using the manufacturers standard internal connectors and in accordance with the manufacturer's recommendations.

Installations shall be in accordance with the appropriate conditions covering the installations of insulated conduit.

Separate protective conductors shall be installed in the trunking.

The Electrical Services Sub Contractor's attention is drawn to Chapter 54 of the IEE Regulations, particularly Section 543 and table 54G.

All joints and fabricated bends etc., in insulated trunking shall be made in a neat and workmanlike manner and all joints in trunking and trunking covers shall fit closely and be free from gaps. Additional fixings shall be provided to the building structure 50mm either side of the joint.

Joints in the lid and trunking must not be allowed to coincide.

Trunking shall only be installed in situations which will remain readily accessible throughout the life of the building. No cable trunking shall be installed behind a plastered ceiling or in other inaccessible situations.

The manufacturers recommendations regarding the installation of insulated trunking must be adhered to at all times.

All conduit entries shall be made by means of purpose made bushes and couplings or adapters.

3.18 CONDUIT AND CONDUIT FACILITIES

Mild Steel Conduit Systems;

Conduits shall be installed as required by the IEE Regulations and as detailed in this specification.

This specification is unsuitable for use in installations, in potentially explosive atmospheres.

Refer to the relevant and applicable British Standards and codes of practice.

All metal conduits must be heavy gauge, seam welded, steel tube, screwed conduits manufactured to BS 31. Steel tube screwed conduits and fittings for electrical wiring Class B BS EN 61386. Steel conduit and fittings with threads of ISO form for electrical installations for metric conduit, unless specified otherwise. Conduits shall be finished class 3 galvanised for internal use, except in positions exposed to water (other than water used in construction), steam condensation or the action of weather, where class 4 hot galvanised conduits shall be used.

Any conduit work rejected by the Client shall be replaced at no extra cost.

Where conduit is used as a protective conductor, it shall comply with requirements of Chapter 54 of the IEE Regulations, particularly Section 543. The Electrical Services Sub Contractor shall install separate protective conductors in the conduit to comply with Section 543 and table 54G of the IEE Regulations.

No conduit smaller than 20mm in diameter or larger than 32mm shall be used.

All bends shall be in accordance with the IEE Regulations, made in conduit on a conduit bending machine, fitted with a former of the correct radii for each conduit size.

Conduits shall be secured in an efficient pipe vice, whilst being screwed.

Conduit systems shall be installed so as to ensure compliance with the requirements of the IEE Regulations.

Conduits shall be stored in dry conditions prior to installation. All conduit damaged mechanically or by oxidization shall be rejected by the Client. The manufacturers thread applied to each length of conduit shall be cleaned by means of conduit thread dye prior to installation.

Conduit Fittings;

Conduit fittings shall have the same finish as the conduits being used and shall comply with BS EN 61386. All conduit fittings shall be screwed in malleable iron circular type, fitted with covers secured by brass screws. Rectangular adaptable steel boxes may be used on multi-conduit runs.

All circular type boxes must be fitted with long screwed spout conduit entries with the screwed thread terminating within the spout, and the edges of the internal orifice of the box rounded and smoothed to act as a bush, excepting the adaptable steel rectangular boxes and loop in conduit boxes, in which case male bush and coupling must be used for conduit connections.

In concealed installations, boxes shall be fixed with the rims flush with the finished surfaces, but when for any reason whatever, the rims are below the surface, suitable extension rings of the required depth shall be provided and installed to finish flush with the surrounding surfaces and fitted with lids of sufficient oversize (7.5mm minimum all round), to cover the junction between box and plaster.

In no case will the use of manufactured bends, sets, elbows, inspection elbows, or tees be permitted, unless specifically allowed in writing by the Client, to meet extraneous conditions.

From every distribution board, a spare hole shall be provided (20mm diameter conduit clearance), fitted with knock-out, or plug will suffice. When trunking is employed to convey final sub-circuits from the distribution board, no spare entries are required.

For surface installations, tangent boxes may be employed to improve the appearance of the system.

Fixing of Conduits;

All conduits must be firmly and rigidly fixed to be entirely without whip or movement. Space bar saddles, or strap saddles must be used on the timbers in roof spaces and will be allowed when conduits are run on the underside of exposed unsealed floor or ceiling joists. Pipe hooks or crampets will not be allowed except for securing conduits in chases, or screeds, when the top of the hook must be at least 10mm below the finished surfaces of the walls or 25mm below the floor finish. Pipe hooks shall be galvanised.

Plain saddles are to be secured to the building fabric via the use of rawl plugs and screws, direct driving into plain saddle will not be allowed.

The standard cast iron distance saddle, (single fixing base and two-screw fixing top) must be used for all conduits run on the surface of walls and ceilings etc., throughout the building, fixed at intervals of not more than 1.2 metres.

Where the conduit system is the sole support of the luminaires via conduit boxes, additional saddles disposed symmetrically about and near to the point of suspension, must be introduced for security of fixing.

In service ducts and/or where conduits converge and run together, approaching distribution centres etc., made-up multi-saddle ensembles with common iron bar base, or plain flat saddles grouped onto neat hardwood strips, are acceptable alternatives, provided that 10mm spacing from the wall surfaces is maintained.

When fixings into the wooden parts of the fabric (i.e. joists etc) are not available, or are not permitted, plastic plugs must be fitted to fully accommodate fixing screws of minimum length 35mm. All fixings shall be effective and shall be capable of supporting the loads imposed by the installation.

The finish of the saddles must in all cases conform to the finish of the supported conduits. Galvanised sherardized or cadmium plated screws shall be used in all cases where galvanised conduit is installed.

When conduits are required to be run on shuttering, prior to the laying of concrete in situ, additional security must be provided near to every box and at intervals of not more than 1.2 metres by the introduction of short lengths of steel wire of not less than 2mm diameter twisted around the conduit and reinforcing steel. The conduits shall be adequately fixed to prevent excessive movement and damage during the pouring and settling of concrete and shall be protected from mechanical damage.

Building construction may require particular treatment in respect of the fixing of conduit and/or fittings, in order to obtain permanent security, the drilling and tapping of non-structural steelwork, the supply and fixing of metal straps, supports, clips, clamps and plates and the introduction of additional conduits of larger sizes than actually required for wiring, together with all fixing devices, must be included for wherever such practices are necessary and particularly when luminaires etc., have to be supported independently off specially suspended ceilings. The Client's written approval shall be obtained before any hole is drilled or cut in structural steel or structural concrete.

Conduit Runs and Concealment;

The conduit installation shall be fully co-ordinated with the other services to be installed in the building or buildings, and routes shall be agreed with the Client prior to commencing the installation. Conduits shall be installed at least 150mm from, and preferably under hot water pipes and at least 50mm from other service pipes and cables. Conduits shall be bonded to other services in accordance with the requirements of the IEE Regulations.

Conduits in floors shall be routed and installed so as to avoid the fixings to floor standing equipment, to be installed in or on the floors.

In the buildings in course of erection, all conduits must be concealed, being run in roof spaces, behind suspended ceilings, under floors, in flooring and roofing screeds, on shuttering prior to the casting of concrete in situ, and in chases cut or cast into walls and/or concrete ceilings.

Earth continuity tests shall be applied to the system before plastering, screeding or casting of concrete is commenced. Surface work will be allowed where certain pre-fabricated methods of construction preclude the concealment of the runs, and on fair faced brickwork or blockwork or other un-plastered walls.

Conduit runs shall be planned to obviate the need for draw in boxes, but where the use of such boxes is unavoidable, they shall be accessible at all times and be fitted with covers.

The positions of every conduit box in a concealed conduit installation which is not used as a support for a luminaire or electrical connection must be agreed in writing by the Client.

The installation of conduit boxes in floors shall generally be avoided but where it is essential and agreed with the Client, the floor mounted boxes shall be fitted with brass covers, recessed to accommodate the floor finish. The covers shall seal the box against the ingress of moisture.

In a building which is being refurbished, every effort shall be used to conceal conduits in floors and available roof spaces. Switch drops and other necessary and unavoidable runs of conduit across plastered walls and ceilings of concrete or ceilings without accessible back space, must be concealed, unless specific instructions are issued in respect of a particular project to allow conduits on surfaces.

When conduits are specified as being installed in the surface, the runs must be arranged to render the whole system as neat and inconspicuous as possible, having regard to existing architectural features, all vertical and horizontal runs must be plumbed and levelled respectively. Particular care must be taken where conduits converge and run together near distribution centres to obtain a symmetrical layout. The distance between conduits shall be maintained through bends and sets and shall not noticeably vary.

All conduit runs must be designed to permit wiring to be readily installed after the complete erection of the conduits through the available draw-in, accessory and luminaire suspension boxes.

No conduit runs will be allowed to be laid underground in any circumstances whatsoever.

In cases where it is necessary to install draw-in boxes, where a number of circuits of the same category, run together in the same direction, adaptable junction boxes of the required size to take all conduits shall be fixed in the run to facilitate the drawing in of the cables instead of inserting a separate circular box in each individual run.

In all positions where the appearance of the conduit layout would be improved by the introduction of dummy lengths of conduit, and in all cases where more secure fixing for the suspension of fittings is considered necessary and would be obtained by continuing the conduits from their respective manual terminations, such dummy conduits and continuations must be included for and introduced.

Where surface mounted equipment (other than luminaires) is specified, all concealed conduits shall be terminated, and an adaptable box installed, recessed into the wall at every surface mounted equipment position. The recessed box shall in every case be completely covered by the surface mounted equipment. Provision shall be made in the back of the surface mounted equipment for the conveying of cables (including protective conductors) from the conduit system via a suitably bushed opening. Any opening between the recessed box and the surface mounted equipment shall be closed when the surface mounted equipment is fixed, to prevent the ingress of dirt etc.

Where surface mounted luminaires are to be fixed to a concealed conduit system, the boxes shall be circular. Screwed metal caps or plugs shall be used to protect the open ends of conduits and boxes. Special care shall be taken to prevent foreign matter entering the conduit. Cork plugs shall be used at conduit terminations to prevent the ingress of foreign matter.

Where ceilings are of the demountable tile type the outlet box for the light fitting shall be fixed to the structure with a cable connection from the outlet box to the light fitting via a 3 pin plug-in ceiling rose. The lighting fittings shall be individually supported using either 20mm conduit or 6mm dia. Threaded rod. Where the light fitting is of the simple suspension type the outlet box shall be brought to the ceiling surface in the same manner as that for a fixed ceiling.

Locking Bushes and Couplings;

All conduit ends must be filed square and reamed before erection, to ensure freedom from internal burrs and roughness.

Running couplings shall be secured by means of lock nuts or lock rings and the exposed thread painted with zinc paint or similar after installation.

Every conduit connection to equipment boxes, distribution boards, loop-in boxes, cable trunking etc., shall be made by means of a screwed coupling and male hexagonal headed smooth bore brass bush. The smooth bore bush shall be fitted to secure the conduits to the item connected via a purpose made clear hole only, sufficiently large to permit the bush to be rotated, the hole to be closed by the bush and coupling when fitted. Paint must be removed from the surface of the item connected, to allow it to be covered by the end of the coupling, which shall be filed clean and square, to ensure a good mechanical and electrical metal to metal joint. Any exposed area of metal from which paint has been removed must be made good in a matching paint. Bushes shall be fitted and tightened by means of correctly fitting spanners. Mutilated bushes must not be fitted, and any bushes damaged whilst being fitted, must be removed and replaced.

Conduits connecting to couplings shall be connected by means of 15mm long threaded sections and shall have a gap of approximately 2mm between them. No threads shall be exposed except at running couplings.

Continuity and Earthing;

The whole of the conduit installations shall be mechanically and electrically sound and continuous throughout their length in accordance with the IEE Regulations.

Painting of Conduits;

All exposed threads shall be painted and all conduit which has suffered minor damage to its paint, shall be made good to prevent oxidation, lubricant or cutting compound shall be removed from conduit prior to painting. Galvanised conduit which is slightly damaged, shall be primed and painted with a metal base paint to match the colour finish of the conduit.

Conduits which are more than slightly damaged shall be rejected.

Insulated Conduit Systems;

Insulated conduits shall be heavy gauge, high impact and manufactured to comply with BS 4607 - 1, non-metallic conduits and fittings for electrical installations. All conduit boxes, couplings, draw-in boxes etc., shall be of the same manufacture and quality as the conduit.

No elbows, tees or inspection bends will be permitted.

During the course of the installation of the conduit system, procedures for working and dressing the installation as recommended by the manufacturers shall be employed.

All bends and sets shall be in accordance with the IEE Regulations, formed with the aid of a helical spring fitted internally, with, if necessary, the conduit warmed sufficiently for it to move without deformation of the bore and without avoidable wall thinning on the outside of the bend.

Conduit systems shall be installed so as to ensure compliance with the requirements of the IEE Regulations.

Insulated conduit shall be protected during storage and during installation by means of wooden plugs, plastic plugs or plastic caps to prevent the entrance of plaster or foreign matter. Protection shall also be afforded against mechanical damage.

Surface conduits shall be supported by spacer bar saddles, which shall be fixed at a maximum of 1 metre intervals, except for bends where saddles shall be positioned 200mm on either side of the bend. Conduits shall be free to slide within the saddles.

All saddles, tubes and boxes must be in perfect alignment to prevent warping, when the installation is complete. Concealed conduits shall be fixed by galvanised crampets. The top of the crampets must be at least 10mm below the finished surface in walls and 25mm in floors.

Expansion couplings shall be installed where any length of conduit inclusive of draw-in boxes etc., exceeds 5 metres in length.

The minimum and maximum sizes of conduit to be employed shall be 20mm and 32mm diameter respectively, unless otherwise stated.

Where luminaires or other items of equipment are required to be supported from an insulated conduit system, the maximum weight supported shall be 3kg and the box or boxes shall be fitted with metal support lugs within each box.

Enclosed luminaires shall not be fixed directly beneath a conduit run, but shall be mounted on a heat resistant box, spurred off the main run.

The back plate of accessories shall be securely fixed and two saddles shall be fitted immediately adjacent on either side of the accessory.

The Electrical Services Sub Contractors' attention is drawn to the IEE Regulations.

Insulated conduit systems shall never be installed where the ambient local temperature is expected to exceed + 60°C or fall below - 5°C. Where insulated conduit tube sections and fittings or accessories are required to be jointed, the manufacturer's proprietary jointing cement shall be used. The cement shall be applied to both surfaces and the tube fittings rotated to ensure complete coverage. The manufacturer's recommendations must be adhered to with regard to jointing procedures.

Where expansion joints occur, these shall be made with the manufacturer's purpose made 'tacky' watertight expansion jointing cement, to ensure adequate movement of the system during temperature changes.

Throughout the entire system of an insulated conduit scheme, a green and yellow coloured and insulated earth continuity conductor, shall be installed in accordance with the IEE Regulations.

Cable capacities stated in the IEE Regulations shall include the separate insulated earth wire.

Conduits in floors shall be routed and installed so as to avoid the fixings to floor standing equipment to be installed in the floors.

Flexible Metallic Conduit;

Flexible conduits shall comply with the BS EN 61386, flexible steel conduit and adapters, for the protection of electrical cable. It shall be used for the final connection from a rigid conduit installation, to the terminal boxes of all equipment provided with a means of positional adjustment and/or where vibration may reasonably be expected to occur.

Flexible conduits shall be PVC sheathed.

Flexible conduits shall be terminated using approved glands.

In all instances, a separate PVC insulated green and yellow coloured protective conductor, minimum size 4mm, shall be installed at each end into purpose made earthing terminals.

Flexible conduits shall not be used externally to a building, where it would be exposed to the weather or in any position where ingress of moisture may occur.

Under no circumstances will flexible conduits be accepted in lieu of sets and bends in rigid conduit installations.

In normal circumstances, flexible conduit shall have a minimum un-stretched length of 300mm and a maximum un-stretched length of 800mm. It shall permit a full range of withdrawal, adjustment or movement of the equipment.

3.19 PAINTING OF SUPPORTING STEELWORK ETC

All supporting steelwork shall be free of rust and treated with an approved rust inhibiting compound, prior to installation. The steelwork shall be painted with a minimum of two coats of red oxide paint, prior to installation and finally painted with the appropriate undercoat and topcoat to match the associated equipment after installation.

3.20 WIRING OF (PVC) CONDUITS AND TRUNKING

All cables shall be LSF insulated to BS 7211, 450/750 volt grade unless an alternative is specified elsewhere in the specification. The quantity and size of cables contained in any one conduit shall comply with the IEE Regulations Prior to commencement of wiring, the conduit system shall be swabbed to render it free from moisture and foreign matter.

All cables installed in a conduit or trunking system shall be single insulated conductors and shall be colour coded in accordance with the IEE Regulations.

No cable with a cross-sectional area of less than 1.5mm^2 shall be used and all cables above 2.5mm shall be multistrand. The conduit installation shall be complete before wiring is undertaken.

No wiring shall be carried out before plastering or screeding is completed and has dried out, and in all cases, permission must be obtained from the Client in writing before wiring is commenced.

Final circuits shall be run in conduits separate from main or sub-main cables. All cables in a conduit shall be drawn in simultaneously.

Where cables are installed in cable trunking, they shall be installed in compliance with the IEE Regulations and cable joints shall not be permitted unless specified via written instruction

Cables shall be drawn into the conduit directly from reels, neatly and without cross-overs. Care shall be taken to protect the cables from abrasion or other damage whilst being installed.

All cables shall be drawn without the use of excessive force, without the use of lubricants and the wiring shall be easily withdrawable. Co-ordination with other services in respect of free access to draw-in boxes is the Electrical Services Sub Contractor's responsibility.

Cables shall not pass through luminaires, unless the luminaires are specifically designed with a wiring way protecting the cables from mechanical damage and/or heat.

The wiring of the installation must be done in strict accordance with the drawings, cable sizes and circuit details given in the specification and schedule of drawings issued for the particular project. All wiring of multi-point sub-circuits must be carried out in the loop-in system, and no joints or connectors, other than those required for the connection of luminaires and others that may be particularly mentioned in the specification, will be allowed. On all AC supplies, care must be taken to ensure that both live and neutral are contained in the same conduit. The insulation of all cables connected to the neutral must be coloured blue, the phase or live being coloured brown in single phase systems.

The minimum length of space cable generally to be left at each accessory, shall be 150mm per conductor, to enable terminations to be re-made, excessive cable lengths shall not be left at accessories.

Lids of all conduit and adaptable boxes and trunking shall not be fitted until the Client has inspected the wiring and given permission for them to be fitted. The Electrical Services Sub Contractor shall advise the Client at least 48 hours prior to his intention to wire the installation and to fix lids.

Cables installed in trunking shall be grouped in their respective circuits, taped together and identified at intervals not greater than 4.00 metres.

Termination of Cables;

Cables shall be terminated in accordance with the IEE Regulations.

Cables shall be terminated by one of the following methods:-

a. The cable conductors shall be sweated into lugs of the appropriate size for the cable and equipment terminal.

b. The cable conductors shall be secured by compression type lugs of the correct size for the cable and equipment terminal.

c. The cable conductors shall be secured in pinch screw terminals.

d. The cables shall be secured by means of clamps.

Where cables are required to terminate at connectors, as at lighting points, such connectors shall have two compression screws and shall be insulated with porcelain. Connections shall receive two layers of PVC self-adhesive tape.

3.21 WIRING OF CONDUITS AND TRUNKING

The cross-sectional area of cable conductors shall not be reduced at terminations, and connections shall secure all the strands of stranded cables. Care shall be taken to ensure that cables are not damaged during preparation for termination.

Cables terminating at pinch screw terminals shall be twisted together and single cables shall have the conductor doubled back to ensure adequate purchase for pinching screws.

Cables connected to lampholders or other components at which heat is produced shall be insulated with heat resisting material capable of withstanding without detriment, the temperature encountered.

3.22 PAPER INSULATED CABLES

These cables shall have copper conductors, unless detailed otherwise. The cables shall be paper insulated, lead covered, single wire or steel tape, armoured and PVC served, in accordance with the relevant British Standard formerly BS 6480.

The cables shall be of the non-draining type, impregnated with a non-running compound.

Paper insulated cables shall be sealed at terminations by means of steel or iron sealing boxes with flanges, for connecting securely to equipment and a brass cone to be neatly and effectively wiped to the cable sheath by means of plumber's solder.

The cable armour shall neatly pass over the wiped sheath joint and be secured to the wiping cone by means of an effective armour securing clamp.

The cable sheath and armour shall be effectively connected to the exposed metalwork of the equipment connected.

The cable shall be terminated by qualified and experienced cable jointers.

Cable cores shall be solder sealed for a length of 25mm within the compound, at the termination and as close to the crutch as possible, to form a solid barrier to the movement of impregnation fluid. The insulation removed to permit the cores to be solder sealed, shall be made good by means of BICC Ltd G5 15 insulating tape or equal and approved. The paper insulating tape shall be protected by at least four layers of BICC Ltd G5 15 insulating cotton tape oil resin impregnated tape or equal and approved, with two tapes applied half lap.

Cable cores shall be protected by means of Scotch 23 self-fusing tape or equal and approved from 10mm below the sealing compound to the conductor terminals. The tape shall be applied in two layers, one tape half lap.

The cable conductors shall be unbroken and connected to the terminals by means of tinman's solder or correctly sized crimp on lugs, effectively crimped to the conductors by means of the correctly sized hydraulic tools.

In every case, all conductor strands shall be contained in and secured by the cable lug, and all soldering fluxes shall be of the non-corrosive type.

Cable terminations shall be sealed by means of asphalt-based compound, manufactured by BICC Ltd, their G8 Class VI or equal and approved. Compound shall be heated and poured in accordance with the manufacturer's instructions.

All cable terminations shall be effectively sealed to prevent leakage of compound. Special care shall be employed where cable terminations are inverted to prevent the egress of cable sealing compound into the equipment during and after pouring of the compound.

Jointing of cables will only be allowed with the Client's approval. Where cable joints are unavoidable, they shall be made in the manner described for cable terminations. Conductors shall be jointed by means of sweating sockets or crimped sockets.

Cable bends shall be in accordance with the IEE Regulations.

3.23 XLPE/SWA/LSF/LSF AND PVC/SWA/PVC CABLES

These cables shall comprise copper Conductors, unless specifically detailed otherwise, laid up with PVC/LSF fillers, bedded with an extruded inner PVC/LSF sheath, armoured with a single layer of galvanised steel wire or aluminium strip as specified and served overall with a PVC/LSF sheath embossed 'ELECTRICAL CABLE'.

All cables shall be delivered to site in cable drums, with the maker's identification labels attached, and these shall be handed to the Client upon demand. Cables shall be manufactured to British Standards PVC / XLPE insulated cables for electrical supply, with conductor dimensions and resistance in accordance with BS EN 60228: 2005, for copper conductors in insulated cables and cords and for aluminium conductors in insulated cables. Armoured wiring shall be galvanised steel to BS EN 10257 - 1: 2011. Cables shall only be handled when the temperature is above 0°C and in accordance with the manufacturer's recommendations.

Where the armour wires of cables are used to provide protective conductors, they shall comply with the requirements of Chapter 54 of the IEE Regulations, particularly Section 543, alternatively the Electrical Services Sub Contractor shall install cables with copper conductors with the armour to reduce it's impedance to a level which ensures compliance with Section 543 of the IEE Regulations.

Unless permission is given by the Client, no joints will be allowed. In the event of joints being unavoidable, they shall be made using plastic joint boxes of approved design, filled with an approved cold pouring plastic or resin compound. The cable box shall incorporate suitable copper tapes and clamps to bond the armouring of the jointed cables.

The conductors shall be joined with compression or soldered joints, and the conductors shall be wrapped with PVC tape to give a degree of insulation at least equal to that of the original insulation.

Compression joints shall be made with the correct size tool and pressure for the ferrules used or have soldered joints using solder of grade 'M' or grade 'G' complying with the requirements of BS EN ISO 9453.

The PVC/SWA/PVC, XPLE/SWA/PVC or XLPE/SWA/LSF/LSF cables shall be terminated in the cable manufacturer's approved glands. These shall be of the compression type providing controlled radial compression of the sheath seal. The gland shall incorporate an armour clamping ring and earthing ring, and where used outdoors, a brass washer shall be used to ensure a watertight joint between the gland and the unit, to which it is fitted. The earthing ring shall be rigidly fixed to the item of equipment and terminated using brass nuts, bolts and washers. BW type glands for indoor use and CW type glands for external use.

All gland terminations shall be manufactured in brass or aluminium as applicable and shall be in accordance with BS 6121 and shall incorporate earth tags.

All gland terminations shall be protected by either a PVC/LSF shroud, which shall fit tightly over the cable. The PVC/LSF shroud must be threaded over the cable before the gland is fitted.

All PVC/SWA/PVC, XPLE/SWA/PVC or XLPE/SWA/LSF cables shall have the cores connected to bolted connections in bus bars etc., by means of compression type terminations, made off by means of hydraulic compression tools and suitable dye to suit size of cable.

Each terminal shall be fitted with a brass washer between the socket and securing nut or bolt to ensure good electrical contact.

Crimping sockets for use with tunnel type terminals shall be of the pin type, manufactured from brass or copper, made off as described above, pin diameter to suit terminal tunnel.

Where cables having aluminium conductors are specified, aluminium/copper bi-metal socket and pin type terminations shall be used,

Cable bends shall be in accordance with the IEE Regulations.

Cables shall be installed as shown on the drawings in service ducts, on walls or ceilings as specified elsewhere in this specification.

The Electrical Services Sub Contractor is responsible for determining the true nature and extent of cable routes. No claim on the grounds of lack of knowledge will be entertained. All cable routes shall be agreed with the Client.

After the cables have been installed and terminated, but prior to putting into service, they shall be subject to an insulation test of 500 volts and the results of these tests (recorded on test sheets) forwarded to the Client. The Client shall witness the tests and shall be given 48 hours' notice to arrange for suitable representation.

XLPE/SWA/LSF cables to BS 6724 shall generally comply with the relevant clauses above and shall normally be the preferred cable type. In the absence of specific detail or drawings, the Electrical Services Sub Contractor shall allow for XLPE/SWA/LSF/LSF cables with copper conductors.

3.24 MINERAL INSULATED COPPER SHEATHED CABLES

Cables;

All MICS cables shall be in accordance with BS EN 60702 - 1 'Mineral Insulated Cables Part 1', being of 750 volt grade, unless other grades are requested. All cables and accessories on any one contract shall be unsheathed or PVC sheathed as specified elsewhere in this specification. Where PVC sheathed MICS cables are used, all other items shall be PVC served in the same colour, e.g. clips and saddles and PVC shrouds fitted at terminations etc.

Where MICS cables are specified as having protective covering of low smoke and fume (LSF) material, the covering shall be to BS 6724

Cables should have a minimum conductor size of 1.5mm.

Clips and Saddles;

Single MICS cables may be supported by one-hole fixing clips, or one, two or three-way saddles for multiple cable runs. Spacer bar saddles shall only be used where indicated later in the specification.

Saddles and clips shall be fixed by brass round headed wood screws, plastic plugs being used for erection on concrete or brickwork. Supports shall be placed not more than 300mm apart or more than 150mm from a termination or bend on small cables, greater distances may be permitted on heavy cables and on vertical runs. Larger cables shall be fixed at intervals not more than those stated in the IEE Regulations.

Where four or more cables are installed together on the surface, they shall be installed on cable tray, unless the use of multiple saddles is required elsewhere in the specification.

Cables shall be straightened and dressed neatly into place during fixing without damage to the cable finish.

Method of Installation;

The Electrical Services Sub Contractor shall ensure that his workmen are fully conversant with, and highly skilled in the installation of MICS cables, and that they have received an approved course of instruction in the installation and termination of all types of MICS cables. The Electrical Services Sub Contractor shall submit details of training given to each individual when requested by the Client.

The manufacturer's recommended tools shall be used throughout the work.

MICS cable shall be installed in accordance with the IEE Regulations and the manufacturer's recommendations.

All bends shall be neat and uniform and not less than 6 times the diameter of the cable. Bending levers with padded surfaces shall be used for making all bends and off-sets in cables larger than 10mm in diameter. Off-sets where cables enter fittings shall be bold and definite with 50mm of straight cable between gland and first bend.

Where cables pass through holes in the building structure, short lengths of insulated conduit shall be threaded over the cables for protection against abrasion.

All holes shall be suitably plugged with flexible material or a weak mortar mix, after the cables have been installed.

Where surface mounted cables pass through floors, they shall be protected to a height of 2 metres by steel conduit, fitted with female bush and sealing compound through which the cable shall pass in order that moisture etc. is excluded.

All parallel cable runs shall be grouped in a neat and orderly manner, without crossover so that all cables may be easily identified, and any cable easily removed at a later date.

Where MICS cables are installed in walls, they shall be run square and vertical, cable run at an angle or in a zig-zag fashion will not be permitted.

All MICS cables laid underground shall be PVC or LSF sheathed and laid at a depth not less than 600mm in accordance with this specification. Where subsidence is likely to occur, allowances shall be made for 'snaking' the cables.

Care shall be taken not to scratch the copper sheathing or break the sheath. Any cables damaged in this way shall be replaced at the Electrical Services Sub Contractors' own expense.

Where MICS cables are fixed in contact with cable tray, stonework, timber etc., likely to give rise to corrosion, or drawn through conduit, the cables must be provided with PVC or LSF sheathing.

Where a cable is required in excess of the manufacturers' maximum manufactured length, the cable shall be extended by means of a factory-made cable joint. Cables shall not otherwise be jointed. All adjacent cables shall be run in the same horizontal or vertical straight lines, diagonal runs are not permitted.

Where single core MICS/PVC/LSF cables enter metal clad switches etc., the holes drilled in the end plates to accommodate the cable glands shall be interconnected by means of a 5mm wide slot to prevent over-heating, due to circulating and eddy currents at one end, and an insulated plate fitted at the other with one cable only bonded to the equipment. Cables used for this purpose shall be fixed using distance saddles.

Cable Terminations;

Cables shall be looped one complete turn, where connections are made to motors and other equipment, or where vibration or expansion is likely to occur. The manufacturer's recommendations shall be followed for the best method of expansion joint relating to the size of cable to be used.

Surge suppressers shall be fitted to termination of MICS cables at contactors and 3 phase star connected motors.

The end of all cables shall be terminated with sealing pots made off without delay in accordance with the manufacturer's instructions.

All glands shall be of the brass universal ring type, and all seals shall be of the cold (105oC) type, filled with the manufacturer's recommended plastic compound. Cable seals shall not project into the interior of any boxes, distribution boards etc. A coupling and male brass bush shall be used at all non-spouted entries.

Where PVC sheathed MICS cable are employed, each gland shall be fitted with a PVC shroud at all terminations which must be threaded over the cable before the gland is fitted.

All conductors at terminations shall be insulated with continuous 'Neoprene' or heat resistant sleeving, they shall then be identified by coloured PVC insulated tape, or by placing a 10mm length of coloured PVC sleeving over the conductor insulation.

All tails shall be of sufficient length to re-make broken connections.

The systems shall be wired on the loop-in principle, but where connections would assist to produce an economical installation, permission shall be obtained from the Client. Any such connections in conduit boxes shall be made using Porcelain insulated, brass tunnel connectors, with pinching screws. Joints in straight runs of MICS will not be permitted.

Galvanised accessories such as conduit boxes etc., shall be used in external situations with the appropriate lid and gasket and the like, otherwise black enameled boxes and accessories shall be used or all insulated type where called for in the specification.

All boxes shall be completed with earth terminal.

In all cases where single conductors of mineral insulated cables of 4.00mm^2 and below are secured in a terminal with a pinching screw, the ends shall be doubled back before insertion. For cables of 6.0mm^2 and above, the ends shall be terminated in a cone grip cable socket of the lug or tag type, specially manufactured for the purpose and sizes for the conductor concerned.

All joints shall be made in circular conduit boxes, complying with BS EN 61386 or in rectangular adaptable boxes, which if of sheet steel shall not be less than No 16 swg (1.6mm), junction boxes may only be used (with the Client's approval) for surface installations.

Where cast boxes and the cases of metal clad gear are not provided with screwed spout entries, they shall have tapped holes into which the terminations shall be screwed and locked with lock nuts.

Where it is impracticable to have the holes tapped in sheet steel boxes, the terminations shall be fixed using coupling and smooth bore brass bush.

Circular conduit boxes complying with BS EN 61386 into which the cable terminations shall be screwed, shall be installed at lighting points except where the luminaires have conduit entries.

All connections within the boxes shall be made by means of porcelain insulated brass connectors with pinching screws.

Testing MICS Cables;

The cables which shall be delivered to site with the manufacturer's seals and identification labels intact, shall be tested upon receipt. During the installation, each individual cable or complete run shall be tested at least 24 hours after sealing with a 500 volt insulation tester. A report of these tests shall be handed to the Client.

Nothing less than an infinity reading must be obtained between the conductors or between any conductor and the cable sheath, all conductors being disconnected from any apparatus, any re-sealing or replacement necessary shall be carried out at the Electrical Services Sub Contractors own expense.

All seals shall be tested immediately after completion and re-tested after the whole of the cable installations are complete in each particular section of the works. Any cable which does not exhibit the prescribed insulation resistance will be rejected by the Client and must be replaced by the Electrical Services Sub Contractor at no extra cost to the Employer.

All cables which are to be covered by cement, plaster or are being buried, shall be tested as detailed above for continuity and insulation resistance, immediately after completion of work by other trades, to ensure that no mechanical damage has occurred.

Only infinity insulation readings will be accepted by the Client in respect of tests on individual sections of cable.

3.25 PVC INSULATED PVC SHEATHED CABLES

Where specified PVC/PVC cables shall have copper conductors, and shall comply with BS 6004, PVC insulated cables (non-armoured) for electrical power and lighting, 300V/500V grade unless an alternative is specified elsewhere in the specification. The insulation shall be Polyvinyl Chloride (PVC) compound applied by extrusion, the cores shall be coloured in accordance with the IEE Regulations.

Generally, PVC/PVC cables shall be run in ceiling and floor spaces and in round heavy duty high impact PVC conduits in walls, other methods of protecting cables in walls may be described in this specification.

Wiring shall be carried out on the loop-in principle, joints being allowed only at approved junction boxes and only in lighting circuits. Joint boxes shall be installed only where they will be accessible after completion of the building, i.e. behind removable ceiling panels. The number of joint boxes installed shall be kept to a minimum and the Client's written approval shall be obtained in each case.

No joints shall be allowed in protective conductors except at items of fixed equipment, socket outlets or other accessories.

The cable shall be installed so as to give maximum re-wireability, commensurate with the specified method of installation.

Cables installed in ceiling spaces, shall be accessible through removable ceiling tiles or ceiling access traps, and cables run in ceiling spaces shall not be embedded in the building fabric.

Cables in ceilings shall be run parallel or at right angles to main and secondary beams or joists etc., and no diagonal runs will be permitted.

All cables in suspended ceiling areas shall be installed into purpose made wiring stirrups, which shall comprise 15mm PVC covered metal 'all round band' cable strapping as manufactured by Critchley Ltd, or approved equivalent.

The band shall be formed into a 75mm deep 'strap saddle' with fixings to the ceiling soffit at 75mm centres, using 38mm No 8 brass wood screws and steel washers. In cases where the Client's approval is given to fixing of joists, then 25mm long screws may be used.

In order to afford a withdrawing facility, not more than 14 single, 8 twin or 5 three core cables, or their equivalent are to be supported within the confines of one run of stirrups.

Where cables in excess of 1.5mm^2 enclosed within a set of stirrups, then the quantities stated above shall be reduced accordingly. Additional sets of stirrups must be introduced as necessary.

Cables shall be free to move in supporting stirrups and shall only be secured at terminations.

The stirrups shall be fixed at intervals not greater than 450mm and at 200mm each side of a bend or other change in direction. A stirrup shall be fixed at 200mm each side of a lighting point so as to support the cables serving the lighting point and wherever cables drop to below the suspended ceiling areas.

'PVC/PVC cables shall not share a common run of stirrups with any other type of cable'.

Where cables cross pipe or duct runs the cables shall be supported beneath the pipes or ducts and deeper stirrups shall be provided and installed.

Cables shall have a loop of 300mm long at expansion joints in the building structure.

Where the cables pass through floors, or may be subject to damage or abuse, they shall be protected up to a height of 1200mm by heavy gauge conduit, suitably bushed. In certain instances, and where indicated by the Client, the cable shall be protected up to a height of 1200mm by plastic capping or oval conduit.

Where cables pass through the building fabric, they shall be adequately protected by means of isolated lengths of bushed conduits.

Cable entry into accessory boxes shall be via grommeted holes.

The internal radius of cable bends shall be not less than those set out in the IEE Regulations.

Cables run on fair faced brickwork, shall be protected by means of heavy-duty high impact PVC conduit, securely connected to the accessory box as described elsewhere, the other end of the conduit shall be suitably bushed.

Where cables converge and run to distribution boards, they shall be supported on galvanised steel cable tray, bonded to the distribution boards. Cable entries to distribution boards shall be via gland terminations, which secure the cable sheath to the distribution boards. The Electrical Services Sub Contractor's attention is drawn to the IEE Regulations, with particular reference to grouping of cables and de-rating.

All PVC/PVC cable terminations shall be made so that a minimum of 150mm of spare cable shall be left in each conductor at an accessory. In distribution boards, conductors shall be sufficiently long to enable them to be connected to any circuit in any phase (though the circuit and phase must be indicated on the drawings).

All protective conductors shall be sheathed with green and yellow sleeving at terminations.

Cables to lighting points shall terminate at bushed steel conduit boxes to BS EN 61386, securely fixed in the ceiling. Cables shall enter via gland terminations and an earthing terminal shall be provided in each box and the box shall be earthed. Cable conductors shall terminate at porcelain brass tunnel connectors with pinching screws.

Final connections to incandescent and fluorescent luminaires or batten lamp-holders shall be made by means of Butyl or heat resistant insulated cables of the same cross-sectional area as the final sub-circuit cables. Final connections to ceiling roses at pendant lighting points may be made directly by the cable conductors and the flexible cord shall be of Butyl rubber.

For close mounted un-ventilated incandescent/low energy ceiling luminaires, the PVC insulated PVC sheathed wiring shall terminate in an accessible standard conduit box, with earth terminal, fitted approximately 300mm from the luminaire. In locations where luminaires are mounted below a ceiling void or roof void accessible via a floor trap, the conduit box shall be fixed to the side of the joist, or on trimmers between the joists, the final connection between the fixed wiring and luminaire being by means of three pin plug in ceiling rose and 1.0mm^2 3 core heatproof insulated flexible cable.

In areas where the conduit box would be inaccessible the conduit box shall be flush mounted in the ceiling, approximately 150mm from the luminaire, with an overlapping lid and bushed back-outlets, final connection being as detailed above, the flexible cable being in the void, entering the conduit box and luminaire via bushed back-outlets. The flexible cable shall be in free space between the conduit box and the luminaire and on no account shall be trapped or pass through ceiling joists.

At recessed luminaires sub-circuit wiring shall terminate at a rigid PVC, BESA type box, located adjacent to the luminaire. A plug-in ceiling rose shall be provided and fitted and final connection shall be made using multi-core heatproof insulated flexible cord.

Surface installation cables shall be fixed by means of 'Hiatt' Thorsman or 'Tower' type clips. The clips shall be spaced in accordance with the IEE Regulations.

Where approval is given by the Client, multi-runs on fair faced brickwork may be secured by plastic plugs and screws and provided and fixed by the Electrical Services Sub Contractor, otherwise they shall be enclosed in PVC conduit as described earlier in this Clause.

Where cables are run under floors and in roof spaces, they shall be passed through holes drilled in the neutral axis of the joists where possible, but in no case shall the holes be less than 50mm from the top or bottom surface of any joist. Notching of joists will not be permitted.

All runs shall be made straight, both parallel with and at right angles to, the sides of the building. All risers and drops shall be vertical.

Where the cable runs on the surface and is not concealed it shall be carefully dressed down after erection to present a tidy finished appearance.

The cable entries of metal clad accessories shall be fitted with cable glands and bushes.

3.26 FLEXIBLE CORDS AND CABLES

All flexible cables and cords shall be of Butyl silicone rubber or equal to BS EN 50525 'Insulated Flexible Cords' rated in accordance with the equipment they serve and shall be suitable for the operating temperature envisaged. In high temperature conditions, flexible cables and cords shall be Elastomer. They shall be multicore circular flexible cables or cords, being insulated and sheathed and shall be colour coded in accordance with the IEE Regulations.
Where chain suspension is specified for luminaires, the colour of the flexible cable used shall match the finish of the metalwork.

All items which are suspended by flexible conductors shall have a straining cord to ensure that no weight or strain is carried by the conductors other than lighting pendants with plastic shades.

All flexible cords and cables shall have a protective conductor of sufficient length to ensure that no undue stress is placed on the conductor.

3.27 BURIED CABLES MARKERS AND COVER TILES

All PILCSWA, MICS, PVC/SWA/PVC/LSF/SWA/LSF cables which are required to be buried below ground level outside the premises shall be laid at a minimum of 600mm below ground level and in accordance with the IEE Regulations.

Wherever cables are to be installed under roads, through foundations, walls or under concreted areas, they shall be enclosed in pipe ducts. These shall have a diameter of at least 100mm. Ducts shall be manufactures by Hepworth Iron Co. Ltd (Hepducts), or equal and approved.

After all cables have been drawn into ducts, the hole shall be sealed by special wedge type seals, as manufactured by the duct manufacturer. Spare ducts when specified, shall be similarly sealed.

Route indicating concrete blocks shall be set into the ground directly above buried cables, the blocks shall have the words 'Electricity Cables' with an indication of the direction of the cables. The top face of each block shall be level with the surrounding ground or finished level. The blocks shall be placed at changes in direction and at intervals of 50 metres.

A brass plate shall be fixed to walls 300mm above ground or floor level where cables pass from ground into a building. The plate shall have the words 'ELECTRICITY CABLES' in 20mm lettering.

Cables installed in the ground shall be laid on a layer of fine sand not less than 50mm deep. A further layer of fine sand shall be placed firmly over the cable or cables to provide a bed for the earthenware or concrete inter-locking cover tiles to protect the cables. Cable tiles shall be at least 50mm wider than the space occupied by the installed cables.

All trenches shall be straight between planned changes in direction and no cables shall be bent at a radius less than those stated in the IEE Regulations.

All underground cables shall be available for and inspected by the Client prior to covering with sand.

3.28 ARMOURED CABLES NOT BURIED UNDERGROUND

Every armoured cable shall be delivered to site protected by the manufacturers cable drum and correctly unloaded. The cable shall be stored and protected prior to installation without being removed from the cable drum.

The cables shall be installed from the top of the cable drum and correctly supported on cable jacks with brakes to prevent overrun. The cable shall be adequately supported during installation and rollers shall be used to ensure that the cable is installed over surfaces through structures etc., without abrasion to the cable sheath.

Care shall be taken to ensure that the cable is installed without being twisted or kinked. Damaged cable will be rejected and must be replaced at the Electrical Services Sub Contractor's expense.

The cable shall be delivered to site with its ends effectively sealed, and any cables cut on site shall have their ends immediately and effectively sealed with a cap which will permit movement of the cores during installation without impairing the seal. Paper insulated cables shall have their ends sealed by means of a plumbed-on cap.

Cables installed on building surfaces shall be secured by means of correctly sized silicone aluminium claw or clamp fixing cleats, claw cleats for smaller cables, clamp cleats for the larger cables. The cleats shall be secured to the structure by means of the maximum diameter cadmium plated galvanised, or sheradised screws, permitted by the fixing holes in the cleats, adequately secured to the structure and out of contact with other building services.

Multiple cable runs shall be planned and installed in such a way that cross-overs are eliminated. The design of multi-way cable support racks shall be submitted to the Client for approval before manufacture.

Spacing between cables shall be in accordance with the IEE Regulations.

The Electrical Services Sub Contractor shall take all reasonable precautions to ensure that the cables are not subjected to heating from adjacent service lines, heater units or plants operating at high temperatures. Where these conditions are likely to be severe and cannot be avoided, baffle plates of heat resistant material shall be interposed to suitably protect the cables.

When the routing of cables is not indicated on a drawing or as described elsewhere in the specification, the Electrical Services Sub Contractor shall submit details of his proposed routing to the Client for approval, prior to commencing the installation.

The Electrical Services Sub Contractor shall supply and install all steel and other support structures required for the support and effective installation of the cables.

Where more than three cables are surface fixed together along the same route, then they shall be installed on to a heavy gauge cable tray of the perforated type, fixed at regular intervals to ensure that no bending or buckling occurs. On no account shall cables be stacked, except where single core cables are specified as being in 'trefoil' formation.

Cables supported to steelwork shall be fixed by approved steel straps. The minimum bending radius of the cables shall be as stated in the IEE Regulations. All cable bends shall be adequately supported.

Special care shall be exercised in supporting cable at terminations to ensure that undue strain is not placed on any part of a cable termination or equipment.

Cables shall be installed as neatly as possible and shall be protected from mechanical damage to a height of 2.0 metres above finished floor level by means of galvanised steel channel, manufactured from steel of at least 2.0mm thickness, designed to span a cable or group of cables and fixings.

Cable entry into a building from the ground shall be by means of glazed earthenware conduit, adequately sized to permit installation without undue strain being placed on the cable when it is drawn in. Earthenware conduits shall be effectively sealed to prevent the ingress of moisture, vermin etc.

3.29 BUILDING EXPANSION JOINTS

Routes of electrical services, cables, conduits, trunkings and cable trays etc., shall be so designed to avoid crossing building expansion joints, if at all possible. Under no circumstances will conduits and cables encased in the building fabric or floor screeds etc., be allowed to cross a building expansion joint.

Where it is unavoidable for surface cables and support systems to cross an expansion joint, the following precautions shall be taken.

a) A sufficient loop of cable must be allowed between fixings on cables, fixed directly to the building structure.

b) All conduits in air must be joined by a 150mm minimum length of flexible conduit, linking conduit and adaptable boxes and be suitably looped to accommodate the maximum variation in the building structure. A minimum protective conductor of 4.00mm^2 shall link the conduit section.

c) All cable trunking crossing an expansion joint shall be linked by flexible trunking connections. The flexible section being a minimum of 250mm in length or greater to accept the maximum building variation. The two fixed sections of trunking shall be linked with a 25mm flexible braided copper earth tape.

d) Cable trays must be stopped at each side of the expansion joint with a minimum gap of 150mm. Sufficient lengths of cable shall be provided on all cables crossing this gap to allow for the

e) Maximum building movement. The cable tray sections shall be connected by two 25mm flexible braided copper earth tapes.

3.30 METHODS OF FIXINGS

The Electrical Services Sub Contractor shall ensure that every fixing installed is adequate to support and/or restrain the items of plant or equipment concerned, making all necessary allowances for the fixing and for the substance into which it is anchored or fixed.

The Electrical Services Sub Contractor's attention is drawn to Chapter 52 of the IEE Regulations.

Accessories and Lightweight Equipment;.

Accessories, lightweight equipment and conduit saddles shall be fixed to brick or concrete structures by means of sheradised screws in white metal, bronze or plastic plugs. Round head screws shall be used where fixings occur inside accessory boxes.

Wherever possible, fixings to brick work shall be made in the bricks and not in the seams. Fixing to enclosed hollow structures of soft or hard fibre boards etc., shall be made using proprietary spring or gravity toggles or equally approved. Under no circumstances shall such fixing methods be used in plasterboard, or materials of a like nature, unless first approved by the Client.

Fixing to timber shall be made using steel wood screws.

Where fixings occur in a damp or humid atmosphere, or are exposed to the weather, galvanised steel, brass of cadmium plated steel screws shall be used.

Lightweight equipment installed on a mild steel sheet structure, shall be fixed by an appropriately sized set screw and must be complete with plain and serrated spring washer.

Where a sheet steel structure is enclosed, fixings may be achieved by using a shake proof self-tapping screw or proprietary spring or gravity toggle.

Fixings to heavy gauge or cast metal shall be made using machine thread screws, entered into holes, tapped by the Electrical Services Sub Contractor. Tapped threads shall be achieved using the correct drill size with taper second and plug taps.

Screws with damaged threads and/or damaged heads shall be replaced by the Electrical Services Sub Contractor.

Heavyweight Equipment;

Fixings to brick and concrete shall be made using an approved expanding bolt, suitably sized and entered into a pre-drilled hole of depth (exceeding plaster thickness) equal to the length of fixing to be used.

The threaded section of an installed expanding bolt fixing, shall protrude through the equipment fixed, to enable a nut plain and serrated or spring washer, to be fixed leaving a minimum of 4mm of thread exposed.

Fixings to brickwork shall be made in the bricks and not in the seams. In items of equipment containing multiple fixing provisions, where it is impossible to make all fixings in the brickwork, then the equipment shall be positioned to enable the upper fixings to be made in the brick.

Fixings may also be achieved in concrete structures by pre-casting or grouting rag bolts.

Equipment installed on a heavy wooden structure may be fixed using coach screws entered into correctly sized pre-drilled pilot holes.

Fixing heavy equipment to metal framework and other substantial structures shall be made using steel set screws or bolts with nuts, plain and serrated or spring washers.

Heavy equipment shall not be fixed by plugs or shot bolts without the written approval of the Client, nor shall any structural steelwork or support be drilled or cut without this approval.

In all cases where fixings, bracket-work and other metal supports are exposed to the weather, or damp, or hostile conditions, they shall be suitably treated with an inhibiting substance or galvanised in accordance with the specification, or as directed by the Client. Under no circumstances will rusted metalwork be installed.

Fixing adapters, brackets or patented approved fixings to steelwork shall be manufactured from mild steel and of a minimum thickness of 4mm.

3.31 GENERAL THREE PHASE AND SINGLE PHASE POINTS

a) Where single phase and three phase power is required for general supplies, heating and ventilating equipment, the supply and installation of all motor starters, isolators, room thermostats, stop buttons, plugs, sockets and other such control and connection equipment, shall be carried out by the Electrical Services Sub Contractor unless otherwise stated.

b) All other equipment, such as pumps, compressors, valves, pipe thermostats and sensing equipment etc., as scheduled on the drawings or elsewhere in the specification, shall be provided and installed under a separate contract, unless otherwise specified. The Electrical Services Sub Contractor shall wire to and connect the equipment in accordance with the controls diagram provided.

c) Where an item of electrical equipment is located remotely from the source of control, an isolating switch breaking all live conductors and suitably sized to the equipment served, shall be mounted as near to the equipment as practicable. Final connections shall be as described elsewhere in this specification. The isolating switch shall be in accordance with the IEE Regulations.

d) Where an item of equipment contains multiple line connection, or electric motor operating on assisted start, e.g. star-delta, a multiple pole isolator, having a pole for each line feed shall be located adjacent to the motor or electrical equipment to isolate the starter coil circuit, each line conductor, and override the starter or control equipment automatic circuits.

Start, reset and other such controls integrated into starters or control panels shall be rendered inactive by the operation of the remotely located isolator. The isolating switch shall be in accordance with the IEE Regulations.

3.32 TERMINATION AT FIXED EQUIPMENT

Apparatus Served from Surface Mounted Final Control Equipment;

In a conduit installation where the final control equipment is remotely located from the electrical apparatus being served, a conduit link shall be installed from the control equipment to terminate adjacent to the apparatus in a fixed through conduit box, complete with lid.

Flexible conduit shall connect the conduit box with the apparatus in accordance with this specification, with particular emphasis on the correct method of earthing as required by the IEE Regulations.

Cables serving the electrical apparatus shall be continuous throughout their length, passing unbroken through the conduit box and flexible conduit. Connectors fitted inside the conduit box will not be permitted unless so directed by the Client.

The Electrical Services Sub Contractor shall ensure that every item of equipment is provided with terminals of adequate size to permit the connection of the conductors specified.

Apparatus Served from Flush mounted Final Control Equipment;

A conduit recessed into the building fabric shall link the final flush mounted control equipment to a conduit termination (end) box, recessed adjacent the apparatus. An extension box with conduit spout outlet shall be fixed to the terminal box using the fixing lugs provided, a break joint ring

being fitted between the two. The screws securing the extension box shall not form part of the earth path, a separate earth being obtained from the recessed conduit box.

The apparatus shall be connected to the extension box, using cables enclosed in the flexible conduit, as described in above.

Insulated and Sheathed Cable Installations;

Where PVC/LSF insulated and sheathed multi-core cables are used to serve an item of electrical apparatus, they shall terminate adjacent to the apparatus in a suitable connection unit and/or isolating switch as specified.

Final connections shall be made using an insulated and sheathed multi-core flexible cable or cord, restrained at each end by either cord grips, forming part of the connection unit and apparatus or approved packing glands, correctly sized to the flexible cable or cord used and fixed
to the connection unit and apparatus by a coupling and smooth bore bush or entered directly into the apparatus by a tapped conduit entry if possible.

Final connection to an electric cooker shall be made using a proprietary cooker outlet connection unit.

3.33 MOUNTING HEIGHTS

The approximate position of main switchgear, control equipment, distribution boards, fittings and accessories shall be as indicated on the drawings. Actual positions shall be determined on site by the Client before the work commences.

The right is reserved prior to the works commencing, to make minor alterations to accessory positions of up to one metre in either direction, without incurring any cost variation to the contract.
Unless reference is given elsewhere in this specification, or relevant drawings, or directed by the Client, the following mounting heights of all accessories above finished floor level shall be adhered to:-

Item	Standard Premises Installation	Disabled Premises Installation
Lighting Switch	1100mm to Centre	1000mm to Centre
Thermostat	1650mm to Centre	1650mm to Centre
Bell Push	1100mm to Centre	1000mm to Centre
Fire Alarm Contact	1100mm to Centre	1000mm to Centre
Socket Outlet / Spurs	450mm to Centre or 150mm above Worktop	900mm to Centre or 150mm above Worktop
Distribution Board	1200mm to Lower Edge	1000mm to Lower Edge

All groups of accessories shall be in line either vertically or horizontally, or as detailed on the drawings.

Where groups of distribution fuse gear, switches, contactors etc., are to be installed in the same location, the Electrical Services Sub Contractor shall submit a detailed drawing of the proposed arrangement to the Consultant Engineer for approval prior to work commencing.

3.34 LUMINAIRES

All luminaires shall be of the manufacture, size and type specified elsewhere in this specification, and shall comply in all respects to BS EN 61386 & BS 4533.

The Electrical Services Sub Contractor shall supply and install all luminaires, including lamps, lampholders, control gear, capacitors, glassware, diffusers or other attachments, heat resistant internal cables, fuses, terminals and all necessary suspension gear.

Unless otherwise stated, luminaires shall be suitable for Class 1 normal indoor environment, giving a degree of protection against ingress of moisture or dust in accordance with International Protection rating IP 22, and shall be suitable for operation in an ambient temperature of 30°C.

All luminaires shall be assembled and installed in accordance with the respective manufacturer's instructions/recommendations in the positions and mounting heights specified.

Luminaires shall not be installed under dirty and hazardous site conditions, and any damage or deterioration to luminaires installed under these conditions will be made good free of charge by the Electrical Services Sub Contractor.

The Electrical Services Sub Contractor shall allow for any modifications to the standard luminaires required by the specification.

The luminaires shall be cleaned free of dust, dirt and other deleterious matter, after completion of the installation. Where dirt, dust, corrosion or other conditions cause imperfections in the luminaires, they shall be replaced.

Luminaires, diffusers, attachments or glassware etc., shall be properly stored prior to final erection, in such a manner as to avoid damage of any kind.

All glassware, diffusers, reflectors etc., shall be left in a clean condition. Allowances shall be made for all plastic surfaces which reflect or transmit light or are visible to view to be treated with an antistatic solution to prevent static electricity.

Luminaire fixings shall be generally suitable for direct connection to conduit boxes or as otherwise specified. Luminaires not provided with suitable BESA box fixings shall be modified as necessary.

Where a flexible cord supports, or partly supports a luminaire, the maximum mass supported by the cord shall not exceed the values set out in the IEE Regulations.

The minimum cross-sectional area flexible core to be employed shall be 1.00 mm^2.

The Electrical Services Sub Contractor's attention is drawn to Chapter 52 of the IEE Regulations.

Pendant low energy luminaires shall be fitted with heat resistant flexible cord, complying with BS EN 50525 capable of continuous operation with a conductor temperature of 150°C. The cable shall be of the circular multi-core type, finished white.

Ceiling mounted tungsten luminaires, spotlights and other luminaires which fall into the category of 'hot' luminaires, shall be wired internally with cables, suitable for continuous operation at 185°C. Where cable tails are provided, they shall be of the heat resistant type, capable of operation at 185°C and of sufficient length to provide a satisfactory connection to the fixed wiring system.

Exterior luminaires, fixed to the walls of buildings etc., shall be wired such that sub-circuit cables so installed shall be provided with heat resistant sleeves from the connection point within the luminaire for a distance of 300mm.

All fluorescent and other discharge luminaires shall be provided with an integral fused connector block. The rating of the fuse shall be in accordance with the manufacturer's instructions to protect the internal wiring of the luminaire and to provide discrimination between final circuit protection and luminaire circuit protection.

All recessed LED and semi recessed luminaires in ceilings SUPPLIED BY A FUSE RATING LESS THAN 10A shall be connected by three core 1.00 mm^2 high temperature flexible cords from the terminals of the luminaires, to a plug-in ceiling rose, fixed and connected to an accessible outlet box in the wiring system within the suspended ceiling, immediately above the luminaire. The ceiling rose shall be accessible via the opening provided in the ceiling.

In discharge LED and other fluorescent luminaires, fuses shall be readily accessible.

All fluorescent luminaires shall be complete with high frequency control gear.

All fluorescent LED and other discharge luminaires shall be provided with suitable capacitors for Radio Interference Suppression purposes in accordance with BS EN 60384.

It is the Electrical Services Sub Contractor's responsibility to ensure that the noise level of the luminaire is suitable for the particular location. In case of doubt, reference should be made to the Client. The Electrical Services Sub Contractor shall bear the cost of replacing luminaires considered by the Client to be too noisy for the particular location.

All control gear for fluorescent and other discharge luminaires shall comply with the following British Standard Specification:-

Item	Type of Lamp	BS
Ballast	Tubular Fluorescent	BS EN 61347
Ballast	HP Mercury and LP Sodium	BS EN 61347
Capacitors	Fluorescent and Discharge	BS EN 61049

Control gear not covered by British Standard Specifications shall be in accordance with the manufacturer's recommendations.

Control gear for mercury discharge lamps shall have a rectifier so that the lamp operates on direct current.

The Electrical Services Sub Contractor shall ensure that the methods of suspension for luminaires are electrically and mechanically sound.

Luminaires suspended by means of tubes shall be fitted to ball joints, allowing a swing of at least 20° all round. Reliable earthing between the fixed and moving parts shall be provided by means of a flexible braided copper tape. The ball joint shall have a stop to prevent rotation by more than 360°.

Fluorescent luminaires shall be provided with a minimum of two fixings, except in the case of recessed modular luminaires or surface mounting luminaires, exceeding 300mm in width, where four number fixings (one from each corner) shall be provided by means of conduit drops, threaded rods or gripple steel wire.

Normally visible luminaire supports shall be chain, gripple or conduit. All fluorescent luminaires shall be solidly mounted, with all assembly nuts, bolts and accessories made tight to prevent vibrations and noise. Anti-vibration packing shall be fitted where necessary. Luminaires mounted direct to trunking shall be fixed by means of the manufacturers recommended fixing assemblies.

Unless stated otherwise, all luminaire supports shall be fixed to the building's primary structure. Luminaires shall not be supported from suspended ceilings, unless detailed otherwise in the specification. The Electrical Services Sub Contractor shall be responsible for mounting and fixing arrangements.

The metalwork of all luminaires shall be effectively bonded to the earthing system in accordance with Chapter 54 of the IEE Regulations and the Electrical Services Sub Contractor shall provide effective bonding to the metalwork of any suspended ceiling. This bonding shall be from the local distribution board.

Care shall be taken to ensure that the internal wiring of luminaires and the cable of any fixed wiring system shall not be in contact with high temperature areas in luminaires.

Fluorescent luminaires controlled by dimmer, shall be provided with all necessary additional equipment (e.g. cathode heating transformers etc.) and wiring such that they will operate in a satisfactory manner and shall be capable of being dimmed to extinction without flicker.

Lighting track shall be of the type, size, finish, number of circuits and manufacture detailed elsewhere in this specification and shall comply with the requirements of the relevant Section of BS EN 60598 & BS 4533.

3.35 LAMPHOLDERS

Lamp holders shall comply with the following British Standards:-

Lamp Type	Type of Cap	BS
Tungsten filament (GLS)	BC	BS EN 61184
Tungsten filament (GLS)	ES	BS EN IEC 60238
Tubular fluorescent	Bi-Pin	BS 5101

Lamp holders for discharge and special purpose lamps shall be as recommended by the lamp manufacturer and detailed elsewhere in this specification.

Lamp holders shall be of the heavy pattern BC for up to and including 100 watts and ES for mercury and high-pressure sodium discharge lamps. Lamp holders shall be complete with skirts.

All ES and GEES lamp holders and BC lamp holders in totally enclosed luminaires, shall be manufactured from brass and with insulating parts made from porcelain.

Lamp holders of the bayonet cap type for incandescent lamps up to 100 watts rating, shall be of the type that has solid plungers and springs, which do not carry the current.

Where the lamp holder is not an integral part of the luminaire, it shall be of the moulded type with cord grip and plain metal bayonet catch and have a skirt. Lamp holders shall be in accordance with BS EN 61184.

Batten lamp holders shall comply with BS 5101 and have threaded vitreous porcelain or steatite interiors, with solid plungers and springs which do not carry current. Batten lamp holders shall have integral heat resisting conductors wired to terminals to which circuit cables shall be connected. The lamp holders shall be suitable for direct attachment to conduit boxes and be manufactured from best quality high temperature mouldings with skirt and plain metal bayonet catch.

3.36 CEILING ROSES

Surface mounted ceiling roses shall be of the all insulated, high impact, moulded plastic construction, complying with BS 67 and shall be suitable for direct attachment to conduit outlet boxes. Recessed or semi-recessed ceiling roses shall be manufactured from porcelain. Break joint rings shall be provided when used on flush conduit outlet boxes.

Ceiling roses shall not be connected to fixed wiring in such a manner that one of the terminals remains 'live' when the associated switch is in the 'off' position, unless that terminal is inaccessible to touch when the ceiling rose cover is removed e.g. for replacement of flexible cord.

Terminals shall be provided for switched, live, neutral and protective conductors. Loop-in facilities shall also be provided.

Where flexible cord is used as a pendant suspension, the ceiling rose shall be provided with an attachment for relieving the strain on electrical terminations.

3.37 LAMPS

Lamps shall be compatible with the luminaire for which they are intended and shall be of the wattage, type and colour specified. Lamps shall be of the correct voltage rating for the particular electricity supply concerned.

Lamps shall comply, according to type with the following British Standard Specification:-

Type of Lamp	British Standard
Tungsten filament	161
PL	1853 & BS EN 60081
SL	1853 & BS EN 60081
2D	1853 & BS EN 60081
Tubular fluorescent	1853 & BS EN 60081
High pressure mercury vapour	BS EN 60188
Low pressure sodium	BS EN 60192
LED	BS EN 62504

Luminaires designed to accommodate lamps with reduced physical dimensions shall be fitted with lamps of the mushroom type, or equal and approved.

3.38 EXTERNAL LIGHTING

External lighting shall include the provision erection and connection of all lighting, columns, bollards, wall and ceiling luminaires and the provision and connection of all control gear, together with the laying and connection of all necessary cables.

Lighting columns and /or bollards shall be plumb and true.

All excavation, trenching, backfilling etc. will be undertaken by the Main Contractor.

The Electrical Services Sub Contractor shall provide attendance during building works associated with the erection of columns/bollards.

All lighting columns shall be approved types and manufacture, complete with an outreach bracket (as specified), flush fitting door, wooden back-board for mounting the 'cutout' specified and cable slot, all suitable for looping in and out three No. 2 core XLPE/PVC/SWA/PVC cables of specified size, or two No 4 core XLPE/PVC/SWA/PVC cables.

The 'cut-outs' shall be mounted in each column, complete with compression glands for looping core PVC/SWA/PVC cables at the bottom and twin protective conduits 2.5mm^2 PVC insulated. PVC sheathed cable at the top. Each 'cut-out' shall be complete with a 5 amp carriage fuse holder and fuse. 2.5mm2 PVC/PVC twin and protective conductor cables shall be used from the 'cut-out' up the column to the luminaire and these shall be supplied, installed and connected in each column.

Where discharge lamps are specified the associated control gear shall be mounted within the base of the column.

Each lighting column/bollard shall be complete with all adaptors, spigots, mounting brackets, luminaires, control gear and lamps and shall be provided with a base compartment and locking door.

All columns/bollards shall be fixed in the correct relationship to the footpath kerb (generally 500mm inside the kerb) and the root depth shall be in accordance with the appropriate British Standard and manufacturers recommendations.

Outreach brackets, where specified, must project over the roadway at right angles to the kerb line, and base compartment door opening shall face away from vehicular traffic.

Lighting columns shall comply with the following British Standards BS EN 40 & BS 5649.

Electrical Services Sub Contractor shall lay the road lighting cable in trenches (prepared and backfilled by the Electrical Services Sub Contractor). Cable shall be installed in accordance with this specification.

All connections shall be made off in an approved manner, the installation shall be finished complete and handed over in working order to the full satisfaction of the client.

3.39 LIGHTING SWITCHES

Lighting switches shall be of the types, sizes and manufacture detailed elsewhere in this specification.

Wall and ceiling switches shall comply with BS EN 60669. Wall and ceiling switches controlling A.C. lighting circuits shall be rated 10 amp and be of the slow break, quick make type unless stated otherwise.

Single pole switches shall be connected only to the phase conductor.

All switch assemblies shall comply fully with the IEE Regulations, concerning the earthing of plates and operating bars and toggles. Where the assembly does not provide a direct reliable electrical contact between the cover, plate and box, with effective connection of metal operating bars or toggles, then an insulated earthing lead shall be provided, solidly connected to the metal plate and operating bar or toggle and terminating at a fixed earthing terminal in the box. This provision shall be made in all cases when switches are grid mounted, and also where PVC insulated, and sheathed cables are installed. All switches shall be of the quick make, slow break pattern.

All switches for wall or ceiling mountings, shall be of specified manufacture, complete with steel boxes of the same manufacture. Switches shall be single or multi-gang, single, 2 way or intermediate, with or without neon indicators, as required. Earthing terminals shall be provided in each switch box. Finish of plates, switch dollies and screws shall be as specified elsewhere in this specification, or as shown on the drawings.

Where several switches on one phase are shown at one position a ganged box shall be used.

Where switches at any location are connected to different phases, purpose made phase barrier switches shall be installed. The phases shall be separated by means of rigidly fixed barriers and the cable for each phase shall be confined to the area enclosed by the barriers for that phase.

Switches connected to a particular phase shall have separate cover or covers fitted over each phase.

The covers shall be engraved 'CAUTION 400 VOLTS BETWEEN PHASES'

The switch plate of the specified finish shall be fitted over the phase covers, to render the switch unit indistinguishable from the switches, which are not phase barrier switches.

The physical 'layout' arrangement of switches in ganged boxes shall be similar in plan to the lighting points which they control. Switches not so arranged shall be engraved in an approved manner to indicate the circuits controlled, but in any case, the Electrical Services Sub Contractor shall suitably engrave all switch plates, six gang and above to indicate each switch function.

All lighting switches shall be ganged as shown on the general lighting layout drawings, being rocker operated and flush or surface mounted, depending upon whether the system of wiring at each particular switch is either fully concealed or a surface installation.

For flush positions on a plastered or equivalently finished wall, the switches shall have overlapping plates.

In any places where the finish is fair faced brickwork, the wiring shall be installed on the back of the wall and make a back entry into the accessories. Each switch in these areas shall be neatly recessed and incorporate an overlapping plate.

For surface mounted positions, such as Plant Rooms, Electrical Switchroom etc., employing a surface mounted system of wiring, switches shall be surface mounted having metal front plates of an aluminium stove enameled finish mounted in matching metal boxes.

All door swings shall be verified prior to commencing the installation on site, and cord and wall switches shall be positioned adjacent to the closing edge of the door. Wall switches shall be located 150mm to the edge of the mounting box, from the door architrave.

Pull cord switches shall comprise a 15-amp capacity quick make, slow break switch action, mounted on a high impact resistant non-hygroscopic moulded base of the semi-recessed type, suitable for mounting in a standard 50mm fixing centre circular BESA conduit box.

Domed covers shall be white insulated. The assembly shall be designed to enable the cords to be renewed without removing the cover.

Semi recessed units shall be complete with a white break joint ring, fitted between the conduit box and the switch unit.

The cords of all ceiling switches shall be of sufficient lengths (without joints) to reach a point of 1.5 metres from floor level unless otherwise specified. Cords of excessive length shall be shortened to this height.

Where cord operated 'Pull' type ceiling switches are specified to be used at door positions, they shall be located on the ceiling in such a manner that the cord will hang free, approximately 75mm from any wall face and also be clear of the door movement. Where this cannot be achieved the Client shall be consulted.

3.40 SOCKET OUTLETS

All socket outlets and plugs shall be supplied and installed in accordance with the manufacture, type, sizes and finish, indicated elsewhere in this specification or shown on the drawings.

All socket outlets shall be switched, and of the screened shutter type unless stated otherwise. 13-amp sockets shall comply with BS 1363.

All round pin 2A, 5A, 15A and 30A socket outlets shall comply with the requirements of BS 546.

All socket outlets shall be switched unless the contrary is stated in the specification and drawings.

All switched socket outlets shall be complete with steel boxes of the same manufacture, complete with earth terminal. Switched socket outlets shall be single or twin, flush or surface mounted, with or without neon indicators, as specified.

Assemblies shall comply fully with the requirements of the IEE Regulations, concerning the bonding of protective conductor terminals, and each such terminal shall be connected by a conductor, having a minimum cross-sectional area of 2.5mm^2 to a permanent earthing terminal incorporated in the associated box providing an effective, solid connection to the earth continuity conductor of the installation.

Where the assembly does not provide a reliable electrical contact between the cover plate and box, with effective connection of metal operating bars and toggles, then an insulated earthing lead shall be provided solidly connected to the metal plate and operating bar or toggle and terminating at the fixed earthing terminal incorporated in the associated box.

13 amp sockets will generally be installed using ring circuits unless stated otherwise.

Assemblies installed in the boiler house plant rooms, ducts, and where specified shall be of the surface mounted metal clad type comprising a socket and switch. Boxes and cover plates shall be galvanised.

3.41 PLUGS (SOCKET OUTLETS)

All plugs shall be of moulded rubber or other resilient material, complying with BS 1363 or BS 546 and PD 4007 supplement No. 1. The plugs shall have internal cord grip. Shields and/or insulation shall be fitted to prevent live pins being touched when the plug is being inserted. 13 amp plugs shall be fitted with cartridge fuse links to BS 1362. The fuse rating shall be selected to give protection to the flexible cord or cable connected.

The Electrical Services Sub Contractor shall supply one plug for every switched socket outlet and socket outlets installed within the contract and shall allow for connecting plugs to equipment indicated on site by the user/client, or as detailed in the specification.

3.42 SWITCHED FUSED SPUR

All switched fused spur units shall be complete with steel box and earthing terminal.

Units shall be flush or surface mounted, switched or unswitched, with or without neon indicator and flex outlet, as specified.

Front plates shall be engraved to indicate the equipment served.

Switched fused spur units shall comply with BS 5733 and shall be of the type which does not expose live metal parts when the fuse holder is opened for replacement of the fuse.

Switched fused spur units shall be fitted with a fuse of the correct rating to protect the appliance and wiring served.

3.43 COOKER CONTROL UNITS

Cooker control units shall be supplied and installed as detailed elsewhere in this specification.

The cooker control units shall be complete with steel boxes for flush mounting and plastic boxes for surface mounting, each box shall be complete with earth terminal and earth connection to cooker control unit.

The front plates shall be all insulated white finish and shall be provided with neon indicators and engraved 'ON/OFF' switch.

All cooker control units for domestic type cooker operating on 230 volt, 50 Hz, single phase supply shall comprise a 45 amp double pole main switch and a 13 amp switched socket outlet.

Cooker control units shall comply with BS 4177 and shall be mounted to a side of the cooker position.

A cooker connector unit shall also be provided with every cooker control unit, mounted at low level adjacent to the cable entry on the cooker and shall be provided with a terminal block for accepting 10mm≤conductors, and having a white plastic moulded cover plate.

3.44 BELLS AND TRANSFORMERS

All transformers installed for bells must be double wound, with earthed screen between windings and having cartridge fuses installed to protect both primary and secondary windings.

The transformer and fuses shall be mounted within a suitable ventilated and earthed metal enclosure, having facility for conduit connections.

One point of the secondary winding of the transformers must be earthed.

Every transformer shall have an isolating switch, mounted adjacent to break all conductors to the primary winding.

3.45 SPARES

The Electrical Services Sub Contractor shall include for the supply of the following spares, which shall be handed to the Clients Representative upon completion of the installation works.

01 One complete set of HRC cartridge fuses of each size used in switch and fusegear.

02 Cartridge fuses for 13A plug tops, clock connectors, fused spur units, shaver sockets and luminaires shall be provided at the rate of six of each size or type and rating.

03 Two number MCB's of each size used up to 60 amp.

04 Two number RCBO’s of each size used up to 40 amp.

05 Six spare glasses, protective covers and cover opening keys for fire alarm break glass contacts.

06 Two number spare lamps of each size, wattage and type.

The above spares shall be supplied in addition to the items installed as part of the installation.

All spare fuses shall be housed in a fibre glass or a rust proofed sheet metal cabinet, fixed in each main Switchroom. The cabinet shall be labelled 'SPARE FUSES'.

3.46 MECHANICAL SERVICES

All mechanical services will be carried out under a separate contract, and the Electrical Services Sub Contractor shall receive details of all electrical and control equipment, together with copies of wiring diagrams showing all necessary circuiting, which will be supplied by the Mechanical Services Contractor. The Electrical Services Sub Contractor shall receive all items of equipment for remote fixing by him, for example space thermostats, outside temperature detectors etc., which have been provided by the Mechanical Services Contractor.

3.47 TREATMENT/ ELECTRIC SHOCK

In all main switch room and/or sub-stations a notice shall be provided and fixed in a conspicuous place, which is to be agreed with the Client, giving full instructions for the method of treating persons suffering from electrical shock.

3.48 TESTING AND COMMISSIONING

Testing and commissioning shall be carried out in accordance with the requirements of this specification, the IEE Wiring Regulations 18th Edition Guidance Notes No. 3 "Inspection and Testing, BS 5266, BS 5839 - 1 & 6: and the Electricity at Work Regulations 1989.

Standard testing of circuits and the distribution system shall include the following tests, prior to energising circuits and commissioning.

Sequence of Tests	
For Initial Testing (From BS 7671)	For Conditions Report Testing (From IEE Guidance Note 3)
(i) Before the supply is connected, or with the supply disconnected as appropriate ° Continuity of protective conductors including main and supplementary equipotential bonding. ° Continuity of ring final circuit conductors. ° Insulation resistance. ° Site applied insulation. ° Protection by separation of circuits. ° Protection against direct contact by a barrier or an enclosure provided during erection. ° Insulation of non-conducting floors and walls. ° Polarity . ° Earth electrode resistance. (ii) With the electrical supply connected (re-check polarity before further testing) ° Earth fault loop impedance. ° Prospective fault current. ° Functional testing of residual current operated devices (the test to be independent of any test facility incorporated in the device).	With the supply disconnected as appropriate ° Continuity of circuit protective conductors. ° Continuity of main and supplementary equipotential bonding conductors. ° Continuity of ring final circuit conductors. ° Insulation resistance. ° Polarity. ° Earth electrode resistance. ° Earth fault loop impedance. ° Functional test of RCD's. ° Functional test of circuit breakers, isolators and switching devices. Note 1: The person carrying out the testing is required to decide which of the above tests are appropriate by using their experience and knowledge of the installation being inspected and tested and by consulting ay available records. Note 2: The tests need not be carried out in the order shown.

° Functional testing of switchgear and control gear assemblies, drives, controls and interlocks.	Note 3:- Refer to IEE Guidance Note 3 for full details.

Full test results shall be submitted on standard N.I.C.E.I.C. test certificates at the completion of works and for handover.

Fire Alarm Installation;

All fire alarm systems shall be tested in accordance with BS 5839.

(1) Commissioning

The commissioning by manufacturers shall be such that the manufacturer is prepared to give an unqualified guarantee to the operation of the system.

The Scope of Works shall include for all visits to site by the manufacturer to carry out the commissioning works and demonstrate the satisfactory operation of the system to the Clients Representative.

The overall responsibility for commissioning shall remain part of the Electrical Installation Works. The Electrical Services Sub Contractor shall programme all commissioning, provide personnel to assist the manufacturer, ensure that all tools, instructions and ancillary equipment (such as ladders and staging, etc.) are provided. All associated costs shall be included in this tender.

(2) Audibility Tests

On completion of the works, the complete fire alarm system shall be proven to the satisfaction of the Clients Representative, including the taking of fire alarm sounder levels in all areas, with all normal plant in operation.

The system shall be tested, and the result forwarded to the Clients Representative. Details of the dates for the FINAL audibility test shall be submitted at least 2 days prior to the testing, to allow the Clients Representative to attend and witness the results.

(3) Certification and Log Book

In addition to full record drawings and maintenance information, the Contractor shall complete and provide certificates of installation and commissioning, together with a log book, all as prescribed in British Standards.

Emergency Lighting;

All emergency lighting shall be tested fully in accordance with BS 5266, and shall include:-

(1) Test for correct operation - both on mains fail and test key switch.

(2) Duration test on battery.

(3) Measurement of illumination in all locations to prove conformance with the required illumination levels.

All documentation and certification required by British Standards and enforcing bodies shall be completed and issued for Handover to Client by the Contractor.

SECTION 4.0 PARTICULAR WORKS

4.01 SCOPE OF WORKS

The design installation and commissioning of the Electrical Services Systems is to be the sole responsibility of the Electrical Services Contractor based upon the details indicated on the Technical Layout Drawings and in this Technical Specification.

4.02 STANDARDS

Standards of design and workmanship must be fully in accordance with the following:-

1. The current edition of the Institution of Electrical Engineers Regulations for the Electrical Equipment in Buildings
2. British Standard Codes of Practice relating to Electrical Engineering in Buildings
3. British Standards relating to items of equipment
4. Accepted Trade Practices
5. Local Authority By-Laws
7. CIBSE Code of Interior Lighting for Museums.
8. Electricity Boards Code of Practice Electricity Supply Requirements
9. Current Building Regulations
10. Latest Building Regulations - Conservation of Fuel and Power Documents L2B
11. Health and Safety at Work Act 1974
12. Fire Officer's Requirements

4.03 EXTENT OF WORK

The work shall comprise the design, supply, delivery and installation of the following:-

(a) Modifications to the Mains and Mains Distribution, including all switchgear etc.

(b) General Lighting

(c) Power Installation

(d) Fire Alarm Installation Alteration & Detector Installation

(e) Provisions for Data and Telephone Cabling Containment

(f) Earthing, Testing and Labelling

(g) CCTV System Containment

(h) Extra Low Voltage Installation & Containment

(i) Power to Display Cabinets

(j) Stripping Out of redundant cabinet lighting

(k) Lighting Control Electronics

(l) Supplies to Audio Visual Equipment

(m) Client Demonstrations

(n) Commissioning and Set Up Equipment and Levels On Site

4.04 MAINS DISTRIBUTION

This section of the work shall commence at the incoming supply termination point on the second floor, Sea Galleries of the building.

The existing distribution board and I Light controller shall remain.

The supply terminates into a fused connection, complete with all accessories, bus bar chamber, outgoing fused ways. This shall remain and be altered to suit the new arrangement.

New labelling shall be installed to show the new designations of the supplies. A new Single Line Diagram shall be mounted adjacent to the switchgear.

From the main switchgear, the Electrical Services Contractor is to provide and install individual sub-main distribution cables to serve all electrical supplies to services in the Building.

All sub-main cables shall have an associated single core CPC conductor terminating at the appropriate earthing point.

The precise arrangement of this distribution system is to be as detailed on the Single Line Diagram.

The Electrical Services Contractor shall provide and install all cable trays and supports to facilitate the installation of the sub-main cables throughout the complex.

The Electrical Services Contractor shall liaise closely with other trades on site to ensure that positions and routes of cable trays are suitable for all parties.

The cable tray shall be light duty galvanized cable tray.

<u>Sub-Main Distribution</u>

The existing RCBO distribution boards shall remain all as Eaton Limited.

Distribution boards shall be complete with RCBO units suitably rated.

All of the above distribution boards shall be of the surface mounted metalclad type, complete with lockable front doors and duplicate keys and be sized with 25% spare capacity.

Contactors, to be supplied and installed by the Electrical Services Contractor, shall be as Bonar Bray 'Enbray' contactors complete with rectified 240 volt coils and control circuit protection fuses.

Single individual supplies shall be installed for specific equipment in excess of the standard electrical requirements.

a. A 20 amp SP&N supply to each external window.

b. 30 amp TP&N supply for future broadcasting use adjacent to the main distribution board.

4.05 GENERAL LIGHTING

Under this clause, the Electrical Services Contractor will be responsible for the installation of a complete Lighting Installation throughout the complex.

The types of luminaires required are generally referred to in the Luminaire Schedule, all being complete with appropriate lamps.

All luminaires shall be dimmable and compatible with the control system as indicated on the drawings.

Note: Luminaires shall be individually dimmable to provide a flexible lighting solution and meet the gallery requirements both now and in the future.

All fittings and components to be coloured black as indicated in the lighting Quotation from Illuma Lighting.

The lighting levels in these areas must conform with the recommendations of the CIBSE Code of Practice for Museum spaces for each particular area and not less than the lux levels requested by the Client (50 lux minimum to all areas).

The lighting system for the other areas shall be via surface independently supported from the Building structure and recessed luminaires in the suspended ceilings.

The wiring installation throughout shall be by means of Black FP 200 Cable, black conduit and black flexible connections and earth cable from the outlet to the luminaire.

Final connection shall be via heat resistant, multi-core, black, flexible cable from the outlet to the luminaire.

Termination of cables at suspended luminaires shall be via a black ceiling rose and flexible multicore cable.

Control shall be achieved via dimmable individual LED fittings on track and the remote I Light control which is to be commissioned and set up by Host Wave.

All lighting fittings must be supported from the structural fabric of ceilings and not from any suspended ceilings. Support suspension systems must be installed in areas where suspended ceilings are fitted.

No lighting fittings must be ordered without the approval of the Client.

See the lighting control fitting quotation, all aspects are to be included in this contract.

Full site setting up and liaison with the Client and Host Wave is to be included in this Contract.

4.06 EMERGENCY LIGHTING

The Electrical Services Contractor shall design, provide and install an Emergency Lighting System throughout the entire Gallery Space areas, to comply with the Fire Officer's requirements. This will be via a mix of existing and new luminaires as necessary.

The installation shall comply with BS 5266:1999, 2005 BS EN 1838:1999 and all relevant certificates will be duly completed and signed by the Electrical Services Contractor and handed to the Client at contract completion.

The system shall be designed to allow the safe movement of personnel in the event of a mains power failure in a particular part of the building and it is to be arranged to switch on automatically in the event of a mains or local lighting sub-circuit failure.

The system shall comprise a number of single point, self-contained, non-maintained lighting units (three hour units), arranged to suit the building layout.

The lighting units shall generally be as existing and reused accordingly.

The extent and location of illuminated Exit Signs shall be arranged in accordance with the British Standard and Local Authority's requirements, all of the maintained pattern.

The units shall be as existing, matching the technology elsewhere in the building.

Wiring shall be LSF singles in galvanized trunking/conduit installed in a similar manner to the general lighting system.

The exit signs shall be wired and arranged on a 3-wire system with control switches, all to be self-testing and self-reporting and linked to the Clients existing system.

The Electrical Services Contractor shall include for the equipment manufacturer to check, test and commission the system on completion. A Test and Commissioning Certificate must then be issued to the Client.

4.07 GENERAL POWER

(a) A number of 13 amp switched socket outlets shall be provided in the corridors and circulation spaces, at regular intervals between fire doors. These shall be rocker operated pattern, wired in LSF singles in black high impact heavy gauge PVC conduit/trunking, connected on the ring main principle.

The switch sockets shall be as manufactured by MK Electric Ltd, with metal front plates finished matt chrome, generally mounted at 450 mm above finished floor level.

(b) Twin switched socket outlets, as indicated on the Drawing, shall be provided in the various individual rooms.

(c) Four power points off individual circuits are to be provided for the intruder alarm system, cabinets, CCTV and deaf loop.

4.08 EARTHING, TESTING AND LABELLING

The Electrical Services Contractor shall complete all necessary earthing, testing and labelling as referred to below:-

1. EARTHING

The whole of the installation shall be Mechanically and Electrically continuous throughout and all earthing must be in accordance with the latest edition of the IEE Regulations and to the satisfaction of the local Electricity Board and their latest requirements.

A separate suitably sized earth continuity conductor shall be run from the main incoming gas and water mains to the main switchgear.

A surface mounted copper earth bar shall be installed in the switchroom for termination of all earthing conductors, complete with engraved label.

All metal pipework, sinks, immersion heaters, radiators and extraneous metalwork Building structure, Lift steelwork, H&V units on roof etc. shall be earth bonded to the main service point using a separate bonding lead for each item.

All earthing clamps etc. shall be in a visible position when all works are completed.

2. TESTING

The installation shall be tested on its completion to ensure satisfactory operation of all items.

The test shall be in accordance with those detailed in the IEE Regulations and typed results for each unit etc. must be handed to the Architect on completion.

3. LABELLING

External labels and internal typed circuit charts must be fitted to all items of distribution equipment.

The external labels must indicate the reference of the item and where fed from and be engraved White/Black/White traffolyte and fixed to the front cover of each unit.

Where medium voltage is present within a switch etc, a White/Red/ White traffolyte label engraved 'DANGER 415 VOLT AC'.

All Kitchen control units to be engraved.

4.09 DATA SYSTEM CONDUIT/TRUNKING/WIRING

The Electrical Services Contractor shall provide and install the conduit and basket tray for the Data Cabling System and the Cat 5E data cables providing a full certified system.

The data points shall be included within the trunking referred to previously in this Specification and at remote locations referred to on the Drawing.

The cable tray system shall be indicated on the drawings, complete with couplers bolted assemblies, bends, tees and mounting brackets etc. routed through the riser position, all finished in black.

They shall be arranged to link to the Communications Cabinet on the Ground Floor.

The cable baskets shall generally be 75 mm wide. They must form a continuous cable route from each outlet point to the communication equipment located at Ground Floor Level.

All works in this contract. Please see the quotation from Stack Data Limited covering these works.

4.10 'AS FITTED' DRAWINGS

The Electrical Services Contractor shall provide to the Employer as part of the Contract, a complete set of 'As Fitted' Drawings, consisting of two negatives prepared on plastic drawing sheets, two paper prints of each drawing and a full set of CAD disks.

The Drawings/Disks shall consist of not less than the number of Tender Drawings and shall include wiring diagrams for power and control circuits, including control panel wiring diagrams.

The Drawings/Disks shall show all runs of cable, conduit, trunking, traywork, with sizes shown, whether they be concealed or on the surface.

These Drawings/Disks shall be prepared in preliminary form during the period of the Contract and submitted to the Engineer for approval one month prior to the completion of the Contract. Following approval, final drawings shall be sent to the Engineer for on passage to the Employer at the time of Practical Completion of the building.

The Electrical Services Contractor shall, during the Contract Period, retain on site a set of marked up prints for the 'As Fitted' Drawings. These prints shall be kept in the site accommodation and be available for inspection at all times by the Engineer. The prints shall be marked up on a daily basis by the Electrical Services Contractor.

The 'As Fitted' Drawings shall be drawn to a minimum scale of 1:50 for all areas within the building. Site Plans may be drawn to the original scale with prior agreement of the Engineer.

The Drawings shall not be copy negatives of the Engineer's Drawings but shall be re-drawn on the Electrical Services Contractor's own drawing sheets. A charge will be made for the use of any Consultant Drawings.

All lettering on the drawings shall be stencilled to a minimum size of 3.5 mm to 150 30981, DIN 6776.

Hand printing shall not be allowed.

The Electrical Services Contractor shall provide with each manual a CAD Disk covering all the 'As Fitted' Drawings. The type of CAD Disks required shall be confirmed with the Engineer.

4.11 OPERATING AND MAINTENANCE INSTRUCTIONS

The Electrical Services Contractor shall provide two sets of Operating and Maintenance Instructions, including fault finding charts.

The Operating and Maintenance Instructions shall be enclosed in stiff backed plastic covers and shall have the Project Title, Electrical Services Contractor's Name, Address and Telephone Number, including Emergency Numbers, printed on the front cover.
The Operating and Maintenance Instructions shall include all sequential operating descriptions and associated drawings and shall be specifically written for the Project.

Manufacturer's Catalogues and Data shall be included at the rear of the books for additional information.

A ring binder containing reinforced Nyrex pockets may be used to contain the Manufacturer's information.

The Operating and Maintenance Instructions shall be sent to the Engineer for on passage to the Employer at the time of Practical Completion of the building.

All completed 'As Fitted' Drawings, Disks and Manuals must be handed to the Client at the time of handover of the Building.

Failure to provide the above information will prevent acceptance of the Building by the Client.

4.12 COMMUNICATION AND PROCEDURES TO BE ADHERED TO

The Electrical Services Sub Contractor is to adhere to the following communication and procedures:-

(a) All operatives are to carry Contractor ID badges.

(b) The site must have its own Foreman to liaise with the Consultant Engineer and School Staff etc.

(c) This Foreman must remain on site for the duration of the Contract.

(d) At no time must the external doors of any Block be wedged open. Security is to be maintained at all times.

(e) There will be no radios or smoking allowed on site.

4.18 BUILDERSWORK

All builderswork requirements shall be carried out in accordance with the Standard Specification Section 2.0.

4.13 LOG BOOK

For all new Buildings and those refurbishment projects designated as requiring compliance with the Building Regulations 2000 Approved Document L2, the Mechanical Services Sub Contractor shall provide a Building Log Book in compliance with CIBSE TM31, with guidance from Action Energy Good Practice Guide 348.

The Log Book shall be provided using the template format set out in TM31.

The Log Book shall be between 20 and 50 pages (5-10 pages for premises less than 200 m^2). Note that the Log Book is not to be confused with the Operation and Maintenance Manual.

The Log Book will typically consist of the following minimum requirements, presented in a fully indexed lever arch A4 file, with cover and spine file descriptions.

1. Internal cover sheet - to indicate presentation date and acceptance name following induction of Building Manager.

2. Updates and annual review section/index.

3. Purpose and responsibilities.

4. Links to other key documents eg. Operating and Maintenance Manuals, As Installed Drawings, Plant Log Books and their location for easy access/recovery.

5. Main contracts - emergency, statutory authorities, maintenance.

6. Commissioning, handover and compliance.

7. Overall building design, simple conceptual diagrams and text.

8. Summary of areas/occupancy - simple floor plans and occupancy types.

9. Summary of main building services plant (main plant locations, meter locations).

10. Overview of controls/BMS.

11. Occupant information (staff awareness of simple good housekeeping for energy use).

12. Metering, monitoring and energy targeting strategy - including calculated energy consumption data from the designers.

13. Building energy performance records.

14. Maintenance reviews.

15. Schedule of major alterations - for building users post practical completion.

16. Results of in use investigations.

The Log Book shall be available at the point of handover.

In the scenario of multi tenanted Buildings, a central Log Book shall be procured for retention by the Landlord, with "sub" Log Books provided for each tenancy. The Tenant Log Books will be abridged versions of the main Log Book, but will still provide all the necessary information to all Tenants to log their energy performance track alterations etc.

Where multi tenanted Buildings are provided the Central Landlords Log Book will also include a Schedule of Tenant Log Books and their designated Managers and Log Book locations. Likewise the Tenant Log Books should show the Landlords details and location of the Central Log Book.

4.14 DATA AND TELEPHONE NETWORKS SYSTEMS

The Electrical Services Contractor shall design, supply, install, connect, test and commission the complete data/telephone system.

The system shall include outlet points with back boxes, structured cable, CAT VE cabling, cable carrier systems, cabinet with patching leads and all associated components and works to give a complete installation.

The system shall comply with the following:-

Structured cable	-	BSEN:50173:1995
Transmission performance	-	ANS/EIA/TIA 568-A5 (CAT Ve)
Installation practices	-	BSEN:50174-2

The installation shall also comply with national codes and standards and the specific requirements of the Client.

The main cabinet shall be supplied and installed in this contract. It shall include all accessories and equipment to allow the Client to terminate his cables and have 25% spare capacity upon completion.

The Electrical Services Contractor shall employ a Specialist Data Sub Contractor to install, terminate and test all cables and equipment and issue the appropriate certification on completion of the works, associated with the new building.

The outlets shall be RJ45 with shuttered cover mounted on a face plate with associated back box. The face plate shall be finished to match the other outlet accessories within the area.

Please see the quotation from Stack Data Limited.

4.15 SITE VISIT

The Electrical Services Sub Contractor shall consult with the Main Contractor prior to submitting a Tender, to determine the nature and location of the site, means of access, availability of space for huts,

storage and existing services. No claim will be considered on the grounds of ignorance of conditions under which the Works will be constructed.

The Electrical Services Sub Contractor shall be deemed to have satisfied himself with regard to

- access to the site,
- the various working heights
- equipment mounting requirements
- secondary support requirements
- existing utility supplies
- the extent and nature of the scaffolding, protective sheeting or boarding

and generally the conditions under which the work will be required to be carried out.

He shall be deemed to have obtained all information on all matters affecting the execution of the work. Any monetary or other claim made by the Electrical Services Sub Contractor on the grounds of want of knowledge of any or all the aforesaid matters will not, under any circumstances, be considered or entertained by the Client.

4.16 INFORMATION TO ACCOMPANY TENDER

The Electrical Services Sub Contractor is required to submit the following information with his tender offer to enable a full evaluation to be made.

(a) A full description of the proposed installations inc. method statement and sketch schemes

(b) A detailed schedule of proposed equipment.

(c) Tender Return Documentation

(d) A programme of the proposed works.

(e) Company Health and Safety Policy

(f) Risk Assessment

(g) Insurance Details

4.17 CCTV CAMERA SYSTEMS

The Electrical Services Sub Contractor shall include for liaison with the CCTV camera surveillance installation with control unit, recorder and CD drive/storage and supplied and installed by a Specialist Installer/Maintenance Contractor, UIS (the existing Client provider).

Final positions of cameras to be approved before installation, recording equipment etc to be located in the Control Room.

All power supplies containment and equipment and maintenance in this contract.

The Main Contractor is to programme in, in their own programme of work, time when UIS can come to site to carry out their own works.

4.18 STRIPPING OUT EXISTING SERVICES

The Electrical Services Sub Contractor shall isolate, disconnect and remove all redundant electrical systems associated with the old display cabinet lighting shall be removed from site on a regular basis.

The Electrical Services Sub Contractor shall modify and extend as appropriate existing services as indicated on the Layout Drawings. All existing systems and circuit supplying adjacent areas must be maintained by utilising existing or new wiring arrangements.

This shall include stripping out of all of the enabling works electrics. Temporary electrics shall be stripped out and the redundant systems such as the fire alarm works shall be removed.

KGA (UK) Ltd, Trinity Chambers, 10 Ivy Street, Birkenhead, Merseyside, CH41 5EF
Tel: 0151-647 5021 Fax: 0151-647 6955 E-mail: eng@kga.co.uk

ELECTRICAL SERVICES SUMMARY OF TENDER

PROJECT: **NATIONAL MUSEUMS OF LIVERPOOL**
MARITIME MUSEUM – LIVERPOOL – SEA GALLERIES – SECOND FLOOR

ITEM	WORKS DESCRIPTION	PRICE £
1.	SUB MAIN DISTRIBUTION	
2.	(a) LIGHTING INSTALLATION (EXCLUDING LUMINAIRES AND CONTROLS)	
	(b) PROVISION AND INSTALLATION OF LUMINAIRES	
	(c) PROVISION AND INSTALLATION OF LIGHTING CONTROLS	
3.	EMERGENCY LIGHTING	
4.	HEATING AND VENTILATING ELECTRICS	
5.	GENERAL POWER	
6.	EARTHING, TESTING AND LABELLING	
	(a) DATA CARRIER SYSTEM	
	(b) DATA WIRING AND WIRING EQUIPMENT	
7.	OPERATING AND MAINTENANCE INSTRUCTIONS AND "AS FITTED" DRAWINGS	
8.	CCTV CONTAINMENT INSTALLATION	
9.	DISPLAY CASE ALARM CONTAINMENT INSTALLATION	
10.	TEMPORARY ELECTRICS	
11.	STRIPPING OUT	
	SUB-TOTAL	

ITEM B	WORKS DESCRIPTION PROVISIONAL SUMS	PRICE £
1.	MODIFICATIONS TO EXISTING ELECTRICAL INSTALLATIONS NOT SPECIFIED	£1,000.00
2.	TEMPORARY ELECTRICS NOT SPECIFIED	£1,000.00
3.	TEMPORARY DATA CONNECTIONS NOT SPECIFIED	£1,000.00
4.	ADDITIONAL ACCESS CONTROL NOT SPECIFIED	£1,000.00
5.	ADDITIONAL FEATURE LIGHTING NOT SPECIFIED	£1,000.00
6.	ADDITIONAL FIRE ALARM WORK NOT SPECIFIED	£1,000.00
7.	ADDITIONAL CONTAINMENT FOR NONE SPECIFIED ADDITIONAL POINTS	£1,000.00
	SUB-TOTAL	£7,000.00

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ITEM C	WORKS DESCRIPTION SUMMARY	PRICE £
1.	MAINS WORKS	
2.	PROVISIONAL SUMS	£7,000.00
	TOTAL FIXED PRICE TENDER	

SIGNED:
PRINTED:
COMPANY:
ADDRESS:
DATE: