couchperrywilkes
engineering change

Rossendale Borough Council

Rawtenstall Market

Electrical Metering Specification

210447

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Contents

Section One (B)

Preliminaries, M&E Requirements

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1B-1 INTRODUCTION AND INTERPRETATION

The Mechanical and Electrical Contractors shall complete the installations as detailed within this specification and associated documentation i.e. drawings, reports etc., employing skilled personnel and Specialist Contractors as necessary to achieve the standards described.

1B-1-1 DEFINITIONS

Authority having jurisdiction (AHJ) - Refers to organization, office, or individual responsible for enforcing the requirements of legislation or standards, or for approving equipment, materials, an installation, or a procedure

Contract Administrator – Refers to a representative of the company administering the project as defined in the Contract preliminaries.

Building Contractor – Where this term is used within the specification, it shall be taken as the Contractor mainly responsible for completing the building works as detailed herein.

Building Services Contractor – Where this term is used within the specification, it shall be taken as the Contractor mainly responsible for completing the combined mechanical and electrical installation works as detailed herein.

Contractor – Where this term is used within the specification, it shall refer to the Contractor completing the Works detailed herein and shall refer equally to Mechanical Main Contractor or Building Sub-contractor or any of the other "contractor" terms defined within this clause.

Electrical Contractor – Where this term is used within the specification, it shall be taken as the Contractor mainly responsible for completing the electrical installation works as detailed herein.

Engineer – Refers to a representative of Couch Perry Wilkes.

Fire Advisor –Refers to organization, office, or persons responsible for approving the fire safety design, equipment, materials, installation and procedures such as Authority Having Jurisdiction (AHJ), Fire Officer, Fire Brigade, Building Control, Fire Consultant etc.

Main Contractor (or Principal Contractor) – Where this term is used within the specification, it shall be taken as the Contractor with overall responsibility for the completion of the Works on behalf of the Employer.

Mechanical Contractor – Where this term is used within the specification, it shall be taken as the Contractor mainly responsible for completing the mechanical installation works as detailed herein.

Specialist – Refers to a specialist company employed by any of the above to complete a part of the Works on their behalf. The employing Contractor shall remain fully responsible for all works undertaken by the Specialist.

Note: None of the above terms imply a contractual relationship this will depend on the contract arrangements.

DEFINITIONS			
BESA	Building Engineering Service Association	CDP	Contractor's Design Portion
BREEAM	Building Research Establishment Environmental Assessment Method	CDM	Construction Design Management (Regulation)
BS	British Standard	CIBSE	Chartered Institution of Building Services Engineers
BS EN	British Standard European Norm	IET	Institution of Engineering and Technology
BS EN ISO	British Standard European Norm International Standard	NICEIC	National Inspection Council for Electrical Installation contracting
BSRIA	Building Services Research and Information Association	TN-S	Separate protective earth and neutral conductors
CCTV	Closed Circuit Television	TN-C-S	Combined Earth and Neutral conductor separate protective earth and neutral downstream

1B-1-2 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the particular sections, commissioning and standard clauses, all of which further define the requirements for the works.

1B-1-3 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS	
BSRIA BG 6 Design Framework for Building Services	Electricity at Work Regulations
BSRIA BG 28 Soft Landing BREEAM	F Gas Regulations
BSRIA BG 38 Soft landing Core Principles	Gas Safety Regulations
BSRIA BG 54 Soft Landing Framework,	Health and Safety at Work Act

STANDARDS	
BSRIA BG 61 Soft landings and Government Soft landings	Health and Safety Executive ACOP and HS Guides
Building Regulations	IET Wiring Regulations (BS7671)
COSHH Regulations	Insurance Company Requirements
Clean Air Act	Pressure Systems Safety Regulations
Clean Air Strategy	(The) Public Health (Infectious Diseases) Regulations
Construction (Design and Management) Regulations	Liquid Petroleum Regulations
Control of Asbestos Regulation	Local Authority Building Control (LABC)
Control of Pollution Act	London Building Act and / or Building (Inner London) Regulations where applicable.
Dangerous Substances and Explosive Atmosphere Regulations	Management of Health and Safety at Work Regulations
Electricity Safety, Quality and Continuity Regulation	National Joint Utilities Group Publications
(The) Health & Safety (Miscellaneous Amendments) Regulations	Water Supply Regulations
Health & Safety at Work Act	
Requirements of the Environmental Health Officer (EHO), Fire Officer and Building Control Officer	

Any EU legislation cited within this specification will continue to be required for the specific services described and forms part of the "retained EU legislation" detailed within the European Union (Withdrawal) Act 2018.

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

1B-1-4 CURRENCY OF INDUSTRY STANDARDS

In general, all works shall be completed in accordance with the latest versions of the relevant standards that are applicable at the time of contract commencement.

These standards may be updated, or new standards issued, during the execution of the works and if so the Contractor shall:

1) Comply with all new or updated statutory requirements that come into force during the contract period. Where notice of a change to these is in place during the tender period then compliance is deemed to be included in the tender price.
2) Advise the Engineer of all other relevant new or updated standards when these become known.
3) Obtain confirmation, from the Engineer, as to whether the works shall comply with these new or updated standards with respect to:
   - Subsequent phases.
   - Variations.

1B-2 GENERAL REQUIREMENTS

This Section of the Specification identifies general requirements which are applicable to all services and all sections of this specification.

1B-2-1 PROJECT DESCRIPTION

The project involves the supply, (modification of existing installation) installation, testing and commissioning of the Electrical Services. Scheduled below is a brief list of the services - this list is not exhaustive and is provided to give a general understanding of the works only:

- **LV electrical distribution system, new 10.0mm sub mains to the outside stalls form the existing Federal electric main panel**
- **Metering**

  Provide new DigiCard Prepay metering as described including RCBO's for Internal units, Units 3, 4A, 6, 7, (10&11) 17 & 17A, (35 to 38) to be provided with new metering and RCBO's. Note the brackets indicate that this is one unit. Currently there are separate supplies to units 3, 4A, 6, 7, (10&11) , (35 to 38) so the work is limited to providing new meters to the existing Distribution boards. Units 17A & 17B have one supply terminating in unit 17A this will need to be split at DB 17A to allow for a meter to 17B along with a new Distribution Board, RCBO, 6.0mm cable and meter to unit 17B

  Externally units (60&61), 66, to 69, 70 to 73, 74 to 77, TS, Vp, Chicken Coop and 97 are to be provided with new metering and where necessary new Distribution Board's Note the brackets indicate that this is one unit. Currently the connections are:-

  One supply feeding (60&61)

  One supply feeding 66, to 69

  One supply feeding 70 to 73

One supply feeding 74 to 77

One supply feeding TS and Vp

One TPN supply feeding Chicken Coop

As a cost option standard meters are requested in the Tender Summary

- **one supply is feeding 66, to 69 so four units are fed from one MCCB The contractor shall split the units into two's and install a new XLPE/SWA/LSF submain to a new 4 way SPN DB with30mA RCBO mains protection and meters to each unit**
- **One supply feeding 70 to 73 so four units are fed from one MCCB The contractor shall split the units into two's and install a new XLPE/SWA/LSF submain to a new 4 way SPN DB with30mA RCBO mains protection and meters to each unit**
- **One supply feeding 74 to 77 so four units are fed from one MCCB The contractor shall split the units into two's and install a new XLPE/SWA/LSF submain to a new 4 way SPN DB with30mA RCBO mains protection and meters to each unit**

- **General Lighting circuit amendments to split the stalls as the metering**
- **General small power circuit amendments to split the stalls as the metering**

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1B-3 SITE VISIT

A site visit shall be undertaken during the tender period to obtain satisfactory knowledge of the following:

1) Local conditions
2) Nature and accessibility of the site
3) The nature and extent of the operations
4) The supply of and conditions affecting labour
5) Storage space for materials
6) Position of underground services and drains
7) Space available for the execution of the works generally
8) Site Permit schemes and any restrictive site practises
9) Access and site restrictions

The tenderer shall include for all costs necessary to take account of the above. Arrangements for the delivery of materials to site shall be such that no congestion occurs and shall include for all additional handling and transporting due to site conditions.

No additional cost/claim shall be considered due to the failure to undertake a visit site and obtain the necessary knowledge.

1B-4 CONTRACT INCLUSION

The specific contract details are laid out in the Contract preliminaries. The Mechanical and Electrical Contractors shall include for all items necessary for the due and proper completion of the works according to the true intent and meaning of the Tender documentation and this shall include, but not be limited to, all:

1) Materials
2) Labour
3) Carriage
4) Offloading and positioning
5) Tools
6) Minor items such as screws, fixings etc.
7) Items shown on Tender drawings but not detailed in specification
8) Items detailed in specification but not shown on Tender drawings

All materials shall be new unless otherwise specified and of a type and rating matched to the duty for which they are intended. Samples of proposed fittings, materials and workmanship, where required by the Engineer, shall be submitted without delay and in good time to suit the project programme. All systems shall be complete and operational unless otherwise specified.

All test requirements at manufacturer's works, as listed in relevant British Standards or elsewhere in this specification, shall be met prior to dispatch of equipment.

All items of plant and equipment shall arrive on Site in good condition and be suitably protected from all hazards once there and all prime movers etc. shall be in working order. If items of plant are found not to function correctly after installation and this causes a delay to the Contract, the Mechanical and/or Electrical Contractor shall be charged for any costs incurred.

Care shall be taken to maintain services to areas that need to remain operational during the works. The Mechanical and/or Electrical Contractors shall not disconnect any services until they have established, in writing and through survey, the extent of these areas, and agreed an exact timing and methodology for the necessary isolation and diversion of services.

Where a client/site permit to work scheme (or similar) exists this shall be complied with in full together with necessary notice periods etc.

Should any of the tender information be found to be incompatible or ambiguous with other information, then this shall be raised as a query during the tender period and if no response is provided prior to the tender return date, the tender return shall include for the most onerous option available.

1B-5 SPECIFIED EQUIPMENT

Where materials are specified in this document they shall be included in the tender without adjustment or alteration. The Engineer may consider alternatives (as a below line tender sum option), at their discretion. Any alternatives must be provided with all supporting information to prove that it is at least equivalent to the specified product particularly regarding the following:

1) Performance
2) Physical size
3) Appearance
4) Longevity (robustness)
5) Energy efficiency
6) Certification
7) Product support and Warranty.

Where the specified product satisfies the criteria for enhanced capital allowances and hence is published within the energy technology product list, the alternative product must do likewise.

1B-5-1 CONSTRUCTION PRODUCT MARKING – (Declaration of conformity)

Following on from Great Britain leaving the European Union changes in product marking now apply. Products shall comply with the Construction Product Regulation as detailed below:

Timeline	GB Market. (England, Scotland & Wales)	Northern Ireland Market	European Market (EEA)
01/01/2021 to 31/12/2021	**CE** or **UKCA** or **CE&UK(NI)**	**CE** or **CE&UK(NI)**	**CE**
01/01/2022 onwards	**UKCA**	**CE** or **CE&UK(NI)**	**CE**

1B-6 PRE-TENDER ENQUIRIES

Prior to issue of this tender package, enquiries to the marketplace may have been undertaken by Couch Perry Wilkes to obtain quotations from suppliers, manufacturers and specialist installers etc. These may have been requested at varying times through the design development and therefore may not reflect the final design requirements of the project as tendered and may be out of date.

The Contractor shall not rely on the accuracy of pre-tender quotations and shall be responsible for obtaining new quotations based on the final design information contained within the tender specification, drawings, schedules and accompanying tender documentation. Where the specification package is issued as Performance information only, the Contractor shall obtain new quotations based on their final design requirements.

No additional cost/claims shall be considered due to the failure to obtain quotations against the final design information.

1B-7 SUPERVISION

Site supervision for the services work is required and shall be by a dedicated Services Site Manager or equivalent permanently based on site throughout the project.

It may be acceptable for a working Charge hand or Foreman to provide this service, but only with prior permission/acceptance by the client.

The supervisor shall be:

1) Present on site whenever work is in progress by or on behalf of the Mechanical or Electrical Contractor.
2) Appropriately qualified and have previous experience for the class of work specified.
3) Approved by the Engineer
4) A responsible representative to whom site working instructions shall be transmitted.

The site supervisor may be changed only after permission to do so has been granted by the Engineer and in exceptional circumstances only.

1B-8 ELECTRICAL SUPPLY

The characteristics of the available electric supply have been determined as follows:

1) Voltage – 400/230 volts
2) Frequency – 50Hz
3) Fault level – TBC by supply authority or measured by Contractor.
4) Earthing arrangements – TN-S or TN-C-S (PME)

The above shall be assumed for Tender purposes only - actual supply details shall be verified on site prior to commencing working drawings / placing orders.

All equipment, including motors and starters shall be provided to suit the voltages and phases as detailed in the particular clauses and shall be verified before final orders for materials are placed.

As part of their co-ordination duties, the Electrical and Mechanical Contractors shall exchange relevant information from their specifications that relate to equipment being procured prior to placing any orders. Thus, for instance, the plant control panels procured by the Mechanical Contractor shall accommodate the incoming cables being procured by the Electrical Contractor.

1B-9 WATER AND ELECTRICITY

Water and electricity consumed during the construction of the works shall be chargeable. For details of any variance refer to Main Contract.

1B-10 DESIGN RESPONSIBILITIES

1B-10-1 CONTRACTOR DESIGN PORTION

The Contractor/Specialist shall assume design responsibility for part(s) of the works as detailed in this clause.

This shall include the following in relation to all systems:

1) Provide details of all builder's work requirements associated with the services installation.
2) Provide fully co-ordinated fabrication drawings.
3) Provide and design all necessary services supports/fixings, including guides and anchors, but excluding any primary steelwork. All such systems shall be appropriately fire rated for the service supported.
4) Provide and design all necessary means for expansion and contraction for the Mechanical Services.
5) Routing and sizing of electrical conduits, cable trunking and cable trays other than principal runs, to facilitate the complete installation and make due allowance for 25% spare capacity within all cable management systems.
6) Undertake co-ordination of all services installations with all other trades on site and the building structure and fabric.
7) Check all attenuation and anti-vibration requirements following completion of fabrication / installation drawings and final plant selection. Provide and design final attenuators and anti-vibration equipment to meet the performance criteria detailed in the specification.
8) Include for "workshop" meetings associated with the ongoing development of each service provided. The number of meetings per service will depend on the complexity of design and the Contractor/Specialist should allow suitable time within the design programme to accommodate these. The Client's design team shall be invited to all such meetings as appropriate (eg the Architect should be invited where design has implications on the building aesthetics)

In addition, the following systems require the Contractor/Specialists to assume design responsibility for the works which shall be developed from the tender package information (as far as these systems are provided within the scope of the Contract):

Refer to appendix for CDP responsibility schedules.

1B-11 DESIGN SUBMISSIONS

The Contractor shall provide design submissions for all systems and equipment for which they have design responsibility. This shall include, where relevant to the system, the following:

1) Detailed design philosophy statements along with any assumptions made.
2) Detailed calculations to determine size of plant/equipment/distribution, etc.
3) Audibility calculations e.g. fire alarm sounders
4) Visibility calculations e.g. fire alarm beacons
5) Calculations for the category of the lightning protection and surge suppression system.
6) Detailed and complete schematic drawings.
7) Detailed design layout drawings.
8) Detailed distribution systems design drawings to include design values, e.g. peak loading, fault levels, fire stopping, flow rate, velocity, resistance and reference for each section/leg.
9) Detailed schedules of all equipment with duties, sizes, redundancy and any other pertinent information.
10) Commissioning engineer's report on commissionability of the concepts and solutions proposed.
11) Detailed controls (BMS) descriptions in plain, clear and concise English.
12) The proprietary names of all significant products to be included in the Works but not covered by the above items.
13) Any other written or drawn information the Contractor considers necessary to submit to further explain their proposals.
14) Identification of any ambiguities, inconsistencies or errors found by the Contractor in the documents provided by the Employer and a statement of how these issues have been dealt with.
15) Identification of any items or work not included in the tender sum but which are necessary for the completion of the Project.
16) A schedule of all comments received along with details of agreed actions taken or clarification to resolve any issues raised. The schedule shall be a "live" document updated on a regular basis as the design develops and the commenting procedure progresses.

Any work that commences without the submission of the relevant calculations, schedules and drawings being submitted shall be deemed to have been undertaken at the Contractor's risk and any installations subsequently found to be non-compliant with the design parameters shall be rectified at the tendering Contractor's own expense with no detriment to the programme.

A statement shall be provided as to whether or not, in each case, products specified by proprietary name, (either stated as specifically required or specified as examples meeting the requirements) are included in the Contractor's Proposals and, if not, the alternative being offered. Any departure from design intent shall be highlighted to be easily identified.

1B-12 TECHNICAL SUBMISSIONS

In addition to the design submissions, the Contractor shall provide full detailed technical submissions to demonstrate that they have understood the requirements of the criteria outlined in the tender documents and have provided a fully compliant solution.

The Contractor shall provide Technical Submissions for all items as listed below:

1) The chosen equipment from the list of manufacturers identified within the specification
2) Where manufacturers provide working drawings (equipment or system)
3) Any alternative item offered that differs from that specified (manufacturer, material, range etc.)
4) Any bespoke manufactured equipment.
5) Equipment with project/user specific programming, labelling or controls

Each Technical Submission shall be complete with the following information:

- A completed schedule for each item to show capacity/ duty, efficiencies, redundancy and design parameters used for the selection. (Use schedules within the specific sections of this specification where given.)
- Clear identification of the component/equipment/system being submitted with catalogue information, e.g. number or reference or title.
- Specific data sheets for equipment which shall include maintenance and any commissioning requirements.
- Working drawings as appropriate.
- All relevant information required to evaluate the proposal.

1B-13 COORDINATION

The tender drawings show design intent. They are not construction or working drawings and therefore do not show all bends, tees, sets etc. that are necessary to locate services correctly to avoid clashes and ensure good maintenance access. The Contractor shall:

1) Include for all materials etc. as required to provide a complete, fully co-ordinated installation for their services.
2) Complete co-ordination in conjunction with the Main Contractor, the Electrical/Mechanical Contractor and the Contract Administrator, both individually and jointly.
3) Be responsible for co-ordination of their Sub-Contractors and/or Specialists' installation
4) Ensure that all services are co-ordinated with the building itself and any other services present and agree the sequence and timing of each element of the installation in a manner that maintains the agreed co-ordinated arrangements and programme.
5) Where services are exposed to view or of architectural merit, mark out on site the positions of all equipment and services routes, including trunking, conduit and pipework etc. prior to their fixing and agree the same with the Architect/Engineer/ Contract Administrator.
6) Review architect's room layouts and elevations where available to determine exact locations.
7) Pay particular attention to ensure that accessories are positioned to suit door openings, fitted furniture, etc.
8) At all "pinch points", heavily serviced areas, congested service routes or corridors and as otherwise specified elsewhere in this specification, produce drawings/sketches/details/REVIT models allocating space for all mechanical and electrical services and demonstrate that crossover points etc. have been agreed in a manner that allows sufficient access to all maintainable items. These drawings/sketches/details shall be produced by the Mechanical Contractor who shall also lead the associated co-ordination process.
9) Produce co-ordinated Mechanical and Electrical ceiling drawings at 1:50 scale, based on Architect's ceiling layouts, showing all ceiling mounted mechanical and electrical equipment. All necessary mechanical information shall be provided by the Mechanical Contractor. The Electrical Contractor shall take the lead to produce these drawings.
10) Submit all drawings etc. following the requirements for working drawings detailed in this specification.
11) Liaise with the Contract Administrator and CDM Principal Designer with regard to the assessment and reduction of hazard and risk in accordance with the current CDM regulations.
12) Include for all necessary aspect ratio changes of ductwork where needed to achieve a fully co-ordinated layout or to allow the systems to fit within available voids / under structural steels. These shall be deemed to have been included within the Tender Sum.
13) Take particular care to obtain uniform and tidy arrangements of pumps, valves, switchgear, outlets and ceiling mounted equipment. The precise position of a piece of equipment shall normally be determined as follows: -
    a) Single items of equipment which are visually remote from other electrical or mechanical equipment shall be erected at the mounting heights stated in the Specification or shown on the drawings.
    b) Two or more items of equipment, whether electrical or mechanical or both, which are to be erected on the same wall or ceiling, or which will otherwise be visually close to each other, shall be arranged in a neat and symmetrical group. Symmetry of arrangement shall be obtained by horizontal and vertical alignment through the centre lines and not the edges of equipment; for this purpose the stated mounting heights may, with the Contract Administrator's approval, be varied slightly.
14) Not install any services in an uncoordinated manner. Any services installed that have not been co-ordinated or as shown on the co-ordinated drawings shall be re-positioned at the Contractor's own expense as necessary.

Any disputes shall be referred to the Main Contractor, who has overall responsibility for co-ordinating the construction activities.

1B-14 BUILDER'S WORK

Allowances are included in the tender for the provision of builder's work for the works such as:

1) Formation of brick or concrete bases for engineering plant.
2) Formation/excavation of trenches.
3) Provision of anchor thrust blocks.
4) Formation of horizontal and vertical service ducts, covers and access panels as appropriate.
5) Cutting/forming of holes and chases, etc., and making good.
6) Cable tiles, marker tapes and cable markers, which shall be provided by the Contractor, shall be installed by the Building Contractor.

The Contractor shall provide

1) Detailed information to the Building Contractor for all builders work required for the Contract works based on working drawings produced by the Contractor and manufacturers' drawings, etc.
2) Dimensioned drawings showing the sizes and positions of all builders work requirements.

Where it is not practical to indicate on the drawing the positions of small (<100mm dia) holes and chases, they shall be marked out on site by the Contractor; this does not apply to holes through structural concrete or beams, which shall be shown on the drawings.

The Contractor shall be responsible for the preparation of builder's work details of all his Sub Contractors / specialists.

The above shall be provided in good time to enable provision to be made for the same during the construction process. The Contractor shall provide builder's work drawings that are:

1) Based upon the installation drawings.
2) Fully co-ordinated as detailed elsewhere in this specification.
3) Provided in electronic format and:
   a) The Contractor shall agree the number of paper copies to be issued for comment by the Engineer,, for tender purposes assume 3 (three).
   b) The Contractor shall agree the number of paper copies to be issued for construction, for tender purposes assume 6 (six).

1B-15 INSTALLATION (WORKING) DRAWINGS

The Tender drawings issued are provided to show primary routes, design intent, component order etc. They shall not be used as working or fabrication drawings. The Contractor shall develop the tender drawings in order to provide a complete set of co-ordinated working and fabrication drawings for the installation works. The drawings and installed systems shall:

1) Include all fittings etc. required to comply with this specification.
2) Be based upon measured site dimensions - under no circumstances shall scaled dimensions from drawings be accepted.
3) Include minimum spacing as specified.
4) Be fully co-ordinated as detailed elsewhere in this specification.
5) Be provided to the following scales:

DESCRIPTION	SCALE
Plant rooms, external compounds and the like, risers, electrical switch rooms and cupboards and meter rooms	1:20
Internal wall elevations for positioning of outlets, components etc.	1:20
Site distribution, incoming services etc. 1:100 as long as sufficient detail can be shown	1:100
Site distribution where insufficient detail can be shown	1:50
Details of brackets, supports and any special fixings	1:10
Manufacturers detail drawings of items of equipment	1:20
Any drawing not listed above	1:50

1) Be provided in electronic format and:
   a) The Contractor shall agree the number of paper copies to be issued for comment with the Engineer - for tender purposes assume 3 (three).
   b) The Contractor shall agree the number of paper copies to be issued for construction with the Engineer - for tender purposes assume 6 (six).
   c) Manufacture / installation works shall not commence until the drawing has been returned without any outstanding comments from the engineer, all comments shall be addressed prior to final copy being issued for manufacture / installation.

1B-16 FURTHER DOCUMENTATION TO BE PROVIDED BY CONTRACTOR

In addition to those items discussed in the preceding clauses, the Contractor shall provide all required documentation detailed within this specification, which shall include the following:

1B-16-1 PROGRESS DRAWINGS

The Contractor shall keep on site, available for reference by the Contract Administrator or other authorised persons, a full set of installation drawings on which the contractor shall record the work as installed.

1B-16-2 RECORD DRAWINGS

The Contractor shall provide record drawings that are:

1) Based upon the installation drawings.
2) An accurate record of the actual installation including any deviations from the working drawings that have occurred on site.
3) Fully co-ordinated as detailed elsewhere in this specification.
4) Indicative of the layout identity, size and position of all services installed.
5) Provided in electronic format.

The Contractor shall agree the number of paper copies to be issued for comment with the engineer - for tender purposes assume 2 (two).

The Contractor shall provide one full set of record drawings for each maintenance manual to include:

1) Reduced A3 colour copy inserted unfolded in A3 clear plastic wallets, all drawings to be visible without removing from wallets.
2) Full size copy folded and inserted into clear plastic wallets.
3) USB drive containing electronic copy in formats described elsewhere in this specification.

1B-16-3 OPERATING AND MAINTENANCE MANUALS

The Contractor shall produce all information necessary for inclusion in the building Health and Safety file, referred to as Operating and Maintenance (O&M) manuals below.

Program for production of O&M manual.

1) 2 (two) hard copies of the manuals are required, to include record drawings as outlined elsewhere
2) Manuals and record drawings shall be compiled during the contract and an initial draft copy shall be available for the first commissioning of the engineering services. (Minimum 21 days before contract completion.)
3) Practical completion shall not be given until final copies (without unresolved comments from the Engineer) are provided.
4) Allow a minimum of seven days for the Engineer to comment.
5) Incorporate all comments, re-issue for comment if substantial change required.
6) Prior to Practical Completion supply final copies.

The O&M manuals shall be presented as a complete and coordinated package and shall include:

1) Bound in covers capable of withstanding continual heavy use.
2) An Index.
3) Helpful telephone numbers.
4) Instructions for dealing with emergency conditions for each plant.
5) All information to enable operational staff to comprehend fully the extent, purpose and method of operation of the plant(s) including a full description of operation.
6) Detailed schedules of all plant and equipment installed, including model numbers, serial numbers and capacities and with reference numbers which agree with the detailed labelling strategy agreed with the engineer.
7) Schedule of manufacturers' names, addresses and telephone numbers.
8) Detailed instructions on the starting up, running and shut-down of all systems
9) Description of operational routines, together with diagrams showing the functions of all controls.
10) Clearly set out schedules showing the extent and frequency for which maintenance is required, in detail, and how it should be carried out
11) Maintenance and lubrication schedules listed in order of frequency.
12) Information to facilitate the ordering of spares and replacements
13) Common fault finding measures and remedial actions.
14) Any precautionary measures necessary to prevent corrosion or freezing etc.
15) Care required of plant which is or may be subject to seasonal or occasional use
16) A final copy of the report(s) prepared during testing and commissioning, including all test certificates.
17) Maintenance instructions provided by the suppliers of equipment and/or plant to support (not replace) the maintenance information
18) A full set of Record or ‘As Fixed’ Drawings.
19) Circuit and Test charts for each distribution board.
20) NICIEC/IET Test and Completion Certificates
21) Emergency lighting test certificates and record sheets.
22) Fire alarm test certificates.
23) Valve charts referenced to coincide with the marking of valve labels etc. called for in this Specification.
24) The size, type and length of each LV cable (to the nearest metre) together with the measured earth fault loop impedance
25) Interconnections between items of equipment, including those provided by others and terminal numbering and cables core identification for all alarm and control circuits
26) Drawings that include the work of Sub-Contractors, e.g. laboratory / medical gases and ventilation ductwork etc.

27) Schematic diagrams of the application of automatic controls and instruments etc. including a “Description of Operation”.
28) The location and depth of buried services including those installed by Gas, Water and Electricity Authorities etc.
29) Schedules and/or diagrammatic presentations to amplify the drawings where necessary for clarification.
30) Building Regulations Part L Log Book.
31) Pressure Regulations documentation.
32) Building users guide.

Each manual to contain a DVD or USB memory device to contain the following:

1) CAD drawings (Latest AutoCAD version) and PDF copies of all Record and ‘As Fitted’ drawings.
2) Microsoft Word (Latest version) and PDF of all of Mechanical and Electrical Contractors’ written instructions.
3) PDF copies of all manufacturers O&M manuals (in separate directory, named and cross referenced to match O&M manual descriptions).
4) PDF Copies of all certificates, commissioning results, test certificates etc.
5) Electronic copy of control strategies as final commissioned state.
6) Electronic copies of models, Building Regulation Part L assessments and log book etc. where prepared by the Mechanical and Electrical Contractors.
7) Pressure Regulations documentation.

1B-16-4 BUILDING LOG BOOK

The Building Logbook shall be completed in accordance with Part L of the Building Regulations.

1) In contracts where the Electrical contractor is employed as the Main contractor the log book shall be complied and issued by the Electrical contractor.
2) In contracts where both Electrical and Mechanical contractors are employed, or where Mechanical contractor is employed as Main contractor, the log book shall be compiled and issued by the Mechanical Contractor

The relevant electrical or mechanical information shall be provided to the contractor compiling the Log book as follows:

1) Information to be provided by the Contractor compiling Logbook (Mechanical and/or Electrical Contractor)
    a) The location of relevant plant and equipment, including simplified schematic diagrams.
    b) The installed capacities (input power and output rating) of the services plant.
    c) A report confirming that the building services equipment has been satisfactorily commissioned.
    d) Simplified Operating and Maintenance instructions that include provisions enabling the specified performance of equipment to be sustained during operation (this may be cross-referenced to O&M manual documentation).
    e) The locations, identifications and descriptions, including instructions of use of all building energy supply meters and sub-meters.
    f) A statement regarding air tests and air permeability carried out on the building. (Information may be required from other parties, such as the Main Contractor or Architect).
    g) A simple description of the operation and control strategies of the energy consuming services in the building. (Control Specialist to develop from Engineers statements included in Specification).
    h) A statement regarding how energy performance of the building (or each separate tenancy in the building) can be calculated from the individual metered energy readings. (Control Specialist to develop from Engineers statements included in Specification).
    i) A schedule of floor areas of each of the building zones categorised by environmental servicing type (e.g. air conditioned, naturally ventilated, etc.).
    j) Microsoft Excel spreadsheets set up for this particular project to allow recording all meter readings and energy consumption.
2) Information provided by the Engineer or Mechanical Contractor where they are the designer:
    a) A description of the whole building, its intended use and design philosophy and the intended purpose of the individual building services systems.
    b) Final Part L model output report and energy certificate / display energy certificate as appropriate to the building.

The contractor compiling the information shall be responsible for providing the Building Logbook as part of the O&M documentation. The format of any necessary input to the above items shall be agreed with the contractor compiling the Building Logbook. It shall be the responsibility of either the Electrical or Mechanical Contractor to provide the information in the agreed format.

The contractor compiling the Building Logbook shall be responsible for obtaining the relevant information from the Engineer and other parties in a timely manner to allow the Building Logbook to be provided with the other O&M documentation for comment and final handover.

In the event of this clause not being complied with to the Engineer's satisfaction, the Engineer reserves the right to recommend to the Contract Administrator that the Certificate of Practical Completion to the contractor compiling the documentation be delayed until such time that these items are approved and/or commission independently a Specialist in this field to provide the information, and to deduct the Specialist's cost from the contractor’s final account.

The contractor compiling the Building Logbook shall be responsible to ensure the sign off of this takes place prior to Practical Completion.

1B-17 FORMAT OF DOCUMENTATION TO BE PROVIDED BY CONTRACTOR

The Contractor shall include for all information issued to the client and design team to be provided in the following electronic formats:

REQUIRED FORMATS	
DESCRIPTION OF DOCUMENT	**FORMAT REQUIRED FOR ISSUE**
Drawings, to be issued in both of these formats concurrently:	AutoCAD, issued in .dwg format with any xrefs bound to the drawing. PDF, without any restrictions on printing, copying, searching etc. (applies to all PDF's described below.)
Document issue sheets, Technical submittals etc.	PDF
Request For Information (RFI)	Word or Excel Document to enable responses to be added to document.
Output from calculation, modelling or part L software. To be issued in both of these formats concurrently:	ZIP compressed file of calculation input files with all information necessary to allow others to run the same calculations. PDF of any output / summary reports with sufficient information to allow results to be viewed and commented on by all parties.
Manufacturer's instructions, certificates, warranties etc.	PDF, original from manufacturer where available, else colour scanned in version by Mechanical and Electrical Contractors
Commissioning Results	PDF generally until final versions agreed then issue in PDF and editable version such as Excel spread sheet.
Certificates etc.	Original signed copy, along with PDF of the same.
H&S O&M manual	Bound printed copies and electronic copy of the same.
Any information / document not already detailed above.	PDF, original from manufacturer / supplier where available, else colour scanned in version by Mechanical and Electrical Contractors
All format versions shall be the latest version generally available at time of issue.	

The above is in addition to the issue of official / hard copies as required by the contract documents.

1B-18 CONTRACTOR SUBMISSION REVIEW PROCEDURE

All information submitted by the Contractor shall be subject to a review process, with the submission being graded as follows:

- Status A – Proceed with design/installation in accordance with the submission
- Status B – Proceed with the design/installation in accordance with the submission incorporating the comments provided in the process.
- Status C – Do not proceed. Re-submit for further evaluation.

Only works graded A or B shall be progressed. No certification or payment shall be given for works undertaken at Status C.

Any drawings or documents prepared by the Contractor shall be prepared in good time to allow for the inspection procedure outlined above and having due regard to site progress and deliveries of materials.

The time allowed for comment by the Contract Administrator / Engineer shall be at least 10 days, subject to an agreed information release schedule. This period shall be allowed for within the program for preparing the above documents.

The above process does not apply to final documentation produced for completion, e.g. as fitted drawings, Building Log book etc. In this case the information shall be updated as required until free of comments, after which the Contractor shall submit final versions in the agreed format.

1B-19 SITE CLEANLINESS

The Contractor shall allow for cleaning up and removal from site of any rubbish as it accumulates during the progress of the works, including that of his Sub-Contractors/specialists. On completion of work the Contractor shall clear up and remove from site all superfluous materials, clean down external faces of buildings affected by the works, scrub paving and floors, clean out gullies and gutters etc., clean glass inside and out, remove all spots, splashes and stains and leave the works and all parts of the premises affected by them clean and in good order to the entire satisfaction of the Contract Administrator.

The Contractor shall ensure that all rubbish, waste and offcuts etc. are cleared away in accordance with the Main Contractor's waste management plan.

1B-20 DAMAGE DUE TO FROST OR RAIN BEFORE PRACTICAL COMPLETION OF THE WORKS

The Contractor shall make good at his own expense damage caused by frost or rain ingress due to building fabric leaking or equipment being inadequately protected. It is the contractual responsibility of the construction team not to store or install services

and equipment in a building that is not sufficiently weather proof or water tight to avoid this damage. Any damaged services and equipment shall be either replaced or repaired to the satisfaction of the contract administrator and all costs for the remedial works shall be borne by the contractor.

1B-21 ARTIFICIAL LIGHTING AND POWER

All artificial lighting and power required for the whole of the works including Mechanical or Electrical Contractor's works shall be the responsibility of the Main Contractor who shall arrange for temporary supplies as necessary, temporary metering and for payment of cost involved.

Temporary metered electrical supplies to Mechanical and Electrical Contractor's site accommodation for heating and lighting purposes shall be provided by the Main Contractor. Special electrical supplies for use by the Mechanical and/or Electrical Contractors, e.g. workshop facilities, shall be provided by the Mechanical or Electrical Contractors.

Mechanical and Electrical Contractors shall allow for picking up from the temporary services provided by the Main Contractor with temporary leads to service his own requirements and he is to allow for reimbursing the Main Contractor the cost of electricity used in the Mechanical and/or Electrical Contractor's site huts.

All temporary electric wiring is to be to the satisfaction of the Contract Administrator.

1B-22 WINTER WORKING - ARTIFICIAL LIGHTING

The Mechanical and/or Electrical Contractors shall at his own expense provide adequate artificial lighting to ensure that normal weekly working hours may be worked on site despite the loss of natural light.

1B-23 TEMPORARY WORKS

1B-23-1 PLANT, TOOLS AND SCAFFOLDING

Allow for providing everything necessary for the proper execution of the work, including all requisite vehicles, plant, scaffolding, gantries, chutes, stages, fans, ladders, trestles, tarpaulins, tools, rods, moulds, templates, levels, tackle and other implements required for expeditious carrying out of the work in proper sequence, together with the carriage and cartage thereof, maintenance, adapting, shifting and removal of same when no longer required.

The Contractor shall provide and remove on completion, temporary screen and tarpaulins required to give adequate protection against wind, weather and prevent the spreading of dirt, dust and rubbish.

1B-23-2 DELIVERY AND OFF-LOADING

The Contractor shall carry out and shall provide all the necessary equipment for the off-loading, site transport and hoisting to the required level of all materials and equipment supplied under this Contract.

1B-24 OVERTIME OR NIGHT WORK

Overtime and Night work shall only take place as detailed within the Contract Preliminaries.

Where applicable the Contractor shall provide and allow for any overtime as stated within the Specification. The Contract Administrator shall receive not less than 24 hours' notice specifying times and locations of the work to be done. Any concealed work executed during overtime for which notice has not been given may be required to be opened up for inspection and reinstated at the Contractor's expense.

Should the Contract Administrator issue specific instructions, in writing, for overtime working other than that specified within the Tender Documentation, then the net difference between normal time and overtime rates shall be added in the final account; provided that accurate and detailed returns are submitted each week to the Contract Administrator.

1B-25 FIRE PRECAUTIONS

The Contractor shall take all reasonable precautions to avoid the outbreak of fire, particularly in work involving the use of naked flames. The Contractor shall set in place and rigorously enforce procedures to minimise the risk of an outbreak of fire, which shall address the following general issues as well as any site-specific issue:

1) Disposal of flammable materials
2) Accumulation of rubbish on site
3) Hot works procedures including:
    a) Use of fire resisting mats, to prevent scorching or fire.
    b) Provision of firefighting equipment during the work.
    c) Fire watch during and after hot works.
    d) Hot works to stop at least two hours before leaving site.
4) Obtaining and clearing any required work permit from the client and following any additional requirements in their safety procedures.
5) Fire escapes being maintained clear and usable at all times.
6) Safe storage of highly flammable materials and gas cylinders.

The above procedure shall be detailed in a method statement issued to all parties for comment, and any comments incorporated, prior to commencing works.

1B-26 TESTING AND COMMISSIONING OF ENGINEERING SERVICES

Detailed Requirements for testing and commissioned are laid out later in this specification. In general:

1) All testing shall be carried out as recommended by the current edition of the IET wiring regulations (BS7671), relevant British and European Standards and Codes of Practice and current legislation.

2) The Contractor shall draw up a detailed testing and commissioning programme indicating critical dates of external influences.

3) The Contractor shall allow for their Commissioning Engineers being in attendance whilst the Engineer verifies the results and ascertains that the various elements of each system are in full working order. A minimum period of 1 week per month of the contract period (Minimum 2 weeks) shall be allowed for this procedure.

4) The Contractor shall allow for his Commissioning Specialist to demonstrate to the Employer that the design intent of the systems has been achieved.

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1B-27 USE OF BUILDING SERVICES

The Contractor is reminded that they are responsible for the permanent engineering installation provided as part of this Contract until such time as the Certificate of Practical Completion is issued.

These installations shall not be used either directly for, or in connection with carrying out Contract works without the written consent of the Contract Administrator and appropriate Contractors and Manufacturers.

Should any systems be used in this way, the following applies:

1) The Employer does not undertake that it will be available.

2) It shall not be used until the plant has been tested to the satisfaction of the Contract Administrator and Engineer.

3) The Contractor shall take responsibility for operation, maintenance (and remedial work) and arrange supervision by and the indemnification of the appropriate Sub-Contractor and pay all costs arising including extending all associated warranties accordingly.

4) The Contractor shall effect any additional insurances required and pay all additional costs associated.

5) The Contractor shall pay costs of fuel or water used.

6) The Defects Liability Period shall commence from the date of Practical Completion of the works, and not from the date when parts of the installation(s) are brought into use for the above reasons.

7) The Contractor shall indemnify the Employer against the reduction in manufacturer's guarantee resulting from use before practical completion.

8) If it has been agreed that the Contractor may use the permanent lighting then the following shall apply:

   a) Diffusers shall be replaced with new just before Practical Completion.

   b) Exposed parts of the luminaire shall be protected against paint splashes and other marks.

   c) Any separate (e.g. fluorescent) lamps that are used during this period shall be removed and replaced by new, permanent lamps immediately prior to Practical Completion.

   d) Where LED fittings with integral lamps are used, the Contractor shall provide financial compensation for the proportion of the fitting life that has been lost due to this usage. This shall be based on the total cost of the fitting and an expected lifespan of 60,000 hours. The running hours shall be logged by the Contractor and certified by the Contract Administrator.

   e) Use of the permanent lighting installation and temporary / replacement lamps shall not incur any additional cost to the contract.

1B-28 SCHEDULE OF RATES

The Contractor shall provide a full quantified schedule of rates which shall:

1) Be provided with 14 days of being appointed

2) Shall be a Bill of Quantities with a total that matches the contract price.

3) List all materials, equipment and quantities applicable to the works.

4) Be broken down into 1st fix, 2nd fix and fit out for each service element as defined in the Tender Analysis.

1B-29 CDM REGULATIONS

CDM regulations documentation, specific risk assessments etc. shall be provided as follows:

1) In electronic format

2) Mechanical and Electrical Contractors shall agree number of paper copies to be issued for comment with the Principal Contractor/Principal Designer and Engineer, for tender purposes assume 2 (two).

3) Manufacture / installation works shall not commence until the documentation has been returned without any outstanding comments from the Principal Contractor/Principal Designer and Engineer, all comments shall be addressed prior to final copy being issued for inclusion in the Health and Safety File.

1B-30 LABELLING OF EQUIPMENT

Each item of plant and equipment shall bear a metal nameplate giving the maker's name, serial number and relevant performance data. In addition all items of plant and equipment shall be provided with site specific reference labelling, for details refer to Section 3 of this specification.

1B-31 EXISTING ASBESTOS INSTALLATION

Reference to the Contract preliminaries shall be undertaken to ascertain any work associated with removal of existing asbestos. The Contractor shall also review the Client’s Asbestos Register to become cognisant with all known locations of asbestos and any risks associated with the presence of asbestos

1B-32 CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS

For the purposes of the Construction (Design and Management) Regulations, the Main Contractor shall be nominated as and assume the duties of Principal Contractor as defined and set out in those Regulations.

Notwithstanding the requirements of the above clause, the Contractor shall be bound to abide by and implement all regulations, byelaws or other legislation relevant to the health, safety and welfare of all persons on or about the works or likely to be affected by the execution of the works.

1B-33 HEALTH AND SAFETY PLAN

The Contractor shall, in conjunction with the CDM Principal Designer, where necessary, amend, adapt, and expand the Health and Safety information provided contained within the tender documents to produce a coherent Construction Phase plan for the project. The plan shall be implemented and monitored and where necessary, adapted, amended or expanded to reflect changes in circumstances which may arise during the construction phase of the project.

1B-34 PERSONNEL

The Contractor shall:

1) Ensure suitably qualified personnel are responsible for preparing, implementing and monitoring the Health and Safety Plan for the duration of the construction phase of the project.
2) Obtain the prior written approval of the CDM Principal Designer before changing any of the personnel referred to above.

1B-35 HAZARDS OF HEALTH AND SAFETY GENERALLY

The Contractor shall advise the CDM Coordinator immediately of any deficiencies in the Pre-tender Health and Safety information provided or of unforeseen hazards to health and safety which may become apparent as the project proceeds.

1B-36 CONTRACTORS

The Contractor shall take all necessary measures to satisfy himself that all Contractors, whether appointed by him directly or not, are competent and have allocated sufficient resources to comply with the requirements on Contractors imposed by the latest Construction (Design and Management) Regulations.

1B-37 INSTRUCTION OF EMPLOYER'S STAFF

The Contractor shall, in conjunction with their Specialists and Commissioning engineer, instruct the employer's staff.

Instruction shall not commence until the following has been achieved:

1) Full commissioning of all services.
2) Checking Verification of Systems.
3) Random Checks of system(s) by Engineer.
4) Note: client instruction shall not take place on same day as commissioning activities for any system.

A programme for all instruction / demonstrations shall be developed in advance and issued to the following parties:

1) Main Contractor
2) The Contractor and his Specialists / Sub-Contractors.
3) Commissioning specialist
4) Electrical/Mechanical Contractor
5) Client's facilities management representatives.
6) Client user group(s) representative.
7) Contract Administrator
8) Engineer

For each system the following procedure shall be used:

1) Prepare documentation for instruction including:
    a) Relevant as fitted drawings / technical drawings.
    b) Relevant section of the O&M manual, including Job specific information, operating instructions, maintenance instructions etc.
    c) Final commissioning results.
2) An invitation to attend the client instruction shall be issued to the parties detailed above at least seven days before the date of the instruction. Invitation shall include:
    a) Electronic (PDF) copies of all of the documentation for commissioning described above.
    b) Agenda for the day's activities developed from the minimum requirements detailed below.
    c) Pro-forma sign off sheet for all attendees.
3) The following parties are required to attend from the contracting team.
    a) The Contractor and their Specialists / Sub-Contractors.
    b) Commissioning specialist
    c) Main Contractor
4) Agenda for system instruction, the following sets out the minimum requirements:
    a) Tour of installed system including identifying all key parts of the system and demonstrating these are correctly indicated on the as fitted drawings.

b) Presentation of commissioning results and demonstrate system operating correctly.

c) Presentation of operating and maintenance manuals.

d) Demonstrate day to day and emergency operating procedures.

e) Any discrepancies identified during the demonstration shall be scheduled by the Contractor along with actions / programme for rectification.

Formal acceptance of the system shall occur when all parties are satisfied with the system and understand correct operation, all parties shall then sign the pro-forma described above.

The Contractor shall include in their tender and programme sufficient time to incorporate the client instruction methodology described above.

Section Two (E)

Electrical Workmanship & Materials

Contents

2E-1 GENERAL DESCRIPTION

This section details the general electrical workmanship and materials requirements and shall be read in conjunction with all other sections of this specification. All electrical installation works shall be undertaken in strict accordance with the clauses detailed herein and the latest version of all applicable standards and guidance.

This section also sets default requirements for methods and/or materials where several alternatives exist. These default requirements shall be followed unless there is explicit instruction to the contrary in a subsequent section dealing with the relevant system in more detail. Where such instruction is unclear or only inferred, written clarification via the Contract Administrator shall be obtained prior to submission of tender costs and in the absence of such the more onerous requirements shall be included.

Throughout this specification references are made to the requirements and recommendations detailed within several statutory and non-statutory standards / documents. It shall be noted the information presented herein is in no way intended to replace the detailed information provided within these documents which must be fully adhered to where applicable.

2E-2 DEFINITIONS

Please refer to the definitions, symbols and abbreviations as detailed within Part 2 of BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations and the following: -

ABBREVIATION / MEANING			
ACB	Air circuit breaker	AFDD	Arc fault detection device
BBC	Backbone bonding conductor	BN	Bonding network
BRC	Bonding ring conductor	CBN	Common bonding network
CPC	Circuit protective conductor	DB	Distribution board
DCL	Device for connecting a luminaire	DNO	Distribution network operator
EBB / ERB	Equipotential bonding busbar / Earth reference bar	ELV	Extra-low voltage
EMC	Electromagnetic compatibility	EMI	Electromagnetic interference
EPO	Emergency power off	EVCS	Emergency voice communication system (Disabled refuge system)
FELV	Functional extra-level voltage	FFE	Furniture, fixtures and equipment
HV	High voltage	LSC	Luminaire supporting coupler
ICT	Information communication technology	IK	Impact protection code
IMD	Insulation monitoring device	IP	Ingress protection code
IPS	Medical isolated power supply system	IT	Information technology
LPZ	Lightning protection zone	LV	Low voltage
MCB	Miniature circuit breaker	MCCB	Moulded case circuit breaker
MSDB	Multi service distribution board	MET	Main earthing terminal
PBB	Primary bonding busbar	PE	Protective conductor
PELV	Protective extra-low voltage	PEN	Protective and neutral conductor (combined)
PME	Protective multiple earthing	PV	Photovoltaic
RBB	Rack bonding busbar	RCBO	Residual current circuit-breaker with integral overcurrent protection
RCCB	Residual current circuit-breaker without integral overcurrent protection	RCD	Residual current device (RCCB or RCBO)
RCM	Residual current monitor	SBB	Secondary bonding busbar
SELV	Separated extra-low voltage	SMDB	Sub-Main Distribution Board
SPD	Surge protective device	TBB	Telecommunications bonding backbone
TBC	Telecommunications bonding conductor	UBC	Unit bonding conductor
UPS	Uninterruptible power supply system	VoIP	Voice over internet protocol

It shall be noted the above abbreviation list is not exhaustive and all other definitions, symbols and abbreviations used within this specification shall be defined upon occurrence.

2E-3 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below: -

STANDARDS & DOCUMENTS	
BS 7671	IET Wiring Regulations, including On-Site Guide, Guidance Notes 1-8 and all Codes of Practice
All Statutory Regulations (and Associated Memorandum) detailed within Appendix 2 of BS 7671 – IET Wiring Regulations	
All British Standards detailed within Appendix 1 of BS 7671 – IET Wiring Regulations	
All current and relevant British Standards, as referenced throughout this specification	
For healthcare projects all current and relevant Health Technical Memoranda (HTM's) and Health Building Notes (HBN's)	
All current and relevant Energy Networks Association / ESI publications e.g. Technical Specifications (ENATS), Engineering Recommendations (ER) and Engineering Technical Reports (ETR)	
For Education projects, all current and relevant Building Bulletins by the DfES and other government agencies	
All current and relevant CIBSE (Chartered Institution of Building Service Engineers) guides and supporting documentation	
NJUG National Joint Utilities Group – NJUG Guidelines – Volumes 1 to 6	
The Construction Products Regulation	

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Any discrepancies between this specification and the relevant standards shall be referred to Engineer via the Contract Administrator for clarification prior to submission of the tender and in the absence of this clarification the Contractor shall include the most onerous requirements.

2E-4 STATUTORY REGULATIONS & BS 7671 IET WIRING REGULATIONS

All electrical workmanship and materials shall be selected, manufactured, installed, inspected and tested in accordance with the latest version of BS 7671 IET Wiring Regulations in addition to any statutory regulations.

2E-5 ELECTRICAL CONTRACTING CERTIFICATION SCHEMES

The Contractor shall undertake all works in accordance with industry best practice and must be registered with an appropriate certification scheme for the electrical installation works being undertaken which provides a six year guarantee on completion of the works to rectify any non-compliance with the Building Regulations and BS 7671 IET Wiring Regulations.

This shall be the NICEIC / ELECSA – Platinum Promise registration scheme, or equivalent.

2E-6 THE CONSTRUCTION PRODUCTS REGULATION (CPR)

The Contractor shall ensure all electrical installation construction products are suitably certified for their intended use, CE marked in strict accordance with the latest requirements of The Construction Products Regulation, accompanied by a declaration of performance (DoP) and covered by a harmonised European product standard (hEN) or European Technical Assessment (ETA).

All fixed wiring power, control and communication cables shall satisfy the requirements of the Construction Products Regulation in respect of their reaction to fire by being provided in strict accordance with their respective European and British Standards.

2E-7 ACCESSIBILITY & MAINTAINABILITY

Access and maintainability of electrical equipment shall be provided in accordance with the standards listed, and as follows: -

1) Adequate space shall be provided for the initial installation and for its potential replacement at a later date.
2) All equipment shall be installed such that it is accessible for operation, inspection, testing, maintenance and repair.
3) To prevent access by ordinary persons (as defined in BS 7671), equipment shall be located behind lockable doors / covers, or shall only be accessible by the use of a tool.
4) Equipment shall be suitably labelled, and adequate signage provided in accordance with BS 7671 and this specification.
5) Operating instructions shall be provided adjacent to all items of equipment where their function is not obvious.
6) Where items of equipment have removable lids, covers etc., it shall be possible to reinstate these to their original state without damaging cabling or equipment.
7) Access and adequate working space shall be provided to all wiring systems and items of equipment to facilitate maintenance or adaptation. This includes every electrical connection and joint, except for:
    a) Joints designed to be buried in the ground.
    b) Compound filled or encapsulated joints.
    c) Connections between a cold tail and the heating system e.g. ceiling / floor heating or trace heating system.
    d) Joints or connections made in equipment by a manufacturer where access is not required.
    e) Equipment complying with BS 5733, suitably marked as a maintenance free accessory and installed in strict accordance with the manufacturer's recommendations.
8) Suitable access arrangements shall be made for all equipment concealed within roof spaces, ceiling / floor voids and other non-accessible locations e.g. openable or removable access hatches / traps etc.
9) All switchgear and distribution equipment shall be located so that it can be operated and maintained safely.

2E-8 PROTECTION AGAINST ELECTRIC SHOCK

Protective measures shall be provided by the following: -

1) Basic protection – Protection against electric shock under fault-free conditions.
2) Fault protection – Protection against electric shock under single fault conditions.

Suitable provisions shall be made in the installation where danger or damage is expected to arise due to an interruption of supply.

Additional protection (e.g. RCD's and supplementary protective equipotential bonding) shall be provided as detailed.

The following protective measures are permitted:

1) Automatic disconnection of supply e.g. protective earthing, protective equipotential bonding, protective devices etc.
2) Double or reinforced insulation e.g. Class II equipment.
3) Electrical separation e.g. safety isolating transformer used to supply equipment (shaver socket).
4) Extra-low voltage (SELV and PELV) e.g. ELV lighting in a special location.

Automatic disconnection of supply shall be the primary protective measure. The other forms of protective measure (items 2 to 4 above) shall be provided if required e.g. within special locations.

The following protective measures, for application only where the installation is controlled or under supervision of skilled or instructed persons, are not permitted by this specification: -

1) Obstacles.
2) Placing out of reach.
3) Non-conducting locations.
4) Protection by earth-free local equipotential bonding.
5) Electrical separation for the supply to more than one item of current-using equipment.

2E-8-1 AUTOMATIC DISCONNECTION OF SUPPLY

This protective measure shall provide both Basic and Fault protection: -

BASIC PROTECTION

This shall be provided by: -

1) Basic insulation of live parts.
2) Barriers and/or enclosures.

Insulation shall completely cover live parts, be suitable for its environment and shall only be removable by destruction. It shall be capable of withstanding the electrical, mechanical, chemical and thermal stresses that it may be subjected to during service.

The insulation to electrical equipment shall comply with the relevant standard(s) for that item of equipment. Basic insulation of live parts shall not be provided by paint, varnish, lacquer or similar products.

Barriers and/or enclosures shall: -

1) Be provided to prevent contact with live parts
2) Provide at least the degree of protection IPXXB or IP2X
3) Provide at least the degree of protection IPXXD or IP4X to horizontal or top surfaces which are readily assessible.
4) Be suitable for the environment in which they are installed.

The removal of barriers, opening of enclosures etc. shall only be possible by:

1) The use of a key or tool, or
2) After disconnection of the supply to all internal live parts

Any item made accessible that may retain a dangerous electrical charge shall be suitably labelled.

FAULT PROTECTION

This shall be provided by: -

1) Protective earthing.
2) Protective equipotential bonding.
3) Automatic disconnection in case of a fault.

When an earth fault occurs the impedance of the fault path shall be low enough to cause sufficient current to operate the circuit protective device within the required disconnection times given in BS 7671 without reliance on the operation of RCDs.

ADDITIONAL PROTECTION

Additional protection shall be provided when there is an increased risk of electric shock and shall include: -

1) Residual current devices (RCD's, RCCB's and RCBO's).
2) Supplementary protective equipotential bonding.

Additional protection shall: -

1) Not be used as a sole means of protection against electric shock.
2) Be provided by RCDs with operating current IΔn not exceeding 30mA and an operating time not exceeding 40ms at 5 IΔn

This additional protection shall be provided: -

1) For socket-outlets with a rated current not exceeding 32A.

   Note: A lighting distribution unit complying with BS 5733, luminaire track system, installation coupler, LSC or DCL is not regarded as a socket-outlet with regards to this requirement.

2) For mobile equipment with a current rating not exceeding 32A for use outdoors.
3) Within (household) premises, AC final circuits supplying luminaires.
4) For all LV final circuits: -
   a) Serving a location containing a bath or shower.
   b) Passing though zones 1 and/or 2 of a location containing a bath or shower.
5) For external lighting LV final circuits to bike stores, telephone kiosks, bus shelters, advertising panels and town plans.
6) Where additional protection is required within special locations as required by Part 7 of BS 7671.

Additional protection shall also be provided to special locations as required by Part 7 of BS 7671 using supplementary protective equipotential bonding conductors between simultaneous accessible exposed-conductive-parts and extraneous-conductive parts.

2E-9 PROTECTION AGAINST THERMAL EFFECTS

Arc fault detection devices (AFDD) conforming to BS EN 62606 shall be provided as a means of additional protection against fire caused by arc faults in AC final circuits for the following locations and as shown on the drawings: -

1) Premises with sleeping accommodation.
2) Locations with a risk of fire due to the nature of processed or stored materials, i.e. BE2 locations (e.g. barns, woodworking shops, store of combustible materials).
3) Locations with combustible construction materials, i.e. CA2 locations (e.g. wooden buildings).
4) Fire propagating structures, i.e. CB2 locations.
5) Locations with endangering of irreplaceable goods.

BE2, CA2 and CB2 locations are defined within Appendix 5 Classification of External Influences of BS 7671.

AFDD's shall be installed: -

1) At the origin of the final circuits to be protected, and
2) In AC single-phase circuits not exceeding 230V.

AFDD's shall be co-ordinated with overcurrent / residual current protective devices and installed in strict accordance with manufacturers' literature.

2E-10 PROTECTION AGAINST IMPACT – CONCEALED CABLING

LV final circuit cabling concealed within the building fabric / structure shall have the following protection against impact: -

<table>
<tr><th>CABLE TYPE AND CABLE SUPPORT / CONTAINMENT</th><th>CABLES UNDER FLOORS OF ABOVE CEILINGS</th><th>CABLES CONCEALED IN A WALL OR PARTITION AT A DEPTH OF LESS THAN 50mm</th><th>CABLES INSTALLED IN A WALL OR PARTITION THAT INCLUDES METALLIC PARTS (SEE NOTE 3)</th></tr>
<tr><td>Single core insulated non-sheathed cables in metallic cable trunking / metallic conduit</td><td colspan="3">Cable trunking and conduit shall be equipotential bonded and satisfy the requirements for a protective conductor.</td></tr>
<tr><td>Flat multicore insulated sheathed cables (T&E) in metallic cable basket / metallic conduit</td><td rowspan="2">Shall be run at least 50mm from the top or bottom as appropriate, of a joist or batten.
or
Where a 50mm depth cannot be achieved they shall be installed within metallic cable trunking (not cable basket) and metallic conduit that is equipotential bonded and satisfies the requirements for a protective conductor.</td><td colspan="2">Conduit shall be equipotential bonded and satisfy the requirements for a protective conductor.</td></tr>
<tr><td>Flat multicore insulated sheathed cables (T&E) clipped / fixed direct to the building fabric / metallic or plastic capping</td><td>Shall be installed within the prescribed zones detailed within BS 7671.
and
Additional protection shall be provided by RCD's (RCCB's or RCBO's).</td><td>Additional protection shall be provided by RCD's (RCCB's or RCBO's).</td></tr>
<tr><td colspan="4">Notes:-
1) As advised by the IET Wiring Regulations Technical Support Group, unbonded metallic conduit, metallic plate (e.g. on the top of joists) or metallic capping (e.g. run within walls) do not provide adequate mechanical protection
2) RCDs shall have an operating current not exceeding 30mA IΔn and an operating time not exceeding 40ms at 5IΔn
3) Other than just metallic fixings such as nails, screws or the like, e.g. metal stud partitions.</td></tr>
</table>

Default cabling / cable support and containment system, shall be included at Tender and used for installation.

May only be used when detailed in a subsequent section of this specification and on the drawings.

2E-11 IDENTIFICATION, NOTICES & LABELLING

This shall be provided in accordance with site standards, BS 7671, all supporting IET documentation and the respective standards for different systems.

Where there is a discrepancy between existing site standards and the accompanying specification(s) / drawing(s), written confirmation via the Contract Administrator shall be obtained prior to submission of tender costs to clarify the requirements, and in the absence of such the more onerous requirements shall be included.

Where locations is to be defined on labelling, diagrams, schedules / charts the room numbers / names used shall be agreed with the client to ensure co-ordination with the final site room referencing system.

2E-11-1 SAFETY SIGNAGE

Safety signage shall be: -

1) Provided as required for the electrical installation.
2) In strict accordance with The Health and Safety (Safety Signs and Signals) Regulations – Guidance on Regulations – HSE L64, BS 5499, BS ISO 3864 and BS EN ISO 7010.
3) Clearly visible and adequately illuminated by both general lighting and emergency lighting as required
4) Provided in strict accordance with their respective standards e.g. BS 5266 for self-illuminated emergency exit signs.
5) Provided in the following geometric shapes, safety colours and contrast colours: -

SIGN / NOTICE / IDENTIFICATION MEANING	GEOMETRIC SHAPE	SAFETY COLOUR	CONTRAST COLOUR	GRAPHICAL SYMBOL COLOUR	INSTRUCTION AND INFORMATION
Prohibition sign	Circle with diagonal bar	Red	White	Black	A sign prohibiting behavior likely to increase or cause danger e.g. no access for unauthorised persons.
Mandatory sign	Circle	Blue	White	White	A sign prescribing specific behavior e.g. eye protection must be worn.
Warning sign	Equilateral triangle with curved corners	Yellow	Black	Black	A sign warning of a hazard e.g. danger: electricity, nominal voltage exceeding 230 V to earth.
Emergency escape or first-aid sign	Rectangle (square or oblong)	Green	White	White	A sign giving information on emergency exits, first aid, or rescue facilities.
Fire / fire-fighting equipment	Rectangle (square or oblong)	Red	White	White	A sign giving information on fire equipment e.g. fire alarm call point etc.

2E-11-2 IDENTIFICATION, NOTICES & LABELLING COLOURS / TEXT SIZE

All labelling used for the identification of electrical services shall be provided in the following colours: -

SIGN / NOTICE / IDENTIFICATION TYPE	BACKGROUND COLOUR	TEXT COLOUR	NOTES
General information	White	Black	Labelling of general switchgear, electrical equipment and wiring accessories
Fire / fire-fighting equipment	Red	White	Labelling of fire / fire-fighting equipment and the circuits that feed them, (including disable refuge panels etc.)
Fire alarm devices	White	Red	Labelling of fire alarm devices

Identification and labelling of electrical equipment shall be carried out using a mixture of Traffolyte or printed adhesive labels (e.g. Brother / DYMO adhesive tape or similar), depending on the application, as specified hereafter. Critchley / Tyco HLX LSZH cable markers or similar shall be used for cables.

Traffolyte labels shall be fixed by either screws or bolts (not adhesive). Labels higher than 25mm shall have fixings in each corner.

All text shall be in capital letters of the following height: -

1) 25mm for warning notices.
2) 12mm for primary identification labels.
3) 6mm for secondary identification labels and all printed adhesive labels.

2E-11-3 IDENTIFICATION & LABELLING OF ELECTRICAL EQUIPMENT

GENERAL REQUIREMENTS

1) Each item of switchgear, controlgear and electrical equipment shall be provided with labelling that indicates its purpose.
2) Switchgear and controlgear terminals shall be marked in accordance with BS 5472 and BS 6272.
3) Protective devices shall be labelled so that the circuit protected is easily identifiable and in accordance with BS EN 61439.
4) Indicating equipment shall be provided in strict accordance with BS EN 60073 and BS EN 60447, where the remote operation of switchgear is necessary.
5) All switchrooms (including rooms containing battery systems), cupboards and risers shall have suitable warning signs.
6) A laminated 'Electric shock: First aid procedures' (resuscitation) poster shall be provided adjacent to every low voltage switch panel, MCCB panel board and MSDB multi-service distribution board.
7) All labelling shall be fully coordinated and consistent throughout.
8) Traffolyte identification labels shall be provided to every termination or joint box indicating the type of service contained.
9) All spare ways shall be labelled.
10) Additional labelling shall be provided as required by BS 7671 e.g. nominal voltage exceeding 230 V to earth, alternative supplies from different sources or circuits etc.
11) Traffolyte shall be used for all external labelling and for internal (circuit) labelling to switchpanels and feeder pillars.
12) Handwritten notices and identification labels are not acceptable under any circumstances.

Labelling shall be provided as detailed in the headings below, including the following external labelling to all items: -

1) Switchgear / equipment reference number.
2) General description and Manufacturer's details.
3) Origin / source of supply (e.g. FED FROM …).
4) Date of installation

LOW VOLTAGE SWITCH BOARDS & FEEDER PILLARS

External labelling to indicate the following: -

1) Form and type.
2) IP rating.
3) Earthing arrangements e.g. TN-C, TN-S, TN-C-S (PME), TT, IT.
4) Nominal voltage.
5) Nominal frequency in Hz .
6) Rated fault current.
7) Busbar rated current, I in A.
8) Incoming device; BS (EN) number, type, rated current in A, settings where relevant.
9) Incoming supply cable(s); circuit reference / number, no. of cables, no. of cores, size and type.
10) Incoming protective conductor cable(s), no. of cores, size and type (if separate).
11) Weight in kg.

Traffolyte labelling shall also be provided externally to all outgoing ways of low voltage switch panels and internally to all outgoing ways of low voltage feeder pillars. For each outgoing way the labelling shall clearly indicate the following: -

1) Circuit description, phase(s) present, supplied switchgear / equipment reference number, (or "Spare")
2) Destination location of the outgoing circuit including the building, floor and room number.
3) Protective device type, BS (EN) number, rating in A and settings (including spare ways fitted with protective devices).
4) Outgoing cable(s) type, size, no. of cables, no. of cores.
5) Outgoing protective conductor cable(s) type, circuit reference, no. of cables, no. of cores, size (if separate).
6) Date of installation if different to main panel

MCCB PANEL BOARDS, CONTROL PANELS, MSDB/SMDB/MCB DISTRIBUTION BOARDS & CONSUMER UNITS

External labelling shall generally be as described above for switch boards apart from those that are inapplicable e.g. form and type does not apply to final distribution boards. Traffolyte shall be used.

Printed adhesive labelling fixed to the manufacturer's internal labelling boxes adjacent to each outgoing way / circuit shall be provided to indicate: -

1) Circuit description and/or the supplied equipment reference number
2) Circuit type e.g. DB1, DB2, ring circuit, radial circuit etc.
3) Destination location of the outgoing circuit including the building, floor and room number.

Further technical details shall be provided on the schedules / charts provided internally for each MCCB panel board, MCB distribution and consumer unit (see section below).

ISOLATORS, FUSE SWITCH / SWITCH FUSE DISCONNECTORS & OTHER INDUSTRIAL SWITCHGEAR

External labelling shall generally be as described above for switchpanels apart from those that are inapplicable e.g. form and type does not apply.

CONTACTORS

External labelling to include No. of poles, Coil control voltage in V, Contactor rating in kW / V / I.

ENERGY METERING

Traffolyte labelling shall be provided externally to all metering enclosures and shall clearly indicate the following: -

1) Equipment reference number.
2) General description.
3) Date of installation.

2E-11-4 LABELLING TO WIRING ACCESSORIES & HIDDEN SERVICES

Labelling shall be provided as follows: -

WIRING ACCESSORIES

1) The face plates of all accessories such as socket outlets, fused connection units, isolators, light switches, etc. shall have printed adhesive labels that indicate the distribution board from which they are fed and their final circuit reference; this shall exclude dwellings.
2) All final circuit references shall be coordinated throughout and consistent on all accessories, schedules and drawings.
3) All fused connection units and isolators shall be labelled as to their purpose. Where available from the specified range, accessories shall have integral engraved labelling e.g. water heater, cooker, etc.
4) Socket outlets identified for cleaners' use shall have the integral engraved labelling 'CLEANER'S SOCKET'.
5) The buttons of scene setting panels shall be labelled showing all scene setting options / programmes to provide ease of use. Where this is not possible, a small laminated clearly legible pictogram shall be permanently fixed adjacent to the devices.
6) Small laminated pictograms shall also be permanently fixed adjacent to all devices where there is insufficient space for printed adhesive labelling e.g. lighting grid switches etc.
7) All data outlets shall have printed adhesive labels that indicate their unique agreed patch panel ID reference, as detailed within Section E5 Voice and Data Systems within this specification (where provided).

Traffoltye labelling shall be used for all externally located accessories and those within dedicated electrical switch rooms, plant rooms and service risers.

HIDDEN SERVICES

Where services are to be concealed above ceilings, colour coded identification markers shall be provided which shall be fixed to the underside of ceilings. These shall be fully co-ordinated with O&M manuals / as-installed information.

The following services shall be identified: -

1) Concealed power supply units.
2) Fire alarm detectors and interfaces.
3) Smoke / fire dampers.
4) Valves / commissioning sets etc.

Fire alarm remote indicators shall be clearly labelled to indicate their function. They shall be sited and/or labelled in such a way as to assist in determining the location of the detectors that they serve.

The appearance and use of colour coded markers must be agreed with the Engineer, Architect and Contract Administrator prior to installation.

2E-11-5 DIAGRAMS & DOCUMENTATION

DIAGRAMS

For each low voltage switch panel and MCCB/SMDB panel board a detailed low voltage distribution schematic(s) shall be provided, mounted within framed clear perspex and screw fixed to an adjacent wall.

The schematic shall be: -

1) Clearly legible.
2) Minimum size of A2.
3) Minimum text size of 4mm in height when printed.
4) Provided with a drawing legend that includes all the drawing symbols used on the schematic.

The low voltage distribution schematic(s) shall include all upstream switchgear and cabling together with the downstream distribution to the next level. All the panel labelling information as detailed earlier shall be repeated on the schematic.

The low voltage distribution schematics shall be provided in strict accordance with BS 5070 and BS EN 61082.

A drawing(s) shall be provided that details all electrical safety installations for firefighting and life safety services. The drawing(s) shall be located at the origin of the electrical installation and adjacent to any other electrical switchgear (e.g. MCCB panel board, MCB distribution board etc.) to which the firefighting / life safety systems relate.

The drawing(s) shall be mounted within framed clear perspex and screw fixed to an adjacent wall. The electrical safety installations drawing shall detail the exact location of the following: -

1) All electrical equipment and switchgear including switchgear / equipment reference numbers.
2) All firefighting and life safety equipment including final circuit designation and the particulars / purpose of the equipment.
3) Special switching and monitoring equipment for life safety power supplies.

Documentation shall be provided within or adjacent to all MCB distribution boards and consumer units that supply heating cables and embedded heating systems e.g. underfloor or ceiling heating systems, as required by BS 7671. This shall include: -

1) Manufacturer and type of heating units.
2) Number of heating units installed.

3) Length/area of heating units.
4) Rated power.
5) Surface power density.
6) Layout of the heating units in the form of a sketch, drawing, or picture.
7) Position/depth of heating units.
8) Position of junction boxes.
9) Cables, earthed conductive shields and the like.
10) Rated voltage.
11) Rated resistance (cold) of heating units.
12) Rated current of overcurrent protective device.
13) Rated residual operating current of RCD.
14) The insulation resistance of the heating installation and the test voltage used.
15) Product information containing provisions about approved materials in contact with the heating units, with necessary instructions for installation.

In addition to the above, the 'Information for the user of the installation' shall also be provided as detailed within BS 7671.

SCHEDULES / CHARTS

Schedules / charts shall be provided to all low voltage switch panels, MCCB panel boards, MCB distribution boards and consumer units, and shall include the following as a minimum: -

1) Switchgear reference number.
2) General description.
3) Date of installation
4) Circuit information including: -
    a) Circuit reference and phase.
    b) Circuit description and the supplied equipment reference number or final circuit type e.g. DB1. DB2, ring circuit, radial circuit etc. including the destination location of the outgoing circuit by building, floor and room number.
    c) Type of wiring.
    d) Reference method from Appendix 4 of BS 7671 – IET Wiring Regulations.
    e) Number of points served.
    f) Circuit conductor cross sectional area for both live and CPC.
    g) Maximum disconnection time (s) permitted by BS 7671.
    h) Maximum Zs permitted by BS 7671 (MCB not RCBO).
    i) Overcurrent protective devices: -
        i) BS (EN) number.
        ii) Type number.
        iii) Rating (A).
        iv) Short circuit capacity (kA).
    j) RCD operating current IΔn (mA) and type.
    k) Presence of AFDD(s).
5) Method used to provide protection against electric shock e.g. basic protection and fault protection.
6) Details of all final circuits having a high protective conductor current.
7) Details of any equipment or circuit vulnerable to 500V insulation resistance testing e.g. electronic devices.

It shall be noted the above schedules / charts shall be provided within or adjacent to the associated switchgear.

Where they are mounted adjacent to the item of switchgear they shall be mounted within framed clear perspex and screw fixed to the adjacent wall, however when they are mounted inside distribution boards (e.g. inside the front cover) they shall be laminated and suitably placed / attached.

Schedules / charts shall be provided that detail all current using equipment permanently connected to firefighting / life safety power supplies indicating: -

1) Nominal electric power.
2) Rated nominal voltage, current and starting current.
3) Duration.

The schedules /charts shall be located at the origin of the electrical installation and adjacent to any other electrical switchgear to which the firefighting / life safety systems relate. The schedules / charts shall be mounted within framed clear perspex and screw fixed to an adjacent wall. The schedules / charts shall include the nominal power, rated nominal voltage, current, starting current and duration.

All switchgear reference numbers / codes shall be coordinated throughout and the same on all identification labels, schedules and drawings.

All final circuit references shall be coordinated throughout and the same on all wiring accessories, schedules and drawings.

EXISTING DIAGRAMS, SCHEDULES & CHARTS

Where electrical installation works is undertaken that requires work to existing site LV distribution systems, firefighting / life safety systems and final circuit wiring, the diagrams, schedules and charts shall be updated in strict accordance with the above clauses and shall incorporate all existing installed information.

2E-11-6 IDENTIFICATION OF CABLES

All main and sub-main cabling shall be provided with identification labels / markers so that it can be identified for inspection, testing, maintenance, repair or alteration of the installation.

Printed identification labels / markers (e.g. Critchley / Tyco HLX LSZH cable markers or similar) shall be fixed as follows at: -

1) Each end of the cable.
2) Locations where buried cabling enters / exits the ground.
3) Draw pit locations.
4) Building entry points.
5) Pass between floors.
6) Pass between 60-minute or greater fire compartments.

Each identification label shall include the following: -

1) Cable reference / circuit number.
2) Source and destination location(s).
3) Indication if the cable is run in parallel with other cables.
4) Date of installation in DD/MM/YYYY.

Cable route markers shall be provided to all underground cabling and shall include: -

1) Depth at which the cable is buried.
2) Cable operating voltage.

Cable markers / sleeves as a minimum shall be made from materials equivalent to that of the cabling being labelled e.g. LSZH, LSOH, OHLS etc. They shall also be selected to suit the environment in which they are installed.

Separate protective conductors that are not part of a multicore cable shall have identification labels as detailed above.

2E-11-7 IDENTIFICATION OF CONDUCTORS BY COLOUR & LETTERS / NUMBERS

Cores of cables shall be identified by both: -

1) Colour and,
2) Lettering and/or numbers.

At terminations and throughout the exposed length of every core shall be identifiable and where appropriate binding and sleeves for identification purposes shall comply with BS 3858.

Identification by colour or marking is not required for concentric conductors, bare conductors and the following when used as a protective conductor: -

1) Metal sheath or armour of cables.
2) Extraneous-conductive parts.
3) Exposed conductive parts.

Neutral or midpoint conductors shall be blue.

The colours green-and-yellow shall only be used for protective conductors and the colour combination shall not be less than 30% or more than 70% for each colour. The single colour green shall not be used except for copper strip earthing tape.

Green-and-yellow PEN conductors shall be labelled at the terminations by blue markings and blue PEN conductors shall be labelled at the terminations by green-and-yellow markings.

Lettering and numbering shall be provided to individual conductors or conductors in a group, in accordance with the following: -

1) Clearly legible and durable.
2) A strong contrast between characters and the insulation of the cable.
3) When used, the numbers 6 and 9 shall be underlined to avoid confusion.
4) Protective conductors shall not be numbered unless for circuit identification.
5) The number 0 shall be reserved for neutral and mid-point conductors.

Conductors shall be identified by colour and alphanumeric / marking as detailed in the table below: -

CONDUCTOR FUNCTION	COLOUR	ALPHANUMERIC / MARKING
Protective conductors	Green-and-yellow	CPC
Functional earthing conductor	Cream	–
AC power circuit[1)]		
Line of single-phase circuit	Brown	L1 / L2 / L3 as appropriate
Neutral of single- or three-phase circuit	Blue	N
Line 1 of three-phase AC circuit	Brown	L1
Line 2 of three-phase AC circuit	Black	L2

Line 3 of three-phase AC circuit	Grey	L3
[1] Power circuits include lighting circuits.		

At terminations marker sleeves with lettering / numbering shall be provided to each cable core as detailed in the table above e.g. for a three phase circuit, brown shall be L1, black shall be L2, grey shall be L3, blue shall be N.

Protective conductors shall not be lettered / numbered other than for the purpose of circuit identification.

Where terminations are made into switchgear such as switch panels, MCCB panel boards, MCB distribution boards, consumer units, main earth terminals / bars and similar, marker sleeves shall be provided to each cable core.

These marker sleeves shall be in accordance with the alphanumeric marking in the above table and shall also detail the way / circuit reference for which they are terminated into e.g. for final circuits terminated into a three phase distribution board: -

OUTGOING WAY	FINAL CIRCUIT TYPE	CIRCUIT NUMBER / LINE or NEUTRAL or CPC CONDUCTOR	CABLE COLOUR	ALPHANUMERIC / MARKING
Way 1 Line conductors (L1, L2, L3)	Three phase	1/L1	Brown	1/L1
		1/L2	Black	1/L2
		1/L3	Grey	1/L3
Way 1 Neutral conductor	Three phase	1/N	Blue	1/N
Way 1 Circuit protective conductor	Three phase	1/CPC	Green-and-yellow	1/CPC
Way 2 Line conductor (L1)	Single phase	2/L1	Brown	2/L1
Way 2 Neutral conductor (L1)	Single phase	2/N	Blue	2/L1/N
Way 2 Circuit protective conductor (L1)	Single phase	2/CPC	Green-and-yellow	2/L1/CPC
Way 2 Line conductor (L2)	Single phase	2/L2	Brown	2/L2
Way 2 Neutral conductor (L2)	Single phase	2/N	Blue	2/L2/N
Way 2 Circuit protective conductor (L2)	Single phase	2/CPC	Green-and-yellow	2/L2/CPC

Where two or three-core cables (6242* and 6243* flat twin / triple and earth cables) are used for switch wires, intermediate and two-way switch wires, they shall be marked / sleeved as follows: -

FUNCTION	COLOUR	ALPHANUMERIC / MARKING OR SLEEVING
Switch wires – two-core cabling		
Line conductor	Brown[1]	–
Line conductor	Brown[1]	–
Intermediate and two-way switch wires – three-core cabling		
Line conductor	Brown	–
Line conductor	Black	L or Brown
Line conductor	Grey	L or Brown
[1] 6242* Twin and earth cabling shall have two brown cores when used for switching circuits, blue cores with brown sleeving or the cable marker 'L' may be used as an alternative.		

2E-11-8 IDENTIFICATION OF NEW CABLING (HARMONIZED COLOURS) INTERFACED WITH OLD CABLING (NON-HARMONIZED CABLE COLOURS)

Where there is an addition or alteration to an existing single phase installation and new cabling (to the harmonized colours) is interfaced with old cabling (non-harmonized colours), identification and marking is not required at the interface provided that: -

1) Old cable colours are red for line and black for neutral.

2) New cable colours are brown for line and blue for neutral.

However, where there is an addition or alteration to an existing two or three-phase installation or a DC installation, and new cabling (to the harmonized colours) is interfaced with old cabling (non-harmonized colours), the conductor markings in the table below are required at the interface location: -

CONDUCTOR FUNCTION	NEW CONDUCTOR	OLD CONDUCTOR

	MARKING	COLOUR	MARKING	COLOUR
Protective conductors	–	Green-and-yellow	–	Green-and-yellow
AC power circuit[1)]				
Line 1 of three-phase AC circuit	L1	Brown[2)]	L1	Red
Line 2 of three-phase AC circuit	L2	Black[2)]	L2	Yellow
Line 3 of three-phase AC circuit	L3	Grey[2)]	L3	Blue
Neutral of single- or three-phase circuit	N	Blue	N	Black

[1)] Power circuits include lighting circuits.

[2)] Three single-core cables with insulation of the same colour may be used if identified at the terminations.

2E-11-9 TECHNICAL SUBMISSIONS

Prior to installation on-site the Contractor shall provide technical submissions for the following: -

1) A schedule of all identification, notices, labels (including safety signage) and cable identification labels / markers along with a physical sample of each label type.

The time allowed for comment shall be as detailed within section 1B of this specification.

2E-12 EXISTING SUPERVISORY / END-USER MANAGEMENT SOFTWARE

Where electrical installation works is undertaken that requires the integration of electrical systems into existing site supervisory / end-user management software (e.g. fire / voice alarm systems, emergency voice communication systems, disabled persons call systems, emergency lighting systems, security systems etc.) the Contractor shall employ the relevant specialist(s) to: -

1) Update the software so that electrical systems within refurbished, remodelled and new build areas / buildings are fully integrated into the existing software.
2) Incorporate room numbers / names co-ordinated with the architectural drawings and the site room referencing system.
3) Upload and integrate into the existing software the latest floor plans where used as part of an end-user GUI.

2E-13 SELECTION & ERECTION OF WIRING SYSTEMS TO MINIMISE THE SPREAD OF FIRE

To minimise the risk of spread of fire appropriate materials and erection methods shall be selected in strict accordance with The Building Regulations – Approved Document B, BS 9999, BS 7671 and all supporting IET documentation.

2E-13-1 PRECAUTIONS WITHIN A FIRE SEGREGATED COMPARTMENT

The general building structural performance and fire safety shall not be reduced by the installation of wiring systems.

All fixed wiring power, control and communication cables shall meet the flame propagation requirements of: -

1) BS EN 60332-1-2.
2) BS EN 60332-3-24 (where required by cable manufacturing standards – see below).

Note: IET Wiring Regulations requires cables to meet the flame propagation requirements of the BS EN 60332-3 series when installed within 'escape routes' and 'fire-segregated compartments that provide a means of escape in an emergency'. However only XLPE/SWA/LSZH armoured, XLPE/LSZH softskin 'fire rated' and XLPE/SWA/LSZH armoured 'fire rated' cabling is tested to meet these requirements, and this is currently under review by the IET.

Therefore, cabling need only meet the requirements of BS EN 60332-1-2 where its manufacturing standard does not require testing to the BS EN 60332-3 series.

Where cables do not comply with the flame propagation requirements of BS EN 60332-1-2 and the BS EN 60332-3 series (where possible), they shall be limited to short lengths for connection of appliances to the permanent wiring system e.g. flexible connections. They shall not pass between fire segregated compartments.

Additional measures shall be taken where a 'particular risk of fire' is identified in strict accordance with BS 7671.

2E-13-2 SEALING OF WIRING SYSTEM PENETRATIONS

The sealing of wiring system penetrations shall be as follows: -

1) Where wiring systems pass through floors, walls, roofs, ceilings, partitions, cavity barriers and other elements of the building construction, the penetrations through the building fabric shall be suitably sealed (e.g. fire barriers / stopping) to provide the level of fire resistance and acoustic properties required by the building element that has been penetrated.
2) Manufacturers' proprietary cable transit systems and sleeves shall be utilised which have been tested in strict accordance with BS EN 1366-3. Other systems may be considered if based on sample construction details and written approval by Building Control and appropriate Fire Advisors.
3) Under no circumstances shall expandable foam be used.
4) Cable ducting, cable trunking, conduit and busbar systems etc. shall also be internally sealed to provide the level of fire resistance required by the building element that has been penetrated.
5) Where the wiring system / products are classified as non-flame propagating according to the relevant product standard, internal sealing is not required provided that: -
   a) The wiring system has a maximum internal cross-sectional area of 710mm^2 e.g. 32mm diameter conduit or smaller, or 25 x 25mm trunking.

b) (However, they may require sealing for other reasons, such as to prevent condensation, in classified hazardous areas etc.).

c) The system has the degree of protection of IP33 to BS EN 60529.

d) Any termination of the system in one of the compartments, separated by the building construction being penetrated, has the degree of protection of IP33 to BS EN 60529.

6) Temporary fire stopping arrangements shall be provided if required during the installation works. Existing fire stopping that is disturbed during alteration works shall be reinstated as soon as practical.

7) The fire sealing must also resist external influences to the same degree as the wiring system e.g. resistance to combustion, ingress protection from water, be from compatible material, permit thermal movement and have adequate mechanical stability.

8) Cable cleats and supports for cable management systems shall be provided within 750mm of all fire barrier / stopping seals and shall be able to withstand the mechanical load induced by the collapse of wiring systems on the fire side of the seal, to prevent strain and damage to the fire seal. This is not required if the seal itself is able to provide adequate support under such conditions.

9) Intumescent gaskets and covers shall be provided where electrical equipment or accessories are installed within ceilings or walls whose fire integrity has been compromised by their installation e.g. recessed luminaires in ceilings to maintain the ceilings fire integrity, accessory boxes in thin skinned walls that form part of a fire compartment etc.

10) Gaskets and covers shall be provided where electrical equipment or accessories are installed within ceilings or walls whose acoustic properties have been compromised by their installation e.g. recessed luminaires, accessory boxes in thin skinned walls etc.

11) Labelling shall be provided at each penetration location and shall have a designated unique reference, include the installation date and details of the specialist installer.

12) On completion of the fire barriers / stopping works fully detailed completion / compliance certification shall be provided along with record drawings that detail all fire barrier / stopping locations.

Technical specifications for all manufacturers' proprietary fire stopping systems and materials (e.g. cable transit systems and sleeves) shall be agreed with Building Control / Fire Advisor and the Architect.

2E-13-3 PROXIMITY & SEGREGATION OF WIRING SYSTEMS

GENERAL

Electrical services cabling shall be segregated in strict accordance with BS 5266, BS 5839, BS 6701, BS EN 50174, BS EN 62305, NJUG Guidelines, BS 8519, BS 7594, BS 7671 and all supporting IET documentation.

Voltage Band I and Voltage Band II circuits must not be contained in the same wiring system as a circuit of nominal voltage exceeding that of low voltage.

EMERGENCY LIGHTING SYSTEM WIRING

Emergency lighting system wiring from a central battery system shall be segregated from all other electrical circuits and wiring systems to avoid the risk of mechanical damage, in strict accordance with BS 5266-1.

OTHER WIRING

The following wiring systems shall be fully segregated from each other and all other electrical circuits and wiring systems: -

1) Security systems.

2) BMS.

3) ELV mechanical services controls.

GENERAL INSTALLATION REQUIREMENTS

The general installation requirements are as follows: -

1) Wiring systems that require segregation shall be installed in their own dedicated cable management systems or in common cable management systems that are provided with individual dedicated compartments.

   Where dividers / partitions are installed on-site they must be from the same manufacturer as the cable management system and the manufacturer's proprietary fixings shall be used.

   The compartment walls or dividers / partitions within the common cable management system shall be:-

   a) Securely fixed and manufactured from the same material as the cable management system.

   b) Mechanically strong and continuous throughout the cable management system.

   c) The same height as the sides of the common cable management system and without perforations.

   d) Equipotential bonded to the cable management system.

2) Signalling and data cabling shall not be installed within a common cable management system that contains low voltage wiring unless the dividers / partitions are manufactured from steel with a minimum thickness of 1.5mm.

3) All wiring systems shall have its own cable conduits and shall not be installed in the same conduits as the cables of other wiring systems.

4) Under no circumstances shall any wiring be strapped or fixed to the outside of cable management systems.

5) Underground electrical wiring systems shall be separated as detailed by the NJUG National Joint Utilities Group or as shown on the drawings. All buried wiring systems shall be installed within their own dedicated cable ducting systems unless specifically shown otherwise.

2E-13-4 PROXIMITY OF WIRING SYSTEMS TO NON-ELECTRICAL SERVICES

Wiring systems shall not be located in close proximity to non-electrical services that produce heat (e.g. hot pipework), smoke or fumes, or below services that may cause condensation (e.g. water, steam, gas services), unless adequate precautions are taken to prevent harmful effects to the wiring.

Mechanical / thermal shielding or suitable spacing shall be provided between electrical and non-electrical services to prevent the operation of one service affecting another.

Under no circumstances shall wet services be installed within LV switch rooms and rooms containing standby battery systems.

Low pressure gas systems shall be separated from electrical equipment in accordance with BS 6891: -

1) Gas pipework shall be at least 150mm from low voltage equipment such as metering, DNO cut-outs / isolators, distribution boards and consumer units.
2) Gas pipework shall be at least 25mm from switches, sockets and low voltage cabling.

The guidance outlined in IGEM/GM/6 shall also be followed: -

1) Gas metering shall not be installed within rooms that are intended for electricity metering and electrical switchgear.
2) Gas metering shall be located away from electricity metering and electrical switchgear and under no circumstances within 150mm.

The only wiring systems that shall be installed within lift or hoist wells shall be those that form part of the lift installation as defined by the BS EN 81 series.

2E-13-5 MEASURES AGAINST ELECTROMAGNETIC DISTURBANCES

To avoid and reduce electromagnetic disturbances the electrical installation works shall also be undertaken in strict accordance with the following standards: -

REFERENCE STANDARDS / DOCUMENTS	
BS 6701	Telecommunications equipment and telecommunications cabling – Specification for installation, operation and maintenance
BS EN 50310	Telecommunications bonding networks for buildings and other structures
BS EN 50174	Information technology – Cabling installation
BS IEC 61000-5-2	Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 2: Earthing and cabling

Where referenced within this section of the specification data and signalling cabling shall include the following non-exhaustive systems: -

1) Information technology and telecommunications systems.
2) All life safety / fire-fighting systems.
3) Security systems.
4) AV/TV/integrated reception systems.
5) BMS systems.
6) ELV mechanical services controls.
7) Nurses call systems.
8) Any other systems that utilise ELV signalling wiring.

Reference shall be made to BS EN 50174-2 for the minimum separation distances from data / signalling cabling to sources of electromagnetic interference (e.g. fluorescent / neon / mercury vapour / high-intensity discharge lamps, arc welders, frequency induction heating, hospital equipment, radio / television transmitters and radars).

As a minimum the following measures must be adopted to avoid and reduce electromagnetic disturbances: -

1) Signalling cabling shall be adequately screened
2) All circuit conductors of low voltage cabling shall be run together in close proximity utilising the same cable support / containment system (e.g. line, neutral and protective earth conductors).
3) Adequate separation and segregation of power (e.g. low voltage) and signalling cables shall be provided.
4) All cable support and containment systems shall be equipotential bonded as detailed within the Earthing and Bonding section within this section of the specification.

Where more onerous measures (e.g. surge protection and/or filters, EMC equipotential bonding networks etc.) are required these shall be detailed elsewhere within this specification.

It shall be assumed, unless unambiguously stated otherwise, that the minimum separation distances given in BS 7671 apply, as summarised below: -

INSTALLATION METHOD (ALL CABLE SUPPORT & CONTAINMENT SYSTEMS ARE STEEL)		SEPARATION DISTANCE
DATA / SIGNALLING CABLING	LOW VOLTAGE CABLING	
Dedicated cable basket or tray	Free air, cable tray or basket	200mm
Dedicated cable basket or tray	Cable trunking	150mm

INSTALLATION METHOD (ALL CABLE SUPPORT & CONTAINMENT SYSTEMS ARE STEEL)		SEPARATION DISTANCE
DATA / SIGNALLING CABLING	LOW VOLTAGE CABLING	
Dedicated cable trunking	Cable tray or basket	150mm
Dedicated cable trunking	Dedicated cable trunking	0mm

Notes: -

1) The minimum separation distances shall apply in three dimensions.
2) Signalling and data cabling shall not be installed within a common cable management system that contains low voltage wiring unless the dividers / partitions are manufactured from steel with a minimum thickness of 1.5mm.
3) Where signalling / data cabling and power cabling are required to cross each other and the minimum separation distances cannot be maintained, they must cross each other at 90 degrees for at least the minimum separation distance either side of the crossing.

Electrical safety and measures to avoid / reduce electromagnetic disturbances may produce different segregation or separation requirements; the electrical installation shall meet both requirements.

2E-14 EARTHING & BONDING

This shall be provided in accordance with BS EN 50310, BS EN 50174, BS 7430, BS 7671 and all supporting IET documentation.

The following definitions apply: -

1) Supply system earthing – Where a connection is provided between the source of energy (e.g. generator winding) and the general mass of earth via a source electrode.
2) Electrical installation earthing – Where the exposed-conductive-parts of an installation are connected to an appropriate means of earthing at the origin of the installation e.g. MET.

For intakes at LV, the DNO is normally responsible for supply system earthing and the provision of a connection for the MET.

All earthing and bonding cabling shall be LSZH (LSOH, OHLS) with emissions of hydrogen chloride gas < 0.5%.

2E-14-1 EARTHING ARRANGEMENTS

Dependent on the installation earthing arrangements, METs shall be connected to earth by one of the following methods as required by BS 7671:

1) TN-S, to the earthed point of the source of energy, my partly be formed by the DNO's lines and equipment.
2) TN-C-S, where protective multiple earthing is provided, by the DNO to the neutral of the source of energy.
3) TT and IT, via an earthing conductor to an earth electrode.

Earth electrodes shall be provided in accordance with BS 7671 and shall be from the following types: -

1) Earth rods or pipes.
2) Earth tapes or wire.
3) Earth plates.
4) Underground structural metalwork embedded in foundations (e.g. piling) or other metalwork installed in the foundations.
5) Welded metal reinforcement of concrete (except pre-stressed concrete) embedded in the ground.
6) Lead sheaths and other metal coverings of cables (existing installations only).
7) Other suitable underground metalwork.

The following shall not be used as an earth electrode: -

1) Metallic pipework for gases or flammable liquids.
2) Metallic pipework of a water utility supply.

Metal objects immersed into water shall not be used as earth electrodes.

2E-14-2 PROTECTIVE CONDUCTORS

The term protective conductor applies to the following: -

1) Earthing conductors.
2) Protective equipotential bonding conductors.
3) Supplementary protective equipotential bonding conductors.
4) Circuit protective conductors.

The following shall not be used as protective conductors: -

1) Gas pipes.
2) Oil pipes.
3) Flexible or pliable conduits.
4) Support wires or other flexible metallic parts.
5) Constructional parts subject to mechanical stress in normal service.

Although permissible by BS 7671 the metal enclosures or frames of low voltage switch panels, control gear assemblies and busbar trunking systems shall not be used as protective conductors.

2E-14-3 EARTHING CONDUCTORS

Earthing conductors and connections shall be suitably protected against mechanical damage and corrosion and be suitably labelled.

2E-14-4 MAIN EARTH TERMINALS (MET)

An MET shall be provided to all electrical installations for connection of the following to the main earthing conductor: -

1) Circuit protective conductors.
2) Main protective bonding conductors.
3) Functional earthing conductors (if required).
4) Lightning protection system bonding conductors (if any).
5) Metallic sheath of incoming telecommunications cables (where agreed).
6) Telecommunications bonding conductors from telecommunications PBB (if required).

Main protective equipotential bonding conductors shall be provided from the following extraneous-conductive-parts to the MET: -

1) Water installation pipes.
2) Gas installation pipes.
3) Fuel oil pipes.
4) District heating pipes.
5) Steam pipes.
6) Laboratory and medical gases.
7) Mechanical service installation pipework and ducting (e.g. ventilation, heating, chilled water etc.)
8) Central heating and air conditioning systems.
9) Exposed metallic structural parts of the building.

The above shall be applied to each building where the electrical installation serves more than one building.

Where agreed with the service provider / owner, the metallic sheath of incoming telecommunications cables shall also be equipotential bonded to the MET. Lightning protection systems shall also be connected to the MET.

Disconnection of the main earthing conductor shall be provided to facilitate measurement of the earthing arrangements. This may be provided as part of the main earthing terminal (MET) in the form of a bolted disconnection test link. It shall only be possible to remove disconnection joints / links by means of a tool.

Metallic pipes entering the building having an insulating section at their point of entry need not be connected to the protective equipotential bonding.

2E-14-5 PROTECTIVE EQUIPOTENTIAL BONDING CONDUCTORS

Main protective equipotential bonding conductors shall be provided from extraneous-conductive-parts to the MET, as detailed above in the section Main Earthing Terminals.

Generally protective equipotential bonding conductors shall be installed on cable support and containment systems, however where they are fixed to the building structure / fabric they shall be supported at spacing's as detailed within IET Guidance Note 8 – Earthing and Bonding.

SIZING OF MAIN PROTECTIVE BONDING CONDUCTORS – WHERE PME CONDITIONS DO NOT APPLY

Where PME conditions do not apply the minimum cross sectional area of main protective bonding conductors shall be in relation to the size of the line and earthing conductors, as detailed in the table below: -

WHERE PME CONDITIONS DO NOT APPLY		
LINE CONDUCTOR CROSS SECTIONAL AREA	EARTHING CONDUCTOR CROSS SECTIONAL AREA	MAIN PROTECTIVE BONDING CONDUCTOR CROSS SECTIONAL AREA
4mm^2 to 10mm^2	4mm^2 to 10mm^2	6mm^2
16mm^2 to 35mm^2	16mm^2	10mm^2
50mm^2	25mm^2	16mm^2
70mm^2 to 400mm^2	35mm^2 to 240mm^2	25mm^2
Note: Assumes all conductors are copper.		

SIZING OF MAIN PROTECTIVE BONDING CONDUCTORS – WHERE PME CONDITIONS APPLY

Where PME conditions apply the minimum cross-sectional area of main protective bonding conductors shall be in relation to the size of the supply neutral conductor, as detailed in the table below: -

SUPPLY NEUTRAL CONDUCTOR CROSS SECTIONAL AREA	MAIN PROTECTIVE BONDING CONDUCTOR CROSS SECTIONAL AREA
35mm^2 or less	10 mm^2
50mm^2	16 mm^2

SUPPLY NEUTRAL CONDUCTOR CROSS SECTIONAL AREA	MAIN PROTECTIVE BONDING CONDUCTOR CROSS SECTIONAL AREA
70mm^2 to 95mm^2	25 mm^2
120mm^2 to 150mm^2	35 mm^2
Over 150mm^2	50 mm^2

Notes: -

1) Assumes all conductors are copper.
2) DNO conditions may require larger main protective bonding conductors and this should be verified with the DNO.

METALLIC PIPEWORK

The main bonding connections to water, gas or other services shall be made as near as practicable to the point of entry of that service into the building.

Where there is a meter, isolation point or union the connection shall be made: -

1) To the hard metal pipework and before any branch pipework.
2) Where the meter is within the building – Where practicable within 600mm of the meter outlet union when the meter is installed within the building
3) Where the meter is outside of the building – where the service enters the building.

If an insulating section has been provided to prevent galvanic corrosion the bonding connection shall be to the building side only.

Bonding clamps that comply with BS 951 shall be used to make main bonding connections to metal pipework and shall be selected to suit the environment in which they are installed. Where bonding clamps cannot be used due to the size of the pipework other suitable means of connection shall be provided.

STRUCTURAL STEELWORK

The structural steelwork shall be equipotential bonded using proprietary clamps at regular intervals with final connection to the MET by means of a bolted lug type connection.

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METALLIC CABLE LADDER RACK, CABLE TRAY & CABLE BASKET

All cable ladder rack, cable tray and cable basket / wire mesh systems shall have adequate electrical continuity characteristics as defined in BS EN 61537. A protective bonding conductor shall connect cable ladder rack or cable tray to the main earth terminal (MET) or the equipotential bonding network (for equipotential bonding networks).

The electrical continuity of the cable ladder rack, cable tray and/or basket shall be tested in accordance with BS EN 61537.

METALLIC CABLE TRUNKING

All cable trunking shall: -

1) Be equipotential bonded using the manufacturer's proprietary components and fixings in strict accordance with the manufacturer's recommendations and with due allowance made for thermal expansion / contraction.
2) Have adequate electrical continuity characteristics as defined in BS EN 50085. A protective bonding conductor shall connect the cable trunking systems to the MET or the equipotential bonding network (for equipotential bonding networks).

The electrical continuity of the cable trunking shall be tested in accordance with BS EN 50085.

METALLIC CONDUIT & FITTINGS

Metallic cable conduit and fittings shall have adequate electrical continuity as defined in BS EN 61386 when connected to cable tray, cable basket and cable trunking. The metallic cable conduit shall be connected to the main earth terminal (MET) via the primary containment systems.

The electrical continuity of the cable conduit shall be tested in accordance with BS EN 61386.

ELECTRICAL EQUIPMENT & WIRING ACCESSORIES

A separate protective conductor shall be run between the earthing terminal within an accessory / equipment and the earthing terminal in the associated back box / enclosure. Notwithstanding Guidance Note 8, a single fixed lug shall not be relied upon as the sole means of continuity.

EMC BONDING NETWORKS

Where EMC equipotential bonding networks are required to avoid / reduce electromagnetic disturbances they shall be detailed elsewhere within this specification.

2E-14-6 SUPPLEMENTARY PROTECTIVE EQUIPOTENTIAL BONDING CONDUCTORS

Supplementary protective equipotential bonding conductors shall be installed between simultaneous accessible exposed-conductive-parts and extraneous-conductive parts, including where practical, the main metallic reinforcement of constructional reinforced concrete.

The equipotential bonding system shall be connected to the protective conductors of all equipment within the area requiring supplementary protective equipotential bonding (including those of socket outlets).

Supplementary protective equipotential bonding shall be provided where additional protection is necessary within special locations as required by Part 7 of BS 7671.

The cross-sectional area of copper supplementary protective equipotential bonding conductors shall be determined from BS 7671, which can be summarised as follows: -

CABLE TYPE / INSTALLATION	SUPPLEMENTARY PROTECTIVE EQUIPOTENTIAL BONDING CONDUCTOR CONNECTION TYPE AND REQUIRED CABLE SIZE		
	TWO EXPOSED-CONDUCTIVE-PARTS	AN EXPOSED-CONDUCTIVE-PART AND AN EXTRANEOUS-CONDUCTIVE-PART	TWO EXTRANEOUS-CONDUCTIVE-PARTS
Sheathed or mechanically protected	Greater than or equal to the cross-sectional area of the circuit protective conductor	Greater than or equal to the cross-sectional area of the circuit protective conductor	Greater than or equal to 2.5mm^2
Non-sheathed single core cabling	Greater than or equal to 4.0mm^2	Greater than or equal to 4.0mm^2	Greater than or equal to 4.0mm^2

Generally metallic ceilings and ceiling grids shall not be supplementary protective equipotential bonded unless detailed elsewhere within this specification.

Where supplementary protective equipotential bonding conductors are fixed to the building structure / fabric they shall be supported at spacing's as detailed within IET Guidance Note 8 – Earthing and Bonding.

2E-14-7 CIRCUIT PROTECTIVE CONDUCTORS

Circuit protective conductors shall only be: -

1) Single core insulated cables (e.g. installed within cable trunking or separate CPC's for armoured cables).
2) Bare conductor within a multi-core cable (e.g. flat twin and earth).
3) Insulated conductor within a multi-core cable (e.g. armoured cable).
4) Metallic sheath, screen or armouring of a cable.

Under no circumstances shall cable support and containment systems be used as circuit protective conductors, however they shall be equipotential bonded, have adequate electrical continuity characteristics in accordance with their respective standards.

Where cable containment systems are required to satisfy the requirements for protection against impact, this shall be independent of other CPCs provided.

Circuit protective conductors provided as per items 1 to 3 above shall be suitably terminated into the electrical switchgear or equipment to which their corresponding final circuit relates.

Where the armouring of a cable is to be used as a circuit protective conductor the armouring shall be suitably connected to electrical switchgear, gland plates or trunking using a brass compression cable gland, gland earth tag washer / ring and gland lock nut. The gland earth tag washer / ring shall be fixed using a suitable stud and shall also be connected with a copper protective conductor and cable lug to the switchgear or equipment earth terminal.

2E-14-8 HIGH INTEGRITY EARTHING

All sockets outlet final circuits shall be provided with high integrity protective conductor connections: -

1) Ring final circuits shall be provided with ring protective conductors.
2) Radial final circuits shall be provided with dual protective conductors effectively wired in a ring configuration.

All socket outlets (single and twin) shall be provided with dual earth terminals for the separate termination of these.

2E-15 DEFAULT CABLING & CABLE SUPPORT / CONTAINMENT SYSTEMS

The tables below detail the default cabling and support / containment systems that shall be used:-

INTERNAL / EXTERNAL POWER DISTRIBUTION SYSTEMS					
CABLE TYPE & CABLE SUPPORT / CONTAINMENT	HV 11kV	LV TAILS (SEE NOTE 2)	LV TAILS (SEE NOTE 3)	LV MAINS & SUB-MAINS	LV FINAL CIRCUIT
XLPE/SWA multicore armoured cables to BS 6622 / BS 7835 on cable ladder rack	✓	X	X	X	X
XLPE/SWA multicore armoured cables (Aluminium conductors) to BS 6622 / BS 7835 on cable ladder rack	O	X	X	X	X
XLPE/SWA multicore armoured cables to BS 6724 on cable ladder rack	X	O	X	O	X
XLPE/AWA single core armoured cables to BS 6724 on cable ladder rack	X	✓	X	O	X
XLPE/SWA multicore armoured cables to BS 6724 on cable tray	X	O	X	✓	O

XLPE/AWA single core armoured cables to BS 6724 on cable tray	X	O	X	O	X
XLPE split concentric cables to BS 7830-3 on cable tray	X	X	X	O	X
XLPE single core insulated and sheathed cables to BS 7211 on cable tray or in cable trunking	X	X	✓	X	X
6491* single core insulated non-sheathed cables to BS 7211 in metallic cable trunking / metallic conduit / dado with metallic dividers	X	X	X	O	✓
As above however with uPVC conduit replacing metallic conduit	X	X	X	O	O
6242* & 6243* XLPE flat multicore insulated sheathed cables (T&E) to BS 7211/BS 6004 in cable basket / metallic conduit / dado with metallic dividers	X	X	X	X	O
As above however with uPVC conduit replacing metallic conduit	X	X	X	X	O
6242* & 6243* XLPE flat multicore insulated sheathed cables (T&E) to BS 7211/BS 6004 clipped / fixed direct to the building fabric / capping	X	X	X	X	O

Notes:

1) The specification of the Cable Support and Containment Systems is given in a later clause.
2) LV tails that connect a transformer to the main LV panel.
3) LV tails that connect the DNO LV cut-out to the main LV panel.

✓	Default cabling / cable support and containment system, shall be included at Tender and used for installation.
O	May only be used when detailed in a subsequent section of this specification and / or on the drawings.
X	Shall not be used.

BELOW GROUND POWER DISTRIBUTION SYSTEMS					
CABLE TYPE & CABLE SUPPORT / CONTAINMENT	HV 11kV	LV TAILS (NOTE 3)	LV TAILS (NOTE 4)	LV MAINS OR SUB-MAINS	LV FINAL CIRCUIT
XLPE/SWA multicore armoured cables to BS 6622 / BS 7835 buried direct below soft dig/paving in uPVC ducts.	✓	X	X	X	X
XLPE/SWA multicore armoured cables (Aluminium conductors) to BS 6622 / BS 7835 buried direct below soft dig / paving in uPVC ducts.	O	X	X	X	X
XLPE/SWA multicore armoured cables to BS 6724 (suitably approved by the manufacturer for being buried direct in the ground or in ducts) for buried direct below soft dig / paving and in uPVC ducts.	X	O	X	✓	✓
XLPE/SWA multicore armoured cables to BS 5467 buried direct below soft dig / paving and in uPVC ducts.	X	O	X	O	O
XLPE/AWA single core armoured cables to BS 6724 buried direct below soft dig / paving and in uPVC ducts.	X	✓	X	O	X
As above but ducted throughout their length.	O	O	X	O	O

Notes:

1) The specification of the Cable Support and Containment Systems is given in a later clause
2) Earthenware ducts are required for contaminated ground conditions
3) LV tails that connect a transformer to the main LV panel.
4) LV tails that connect the DNO LV cut-out to the main LV panel.
5) XLPE/SWA/PVC multicore armoured cables must run within the ground for their entire length and terminate into switchgear / equipment at the point of entry into the building. Under no circumstances shall they be run within buildings.

LIFE SAFETY, FIRE-FIGHTING & COMMUNICATION SYSTEMS					
CABLE TYPE AND CABLE SUPPORT / CONTAINMENT	FIRE & SMOKE SYSTEMS	GENERAL ELV	VOICE / DATA	SECURITY SYSTEMS	BMS / CONTROLS
XLPE/LSZH enhanced fire resistant multicore sheathed cables to BS 7629-1 (classification PH120) on cable tray / metallic conduit.	✓	X	X	X	X
LSZH single core cables to BS 7211 in metal trunking/conduit or dado with metal dividers.	X	✓	X	O	O
LSZH multicore cables on cable tray/metal conduit or in cable basket/metal conduit.	X	O	X	✓	✓
LSZH backbone fibre and copper (Cat 6 etc.) data cables in cable basket / metallic conduit / dado with metallic dividers.	X	X	✓	O	O
Mineral insulated (MICC) cables shall be manufactured to BS EN 60702.	O	X	X	X	X

Notes:

1) Voice alarms, central battery emergency lighting and other life safety / fire-fighting shall be as fire alarm & EVCS.
2) Disabled persons call system remote combined overdoor lamp / sounder units, remote control panels or when integrated into an EVCS system shall be as fire alarm & EVCS.
3) BMS cabling operating at LV shall be wired as LV final circuits.
4) When buried underground the above wiring systems shall be ducted throughout their entire length.
5) Standard fire resistant cables with PH30 classification shall not be used for fire-fighting / life safety systems.

✓	Default cabling / cable support and containment system, shall be included at Tender and used for installation.
O	May only be used when detailed in a subsequent section of this specification and / or on the drawings.
X	Shall not be used.

2E-16 CABLE SUPPORT & CONTAINMENT SYSTEMS

This section of the specification details the general requirements for cable support and containment systems.

2E-16-1 SPARE CAPACITY WITHIN CABLE SUPPORT & CONTAINMENT SYSTEMS

Cable support and containment systems shall be provided with 30% spare capacity and also an additional 30% allowance shall be added to the calculated safe working load (SWL) for supports, for the provision of future cabling.

Where spare capacity is provided to cable ladder rack and cable tray, this shall be a dedicated section of the system and shall not be above or between installed cabling.

2E-16-2 GENERAL REQUIREMENTS FOR CABLE SUPPORT & CONTAINMENT SYSTEMS

All cable support and containment systems shall be provided as follows: -

1) They must be fully continuous throughout and utilise (where applicable) couplers, joint strips, connectors, brackets, bends, gussets, clips, clamps, risers, angles, tees, cross pieces, reducers, bell mouths, end caps, conduit boxes, adaptable boxes, conduit take-off plates and fixing components etc. from the same manufacturer.
2) Where visible, uPVC systems shall be from the same manufacturer so that variations in colour are avoided. uPVC systems shall not be used within environments that have extreme low or high temperatures.
3) Angles, bends, etc. shall be sized to accommodate the minimum bending radius of the largest cabling to be installed, based on the IET On-Site Guide, IET Guidance Note 1 and cabling manufacturer's recommendations.
4) Where possible cabling shall retain its position through all bends, tees, cross pieces etc. so that cross overs are minimised.
5) All fasteners, screws, bolts, washers, nuts, etc. clips shall be the proprietary type from the same material and manufacturer as the system. These shall not create snags that may cause damage to the cabling.
6) Where covers and partitions are specified, they must be from the same material and manufacturer as the system.
7) Covers / lids and dividers / partitions shall be fully continuous throughout the entire system. All covers / lids and dividers / partitions shall be fixed using the manufacturers proprietary screw fixings and self-tapping screws shall not be used.
8) Covers / lids shall be removable. However, where systems pass through the building fabric the covers / lids shall be cut to project 75mm on either side, remaining fixed when the structure is made good.
9) Printed labels shall be fixed at 10m intervals to denote the use of the system. These shall be external to single use systems and attached to partitions on multiple use systems.
10) Where galvanised steel systems, fittings or accessories are cut, all burrs must be removed and edges suitably painted with cold galvanise zinc-rich paint before erection. All cuts shall be straight and squared off. Any damage to the galvanised shall be similarly treated.
11) Where uPVC systems are cut all burrs must be removed and all cuts shall be straight and squared off where required.
12) Proprietary cutters / croppers shall be used in accordance with the manufacturer's recommendations.
13) Adequate allowance shall be made for thermal expansion and contraction. Expansion as opposed to rigid couplers shall also be used across expansion joints of the building structure. Connections that provide electrical continuity shall also allow for thermal expansion / contraction.
14) Calculations for flexible couplers shall be in accordance with the manufacturer's recommendations.
15) Where systems pass through the building(s) suitable measures shall be undertaken to prevent thermal bridging.
16) Non-metallic systems shall not be installed external to the building(s) e.g. uPVC conduit and fittings.
17) Under no circumstances shall slab fixed cable tie support systems be used.

2E-16-3 METAL CHANNEL CABLE SUPPORT SYSTEMS & OTHER ASSOCIATED SUPPORTS

Metal channel (e.g. Unistrut) and/or manufacturer's proprietary systems shall be used to support all cable management systems. The former shall comply with BS 6946. The latter shall be provided in strict accordance with the manufacturer's recommendations.

These systems shall be provided as follows: -

1) All components shall be formed from steel compliant with BS 1449-1 and shall be hot dip galvanised after manufacture to the requirements of BS EN ISO 1461.
2) Supports shall be provided at intervals to prevent excessive deflection of the cable management systems in strict accordance with the manufacturer's recommendations, subject to a minimum interval of 2000mm.
3) Supports shall be provided within 300mm of couplers, brackets, bends, risers, tees, crosspieces, reducers and all other fittings. Vertical cable management systems shall be fixed to metal channel at 1500mm centres.
4) All cut ends of metal channel shall be painted with cold galvanise zinc-rich paint and be fitted with plastic protective caps.
5) Threaded drop rods (minimum 8mm diameter) shall be secured to brackets or supports by vibration proof lock-nuts. All drop rods shall be straight and vertical. Manufacturers' proprietary angle brackets shall be used where necessary. Any projections shall be shortened to within 10mm and fitted with plastic end caps.
6) Supports shall not be shared between services unless designed specifically with this in mind.
7) Wire suspension systems shall not be used to support primary cable support and containment systems without written authorisation from the Engineer.

2E-16-4 FIRE RESISTANCE OF CABLE SUPPORT & CONTAINMENT SYSTEMS

The fire resistance of cable support and containment systems shall be as follows: -

1) All wiring systems shall be adequately supported to prevent premature collapse under fire conditions in strict accordance with BS 7671. Steel cable support and containment systems are deemed to meet this requirement.

   Under no circumstances shall: -

   a) Non-metallic cable clips or cables ties be used as the sole means of support for cables.

b) Non-metallic cable trunking be used as the sole means of support of the cables therein.

c) Non-metallic cable trunking systems pass through walls, floors or fire compartments.

2) All fixing anchors supporting cables or containment systems shall provide equivalent fire resistance. This precludes the use of plastic plugs or similar – all metal fixing anchors shall be used.

3) Containment, supports and clips/cleats/ties shall have the same fire survival time as any fire-fighting / life safety cabling that is being supported, in strict accordance with BS 8519 and BS 5839.

4) For life safety / fire-fighting cabling they shall be fully continuous throughout from source to destination and shall be formed from steel that has been hot dip galvanised after manufacture to the requirements of BS EN ISO 1461.

5) All components shall be sized and selected with consideration for the reduced tensile strength of steel in a fire situation and shall be in accordance with manufacturers' literature.

6) The cross sectional area of drops rods shall be calculated in accordance with BS 8519 and manufacturers' literature.

7) Cable cleats and supports for cable management systems shall be provided within 750mm of all fire barrier / stopping seals and shall be able to withstand the mechanical load induced by the collapse of wiring systems on the fire side of the seal, to prevent strain and damage to the seal, as required by BS 7671. This is not required if the seal itself is able to provide adequate support under such conditions.

8) Internal fire barriers shall be provided where metallic cable trunking systems pass through walls, floors or fire compartments, these fire barriers shall be rated in accordance with the fire compartmentation. Internal fire barriers shall also be installed within vertical cable trunking systems greater than 5m in height.

9) Fully continuous metallic systems that meet the necessary flame propagation requirements (as specified within their respective standards) shall be utilised as opposed to fire-rated clipping, unless agreed with the Engineer via the Contract Administrator.

2E-16-5 CABLE CLEATS & STRAPPING

Cable cleats and strapping shall comply with BS EN 61914 and BS EN 62275, be suitable for the environment in which they are installed, be adequately sized to suit the cable and installed at intervals recommended by the manufacturer. They shall be provided before and after all direction changes.

Where multiple cables share a route they shall run in an orderly manner and retain their positions through direction changes to minimise cross overs.

Cables up to 40mm diameter shall be supported at spacings detailed within the IET On-Site Guide and IET Guidance Note 1. Larger cables shall be supported at spacings as recommended by the manufacturer.

Cable cleats and strapping shall be provided as follows:

CABLING TYPE / SIZE	CABLE CLEAT / STRAPPING TYPE	FIXING METHOD
Single Core Cables	Aluminium alloy or nylon (LSZH) trefoil cable cleats – suitable for clamping three cables together	Two bolt fixings shall be used for vertical cable runs
Multi-Core Cables up to and including 25mm diameter	Perforated / pre-drilled galvanised steel / aluminium cable strapping (all round banding), where coated (LSZH)	Single bolt fixings to both sides of the cables
Multi-Core Cables greater than 25mm diameter	Aluminium alloy or nylon (LSZH) claw type cable cleats	Two bolt fixings shall be used for vertical cable runs

2E-16-6 CABLE LADDER RACK SYSTEMS

Cable ladder rack systems, including all fittings and components, shall: -

1) Comply with BS EN 61537 and be Extra Heavy-Duty type.

2) Be supported on heavy duty trapeze hangers where space allows.

3) Be formed from steel sheet compliant with BS 1449-1 and hot dip galvanised after manufacture to the requirements of BS EN ISO 1461. Deep galvanised, pre-galvanised, stainless steel, powder coated and non-metallic systems shall not be used unless specified elsewhere within this specification.

4) Have a free base area to Classification Z as detailed within BS EN 61537.

Cabling shall be fixed to the rack using straps, saddles or cleats depending upon the diameter of the cabling to be installed.

2E-16-7 CABLE TRAY SYSTEMS

Cable tray systems, including all fittings and components shall: -

1) Comply with BS EN 61537 and by heavy duty, return flange type (medium duty for fire alarm, EVCS or similar.)

2) Be supported from heavy duty trapeze hangers where space allows

3) Be formed from steel sheet compliant with BS 1449-1 and be hot dip galvanised after manufacture to the requirements of BS EN ISO 1461. Deep galvanised, pre-galvanised, stainless steel, powder coated and non-metallic systems shall not be used unless specified elsewhere within this specification.

4) Be perforated to Classification D as detailed within BS EN 61537.

Cabling shall be fixed to the tray using straps, saddles or cleats depending upon the diameter of the cabling to be installed.

5) Conduit take-off plates, shall be utilised to connect conduit to the system.

The cable tray and conduit shall form a fully continuous system throughout from source to destination terminations.

2E-16-8 CABLE BASKET / WIRE MESH TRAY SYSTEMS

Cable basket / wire mesh tray systems shall comply with BS EN 61537 and shall be supported by metal channel and/or manufacturer's proprietary components e.g. cantilever arms, central hangers, suspension hangers, etc.

Where the term cable basket system is used within this specification it also refers to wire mesh cable tray systems.

Cable basket / wire mesh tray systems, including all fittings and components, shall: -

1) Comply with BS EN 61537
2) Be formed from steel wire welded into a mesh pattern and electro-galvanised after manufacture (electroplated with zinc) to the requirements of BS EN 12329 / BS EN ISO 2081. Deep galvanised, hot dip galvanised, stainless steel, powder coated and non-metallic systems shall not be used unless specified elsewhere within this specification.
3) Include bends, risers, tees, cross pieces etc. that are cut / formed on site using proprietary cutters / croppers in strict accordance with the manufacturer's recommendations.
4) Include conduit take-off plates to connect conduit to the system, the basket and conduit forming a fully continuous wiring channel from cable source to destination terminations.

   Cabling shall be fixed to the basket using cable straps and ties as required.
5) Under no circumstances shall systems be used to support armoured cables or be installed external to the building(s).

2E-16-9 CABLE TRUNKING SYSTEMS

GENERAL REQUIREMENTS

Cable trunking systems shall: -

1) Be supported at spacings as detailed in the IET On-Site Guide, Guidance Note 1 and manufacturers' recommendations.
2) Be sized as detailed within the IET On-Site Guide and IET Guidance Note 1 – Selection & Erection.
3) Utilise proprietary multi-compartment bends, tees and cross overs to maintain full segregation throughout.
4) Include cable retainers at intervals of 600mm where lids are to the bottom or side of the system.
5) Include pin racks on vertical runs at 2m intervals.
6) Provide at least the degree of protection of IP4X or IPXXD to BS EN 60529 and require the use of a tool or deliberate action to secure or remove the trunking lid.
7) Not be installed external to the building(s).

METALLIC CABLE TRUNKING SYSTEMS

This section of the specification does not apply to metallic dado trunking systems.

Metallic cable trunking systems, including all fittings and accessories, shall: -

1) Comply with BS EN 50085
2) Be formed from steel sheet and shall be pre-galvanised before manufacture to the requirements of BS EN 10346. Deep galvanised, hot dip galvanised, stainless steel, powder coated and non-metallic systems shall not be used unless specified elsewhere within this specification.
3) Include circular conduit boxes or couplings, brass male bushes and serrated washers to connect conduit to the system, the trunking and conduit forming a fully continuous containment system from cable source to destination terminations.
4) Not contain conduits passing through compartments to reach the destination compartment
5) Not be used as a circuit protective conductor (CPC) for final circuit wiring, (although shall satisfy the requirements of a CPC where used to provide protection against impact).

uPVC CABLE TRUNKING SYSTEMS

This section of the specification does not apply to non-metallic dado trunking systems.

Non-metallic cable trunking systems, including all fittings and components, shall: -

1) Comply with BS EN 50085 and BS 4678.
2) Be fixed and supported in accordance with manufacturers' recommendation
3) Be heavy gauge white uPVC with the following properties: -
   a) Corrosion resistance.
   b) High impact resistance.
   c) Non-flame propagating.
   d) Self-extinguishing.
4) Not be used unless specified elsewhere within this specification and never in conjunction with metal conduit.
5) Include manufacturer's proprietary couplers, bends, tees, cross overs, end caps etc. and NOT trunking lengths cut on site to form components.
6) Include conduit boxes or couplings / male bushes to connect conduit to the system, the trunking and conduit forming a fully continuous containment system to IP4X or IPXXD from cable source to destination terminations.

2E-16-10 DADO, SKIRTING & BENCH TRUNKING SYSTEMS

GENERAL REQUIREMENTS

1) Where applicable the general requirements for cable trunking systems shall also apply.
2) Systems shall comply with BS EN 50085 and BS 4678.
3) Systems shall be fixed and supported in accordance with manufacturer's recommendations.

4) Systems shall be suitable for all the types of cabling to be installed, including the category of data cabling (e.g. Cat 6A) and shall not impair the performance of the cabling.
5) Systems shall have a minimum of two compartments and it shall be possible to install manufacturer's proprietary 45mm deep back boxes. (35mm in bench trunking.).
6) Signalling and data cabling shall be installed within a separate compartment to LV wiring and steel screening dividers having a minimum thickness of 1.5mm shall be provided.
7) Dado and skirting trunking shall include cable retainers at intervals of 600mm.
8) Dado and skirting trunking systems shall generally include vertical sections linking to primary containment in the ceiling void. However, where conduit drops are used, these shall be concealed (flush) and connect to the trunking via recessed circular conduit boxes located immediately behind the destination compartment. The number of conduit drops shall be such that 100% spare capacity remains once the specified cables have been installed.

METALLIC DADO, SKIRTING & BENCH TRUNKING SYSTEMS

Metallic dado, skirting and bench trunking systems, including all fittings and components, shall: -

1) Be formed from steel sheet and shall be pre-galvanised before manufacture to the requirements of BS EN 10346 (unless Aluminium systems are specified elsewhere in this specification).
2) Have a white powder coat finish to RAL 9010 or RAL 9003.
3) Include proprietary components selected to suit either dado trunking, skirting or bench trunking systems.

uPVC DADO, SKIRTING & BENCH TRUNKING SYSTEMS

Non-metallic dado, skirting and bench trunking systems shall comply with the requirement given earlier for general uPVC trunking systems and shall include proprietary components selected to suit dado trunking, skirting trunking or bench trunking.

2E-16-11 CONDUIT & FITTINGS

GENERAL REQUIREMENTS

1) Conduit sizes and support spacings shall be as detailed within the IET On-Site Guide and IET Guidance Note 1.
2) Conduit systems shall include spare capacity so that 30% more cable/s of a similar size and type can be installed.
3) Conduits shall be dedicated to a single system/service.
4) The conduit system shall include sufficient accessible draw points to facilitate re-wiring or installation of additional cables in the future. Conduit behind inaccessible ceilings shall be configured as a loop-in system.
5) Conduits less than 20mm diameter shall not be used.
6) Surface conduits shall also be supported within 300mm of floors, ceilings, boxes and at each side of every bend.
7) Fixing of conduits shall be as follows: -
   a) Wall chases or floor screed – Crampets or ordinary saddles.
   b) Ceiling, roof or floor voids – Spacer bar saddles.
   c) Surface mounted on ceiling – Spacer bar saddles.
   d) Surface mounted on walls – Distance saddles.
8) Bends, elbows, tees or u-bends shall not be used. Bends for metallic conduit shall be formed on a proprietary bending machine. uPVC bends shall be formed using a suitably sized spring and by the application of heat.
9) Where conduits are installed for use by third parties, draw wires shall be provided to facilitate the installation of cabling.
10) All conduit boxes and adaptable boxes shall be filled with moisture repelling compound or have drains where there is a risk of condensation and within plantrooms / external locations all box lids shall be fitted with gaskets. In damp environments conduits shall enter wiring accessories from the bottom to prevent the build-up of moisture.
11) Chasing of walls must be carried out in accordance with the Structural Engineer's recommendations. Horizontal chases exceeding 500mm in length or Back to back chasing is not permitted.
12) Conduit shall not be installed within floor screeds or cast-in unless detailed elsewhere within this specification.

METALLIC CONDUIT & FITTINGS

Metallic cable conduit shall comply with BS EN 61386 with resistance to corrosion classification of 'Class 4' and shall: -

1) Comply with BS EN 61386 and have resistance to corrosion classification 'Class 4'.
2) Be formed from heavy gauge steel and hot dip galvanised after manufacture to the requirements of BS EN ISO 1461.
3) Connect to accessory boxes on a concealed installation with couplings, brass male bushes and serrated washers. For surfaces installation, flanged couplers with lead washers shall be used.
4) Be threaded to butt closely together in couplings and sockets.
5) Avoid exposed threads, except at running couplings, where they shall be cleaned, primed and painted with cold galvanise zinc-rich paint after installation.
6) NOT include pressed steel accessories and all conduit boxes, adaptor boxes and accessories shall be formed from malleable cast iron.
7) NOT be used as a circuit protective conductor (CPC) for final circuit wiring, (although shall satisfy the requirements for a CPC where providing protection against impact).
8) NOT include push-fit / quick-fit conduits – all conduit joints shall be threaded.

uPVC CONDUIT & FITTINGS

uPVC conduit and fittings shall be provided as follows: -

1) It shall comply with BS EN 61386 and shall be heavy gauge white or black uPVC and have the following properties: -

a) Corrosion resistance.
b) High impact resistance.
c) Non-flame propagating.
d) Self-extinguishing.

2) It shall not be used unless specified elsewhere within this specification.
3) Connections to accessory boxes shall be with couplings / male bushes and care must be taken to ensure that all joints are glued correctly.
4) In extremely cold weather the cable conduit shall be slightly warmed before use in accordance with the manufacturer's recommendations.
5) Proprietary steel or brass insert clips shall be fitted where luminaires are suspended from circular boxes to ensure that the weight of the luminaries is carried by the structure rather than the conduit box.

FLEXIBLE & PLIABLE CONDUIT

Flexible and pliable conduit shall comply with BS EN 61386 and be provided as follows: -

1) Metallic flexible conduit shall be formed from helical coiled steel with an overall waterproof sheath.
2) Non-metallic flexible conduit shall be heavy duty, corrosion resistant and non-flame propagating.
3) Non-metallic flexible conduit shall not be used unless specified elsewhere within this specification.
4) Generally it shall be used for the final connection to the following: -
   a) Equipment that is required for ducting, pipework etc. such as control sensors, motorised valves etc.
   b) Equipment subject to vibration e.g. motors, pumps etc.
   c) Equipment where movement may be required for maintenance / access.
5) It shall be connected to conduit boxes and equipment termination boxes using compression glands.
6) The length of flexible conduit shall not exceed 1000mm.
7) Non-metallic flexible conduit shall not be used in environments where heat may be detrimental to its material properties or where additional mechanical protection may be required.

2E-16-12 BELOW GROUND CABLING

DEPTH REQUIREMENTS

Cabling and ducting shall be buried at the following depths unless detailed elsewhere within this specification and/or drawings. These depths are from final finished ground level and care shall be taken to ensure that this is checked prior to installation.

CABLING TYPE / SIZE	MINIMUM DEPTH OF LAYING
High Voltage – 11kV	800mm
Low Voltage	600mm
Communications	450mm
BT Openreach	450mm

All buried cabling and ducting shall also be provided in accordance with NJUG National Joint Utilities Group guidelines.

EXCAVATION

Excavation shall be provided as follows: -

1) All trenches for cables must be straight between points where there are no changes in direction. Trenches must not have step changes in level but be gradual where needed.
2) The bottom of trenches must be smooth and free from stones.
3) Where excavations reveal unsuitable ground containing rocks or ashes with a predominant or unusual chemical content, or any conditions liable to affect the life or performance of the cable, it must be brought to the attention of the Engineer.
4) Means are to be proposed and agreed via the Contract Administrator to minimise the effects on works traffic due to required excavations.
5) Where trench depths exceed 1.2m, trench boarding must be provided.
6) Where other services are encountered, during excavation, adequate support and protection must be provided particularly when digging, backfilling and cable pulling.
7) In conditions which may result in trenches flooding, the provision of pumping equipment must be allowed for. The method of disposing of pumped liquid must be approved.

CABLING IN TRENCHES

Cabling in trenches shall be provided as follows: -

1) Cables must be laid in the trenches using roller, or other approved devices, to prevent dragging, and consequent abrasion.
2) A minimum horizontal space of 300mm must exist between adjacent cables of differing service unless otherwise specified.
3) Cables must be laid on a bed of not less than 100mm of soft sand and covered with a further 150mm of hand compacted soft sand. Sifted soil may be used as an alternative, subject to approval via the Contract Administrator.
4) Earthenware or Stokbord, concrete/polypropylene interlocking cover tiles must be laid on the sand/earth directly above and 75mm from the cables, to provide covering at least 50mm wider than the space occupied by the installed cables. The cable tiles must be covered with 75mm of hand compacted, excavated material free from stones or other sharp objects.

5) Backfilling must be compacted in layers not deeper than 250mm and the final surface reinstated so that after settlement it must be consistent with the surrounding surface level. Surplus material must be disposed of.

6) The excavation must be inspected 12 weeks after the ground finish has been completed, and any hollows must be filled using approved materials and methods.

7) Plastic cable marking tape shall be laid at a depth of 200mm, using multiple runs as necessary to cover the width occupied by the cables. The tape must be yellow with black text "CAUTION ELECTRIC CABLE BELOW" printed along its length.

8) Where cables are laid along routes on which the ground will not immediately be made up to its final level, the routes must be marked by temporary notices indicating the danger present, over the total length of the route involved.

9) All temporary markers must be of a durable weatherproof nature and be approved.

10) The ground finish on completion must be similar to that in the immediate area.

CABLE DUCTS

Cable ducts shall be provided as follows: -

1) They must be of reputable manufacture, made from uPVC unless otherwise specified and of minimum 150mm diameter.

2) Earthenware cable ducts shall be used where there are contaminated ground conditions.

3) The ducts must be laid and bedded in such a way as to prevent damage from rocks etc.

4) Where cables pass under areas of hard standing or through foundations etc, they must be enclosed in pipe ducts or sleeves. Protection of ducts running under roads etc. shall be by concrete haunchings or other approved suitable means.

5) The provision of cable draw pits at points of route deviation, and the transition from open ground to ducts must be agreed via the Contract Administrator. Draw pits shall be suitably sized taking into account the number, type and size of cables to be installed. Deep draw pits must be of a sufficient size to allow access to the lowest ducts.

6) High voltage cables must be run in separate ducts to any low voltage cables.

7) Where new ducts clusters are being installed, 25% of the total ways available must be spare, with a minimum of two, unless single way ducts are specified. All spare ducts must be sealed against ingress of water and or vermin, with proprietary products approved by both the duct and cable manufacturer.

8) Cable ducts shall be laid at a gradient away from building entries.

9) A nylon draw cord must be left in each spare duct for its entire length and in any used ducts with spare capacity.

10) Before cables are drawn into any ducts, new or existing, the ducts must be swabbed to ensure that it is free of debris.

11) Before cables are drawn into ducts the entry points must be protected by temporary bellmouths to ensure that there is no damage to the outer serving of the cable during the pulling operation.

12) Following the drawings in of the cable, the duct must be sealed using materials or devices authorised to provide protection against water, vermin, passage of gases, fire etc. These shall be a proprietary product from a specialist manufacturer such as CSD Sealing Systems Ltd.

2E-16-13 SURFACE / EXPOSED CABLE SUPPORT & CONTAINMENT SYSTEMS

Where surface/exposed primary (e.g. cable ladder, tray and trunking) and secondary (e.g. final conduit runs) containment is acceptable, the location and routing of these systems must be agreed with the Engineer/Contract Administrator prior to installation.

2E-16-14 DESIGN REQUIREMENTS

The Contractor shall assume design responsibility for those aspects of the Electrical installation detailed in Section 1B.

2E-17 CABLING & WIRING SYSTEMS

This section of the specification details the general requirements for cabling and wiring systems.

2E-17-1 DEFINITION OF TERMS

Key definitions applicable to this section of the specification:

ABBREVIATION / MEANING			
AWA	Aluminium wire armour	CSP	Chlorosulphonated polyethylene
CY	Multi-core insulated and sheathed PVC or LSOH cables with internal copper wire braiding	EPR	Ethylene propylene rubber
GSWB	Galvanised steel wire braid	HOFR	Heat oil resistant, flame retardant
LSF	Low smoke and fume	LSOH LSZH OHLS	Low smoke zero halogen – Emissions of hydrogen chloride gas < 0.5%
MI	Mineral insulated	PILC	Paper insulated lead covered cables
PVC	Polyvinyl chloride	SWA	Steel wire armour
SY	Multi-core insulated and sheathed PVC or LSOH cables with external steel wire braiding and outer transparent sheathing	TRS	Tough rubber sheath
XLPE	Cross-linked polyethylene	YY	Multi-core insulated and sheathed PVC or LSOH cables

2E-17-2 GENERAL REQUIREMENTS

All fixed wiring power, control and communication cables shall: -

1) Meet the flame propagation requirements of BS EN 60332-1-2 and the BS EN 60332-3 series (where possible).
2) Satisfy the requirements of the Construction Products Regulation in respect of their reaction to fire by being provided in strict accordance with their respective European and British.
3) Be LSZH (LSOH, OHLS) with emissions of hydrogen chloride gas < 0.5%. (Note: General 'LSF' cabling does not comply).

2E-17-3 MANUFACTURERS' IDENTIFICATION OF CABLES

All cables shall have manufacturers' identification, date of manufacture and a specification reference / standard number printed on the sheath to enable testing, if necessary, and traceability.

2E-17-4 GENERAL LV INSTALLATION CABLES

CABLE TYPE	CABLE SPECIFICATION
Single core armoured cables	694*B XLPE/AWA/LSZH single core armoured cables shall be manufactured to BS 6724.
Multicore armoured cables	694*B XLPE/SWA/LSZH multicore armoured cables shall be manufactured to BS 6724.
Split concentric cables	XLPE/LSZH split concentric cables shall be manufactured to BS 7870-3.
Single core insulated non-sheathed cables	6491B LSZH single core insulated non-sheathed cables shall be manufactured to BS 7211.
Single core insulated sheathed cables	6181B XLPE/LSZH single core insulated sheathed cables shall be manufactured to BS 7211.
Flat insulated sheathed cables – Flat twin and earth cables	6242B & 6243B XLPE/LSZH flat multicore insulated sheathed cables shall be manufactured to BS 7211.
Mineral insulated (MICC) cables	Mineral insulated (MICC) cables shall be manufactured to BS EN 60702.
Flexible plastic cables and cords	LSZH/LSZH flexible plastic cables shall be manufactured to BS EN 50525.
Flexible rubber cables and cords	EPR/HOFR flexible rubber cables and cords shall be manufactured to BS EN 50525. EPR or VIR/TRS flexible rubber cables and cords shall be manufactured to BS EN 50525.
* Denotes the number of cores in a multicore armoured cable and can be 2, 3, 4 or 5 cores.	

2E-17-5 INSTALLATION & USE OF 'NON-STANDARD' CABLES OR CABLES TO BS 8436

Cables for low voltage installation shall be selected from table above. Under no circumstances shall the following cables be used.

1) SY cables – LSZH/GSWB/LSZH or PVC/GSWB/PVC – Steel braided, translucent sheath, insulated flexible conductors.
2) YY cables – LSZH/LSZH or PVC/PVC – Usually grey sheath, insulated flexible conductors.
3) CY cables – LSZH/LSZH or PVC/PVC – Tinned copper wire braid, usually grey sheath, insulated flexible conductors.

Where, S = steel braid, Y = LSZH or PVC, C = copper braid.

SY, CY and YY cables that comply with relevant parts of BS EN 50525 and have LSZH sheaths may be used for ELV controls wiring. However, they must not pass from one fire segregated compartment to another unless they comply with the flame propagation requirements of BS EN 60332-1-2 and the BS EN 60332-3 series (where possible).

2E-17-6 CABLE GLANDS

Cable glands shall be manufactured to BS 6121 and BS EN 62444, and shall be provided as detailed below: -

TECHNICAL DETAILS	CABLE TYPE		
	STEEL WIRE ARMOUR (SWA) CABLES	ALUMINIUM WIRE ARMOUR (AWA) CABLES	WIRE BRAID ARMOUR (GSWB) CY & SY CABLES
Gland type	CW Brass Gland	CW Aluminium Gland	RXT Brass Gland
Ingress protection	IP66 to BS EN 60529	IP66 to BS EN 60529	IP66 to BS EN 60529
Temperature	-20°C to 90°C	-20°C to 90°C	-20°C to 90°C
Gland material	Brass to BS 2874	Aluminium	Brass to BS 2874
Seal material	LSZH silicone	LSZH silicone	LSZH silicone
Shroud material	LSZH silicone	LSZH silicone	LSZH silicone
Shroud colour	Black	Black	Black
Notes: 1) To achieve the IP66 rating a sealing washer must be provided between the gland and the housing.			

TECHNICAL DETAILS	CABLE TYPE		
	STEEL WIRE ARMOUR (SWA) CABLES	ALUMINIUM WIRE ARMOUR (AWA) CABLES	WIRE BRAID ARMOUR (GSWB) CY & SY CABLES
2) An earth tag washer / ring must be provided.			

Glands for single core AWA cables shall be installed into non-ferromagnetic metal gland plates (e.g. aluminium / brass).

Cable glands for life safety / fire-fighting cabling shall have the same fire survival time as the life safety / fire-fighting cabling being installed. The cable gland shroud shall be the same colour as the life safety / fire-fighting cabling to be installed.

Cable glands for hazardous areas (ATEX and explosive atmospheres) shall be suitably certified for use in that environment.

In other instances, cable glands may be manufactured from durable nylon, however they must provide adequate mechanical protection and be suitably IP rated to suit the environment in which they are installed.

All non-metallic parts to cable glands shall be low smoke zero halogen (LSZH) and shall not be low smoke and fume (LSF).

2E-17-7 TECHNICAL SUBMISSIONS

Prior to installation on-site the Contractor shall provide technical submissions for all cabling and wiring systems to be installed.

The time allowed for comment shall be as detailed within section 1B of this specification.

2E-18 INSTALLATION OF FLAT INSULATED SHEATHED CABLES (FLAT TWIN & EARTH)

This section of the specification details the installation requirements for 6242B and 6243B XLPE/LSZH flat insulated sheathed cables (twin / triple and earth) manufactured to BS 7211 and for 6242Y and 6243Y XLPE/PVC to BS 6004. These clauses only apply if twin and earth is the specified wiring system.

GENERAL REQUIREMENTS

1) Twin and earth cabling shall be installed within cable basket and conduit throughout its length.
2) If specifically allowed elsewhere within this specification it may be clipped direct.
3) Regardless of the above installation methods:
   a) Cables that are concealed within walls or partitions at a depth of less than 50mm shall be installed within the prescribed zones detailed within BS 7671 and additional protection shall be provided by RCD's
   b) Cables installed in a wall or partition with an internal construction which includes metallic parts other than just metallic fixings (e.g. metal stud partitions) shall have additional protection provided by RCD's
4) Requirements to provide adequate supports to prevent premature collapse under fire conditions as detailed earlier in this section apply equally to twin and earth cabling.
5) The exposed circuit protective conductor core shall be provided with green and yellow sleeving to the point of termination which shall be secured in place by means of insulation tape or heat shrink.
6) Under no circumstances shall twin and earth cabling be laid on suspended ceilings.

CABLE BASKET & CONDUIT INSTALLATION

The basket and conduit installation given earlier in this section fully applies when it is used for twin and earth cabling.

CLIPPED / FIXED DIRECT INSTALLATION

When twin and earth cabling is clipped / fixed directly to the building fabric the following shall apply: -

1) It shall be recessed within the building fabric and shall be adequately supported along its entire length.
2) Proprietary LSZH cable clips shall be used.
3) Clips shall be provided at no less than 250mm spacing's when horizontal and 400mm spacing's when vertical. Cable clips shall also be provided where the cable bends.
4) Under no circumstances shall joists be notched or sawn. Where there are concerns over structural integrity this shall be brought to the attention of the Engineer and Contract Administrator.
5) Where a minimum installation depth of 50mm cannot be achieved in joists / battens in ceilings and floors, twin and earth cables must be installed within metallic conduit and must be equipotential bonded.
6) All holes in boxes and accessories shall have suitably sized rubber grommets.
7) The outer sheath of twin and earth cabling must project at least 10mm into boxes and accessories.
8) Cables shall run in continuous lengths between wiring points i.e. without joints or junction boxes.
9) When installed within partition walls cables shall be drawn through suitably sized holes in noggins / vertical studs at the centre line of the partition construction.

2E-19 WIRING ACCESSORIES

Wiring accessories shall comply with BS 8300, The Building Regulations – Approved Document M and BS 7671. They shall be IP rated to suit their environment (or maintain IP rating of equipment) and installed in accordance with manufacturers' recommendations.

All flush accessories shall be from a common manufacturer and range to achieve a neat and homogenous appearance. This includes audio visual and voice/data system outlets.

Under no circumstances shall screw less, clip-on accessories be used.

A difference of 30 points in Light Reflectance Value (LRV) shall be provided between wiring accessories and their surroundings.

Unless otherwise specified in the system specific sections, wiring accessories shall be dark grey with white rockers on light coloured surrounds.

The appearance and colour shall be agreed in writing with the Engineer, Architect and Contract Administrator prior to installation.

2E-19-1 TECHNICAL SUBMISSIONS

Prior to installation on-site the Contractor shall provide technical submissions for the following: -

1) A schedule (including images) and technical specifications for all wiring accessories, along with a physical sample of each wiring accessory type.
2) A physical sample of coloured surrounds / side wings (where called upon elsewhere within this specification).

The time allowed for comment by the Engineer shall be as detailed within section 1B of this specification.

2E-20 POSITIONING & MOUNTING HEIGHTS OF ELECTRICAL SERVICES

Electrical services shall be positioned in accordance with relevant British Standards and in particular BS 8300, and The Building Regulations – Approved Documents M & P.

Compliance with these standards allows a range of mounting heights as shown in the table below, with the preferred height shown underlined. These shall be used as the default heights unless indicated otherwise in system specific sections of this document and the associated drawings, or on architect's room elevation drawings.

All outlet locations shall be marked up on site and agreed with the Engineer/Architect prior to installation.

EQUIPMENT / ACCESSORY	MOUNTING HEIGHT AFFL TO THE CENTRE	NOTES
Metering:		
Metering	1200 –1400mm	Readings shall be visible to a person standing or sitting. Prepay meters shall be protected to prevent child tamper.
Lighting:		
Lighting switches and controls	1000 – 1200mm	Horizontally aligned with door handles (TBC).
Lighting switches for public use	900 – 1100mm	Horizontally aligned with door handles (TBC).
Lighting pull cords	1000 – 1200mm	Bottom of the pull cord to be located within this range.
Outlets:		
13A socket or data/voice outlets	450 – 1000mm	Or 150mm above desks/worktops (1050mm max)
Shaver socket outlets	800 – 1000mm	Generally, to one side of a mirror.
Bathrooms for wheelchair uses:		
Switches, sockets, stopcocks and controls	700 – 1000mm	Outlets switches and controls shall be a minimum of 300mm from the corners of the room.
General:		
Isolators, switches and controls	1200mm	Dependent on equipment being supplied.
Domestic consumer units	1350 – 1450mm	To centre of isolator/lowest row of protective devices
Cooker control units	750 – 1200mm	At least 100mm from the edge of the cooker hob.
Clocks	2500mm	Or 150mm from the top of the clock to the ceiling
Fire alarm:		
Fire alarm control panels	1200mm	At main entrance agreed central control point.
Manual call points	1200mm	
Visual alarm devices	Not less than 2100mm	Dependent on manufacturer to achieve compliance.
Optical beam detectors	Not less than 2700mm	
Door entry and access control:		
Proximity reader (card / fob) / release push button / activation pad	900 – 1100mm	Preferably adjacent to the door handle and within 200mm of the door frame.
Swipe insertion-type reader	900 – 1000mm	As above.
Green emergency break glass	1000 – 1200mm	To align with other door access devices.
Emergency assistance alarm systems:		
Emergency assistance pull cord	800 – 1000mm & 100mm	Two red bangles, one at each of the heights given.

EQUIPMENT / ACCESSORY	MOUNTING HEIGHT AFFL TO THE CENTRE	NOTES
Emergency assistance reset button	800 – 1000mm	
Emergency voice communication systems (EVCS) – Disabled refuge systems:		
Master station / control panels	1200mm	Generally adjacent to the fire alarm panel
Outstations	1200mm	
Fire-fighting:		
Fire-fighters switches	1200mm when internal 2750mm when external	Adjacent to fire alarm panel (where internal)
Intruder alarm:		
Intruder alarm control panels and keypads	1200mm	
Electric vehicle charging systems:		
Socket outlets	750 – 1200mm	
Equipment with visual displays, however no controls, switches or pushbuttons:		
Equipment with visual displays	1200 – 1400mm	
Emergency lighting:		
Emergency lighting luminaires	Not less than 2000mm	
Mechanical services controls:		
Heating and ventilation controls	750 – 1000mm	See also Controls section of this specification.

Notes:

1) Outlets and controls shall be a minimum of 350mm from the corners of a room or area, unless otherwise stated.
2) Electrical equipment / accessories of the same type shall be mounted at the same height throughout the building.
3) The mounting heights for fire alarm and EVCS control panels may be increased based on agreement of the personnel responsible for their management if ratified by the local fire authority / building control.

2E-21 ENGINEERS & ARCHITECTS DRAWINGS

All visible elements of the electrical installation shall be set out as detailed on agreed Architect's/Specialist's elevation drawings. In the absence of these the Contractor shall produce elevation drawings for approval.

Any discrepancies between the elevation drawings and this specification (e.g. mounting heights) this shall be brought to the attention of the Contract Administrator for further guidance/instruction.

The symbols used on the Engineer's drawings are not to scale so allowance shall be made for locating any item within a 1000mm radius of the indicated position at no further cost.

The above submissions and liaison shall take place in a timely manner to suit the construction programme.

2E-22 FIXINGS TO THE BUILDING STRUCTURE / FABRIC

These shall comply with BS 5080, BS 8000, BS 8539, BS 7671 and all supporting IET documentation.

Fixings shall not compromise the structural, acoustic or fire performance of the building. The following fixing methods are likely to be acceptable: -

FIXING APPLICATIONS / BASE MATERIALS	FIXING TYPE
Building structural steelwork	Clamp-on bracketry e.g. flange clamps
Heavy loads to concrete, blockwork and brickwork	Proprietary fixings such as metallic expansion anchors / bolts
Light loads to concrete, blockwork and brickwork	Proprietary fixings such as metallic expansion anchors/bolts, plugs/screws
Plasterboard	Wooden patresses, noggins and battens with wood screws Proprietary fixings such as expansion plugs / screws, self-drive fixings, plastic toggles, spring toggles, etc.
Wood	Screws

The following fixing methods are not acceptable: -

FIXING APPLICATIONS / BASE MATERIALS	FIXING TYPE
Building structural steelwork	Cutting and drilling of the buildings structural steelwork

Building structural steelwork	Welding to the buildings structural steelwork
Blockwork and brickwork	Fixings to blockwork and brickwork in the mortar joint.

All fixing anchors supporting cables shall provide fire resistance so as to prevent their premature collapse during a fire as detailed earlier.

2E-23 ELECTRICAL EQUIPMENT AND SPECIALISTS SCHEDULES

The appendices to subsequent sections of this specification include Electrical Equipment & Specialists Schedules which detail specialists, manufacturers, product ranges and materials (where applicable) that shall be included in the tender submission.

Where possible a number of suppliers have been provided for items of equipment to give a reasonable choice to the Contractor.

Where more than one specialist, manufacturer, product range or material is specified, this may be due to: -

1) Alternatives not being available which are equivalent.
2) To match existing site installations or site standards.
3) Specification by the Employer.

Reference shall be made to Section 1B with regards to the proposal of alternative equipment.

Section Two (F)

Electrical Inspection and Testing

Contents

2F-1 GENERAL DESCRIPTION

This section details the inspection and testing requirements for new installation work (including alterations and additions to existing installations) and the replacement of electrical switchgear).

These requirements shall be followed unless there are explicit instructions to the contrary in a subsequent section of this specification (e.g. site specific witnessing requirements). Where such instructions are unclear or only inferred, written confirmation from the Engineer shall be obtained prior to submission of tender costs to clarify the requirements, and in the absence of such the more onerous requirements shall be included.

Throughout this section references are made to requirements and recommendations detailed within several statutory and non-statutory standards / documents. It shall be noted the information presented herein is in no way intended to replace the detailed information provided within these documents which must be fully adhered to where applicable.

This section does not cover the testing of specialist systems e.g. lighting controls, fire-fighting and life safety systems, security systems, communication systems etc. Requirements for these systems are detailed in the relevant section dealing with that system.

2F-2 DEFINITIONS

Refer to Section 2E / Section 1B of this specification and Part 2 of BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations for further details regarding definitions, symbols and abbreviations.

Additional definitions specifically associated with inspection and testing are as follows:-

Departure – Deliberate decision not to comply fully with the requirements of BS 7671 for which the designer must declare that the resultant degree of safety is not less than that achievable by full compliance.

EIC – Electrical Installation Certificate.

EICR – Electrical Installation Condition Report (formerly known as Periodic Inspection Report).

Inspector – Refers to the person(s) employed by the Contractor responsible for undertaking the inspection and testing works.

Qualified Supervisor – Refers to the person employed by the Contractor responsible for overseeing the inspection and testing works. They shall also be responsible for the review and verification of the certification and/or reports.

The Inspector may also be the Qualified Supervisor.

Non-compliance – A non-conformity that may give rise to danger.

New Installation Works – Refers to new installation work, and for alterations or additions to existing installations where new circuits have been introduced. This includes the replacement of existing electrical switchgear such as low voltage switch panels, MCCB panel boards, MCB distribution boards, consumer units etc.

Where referenced within this documentation Electrical Installation Condition Reports (EICR) shall mean the same as Periodic Inspection Reports (PIR), which is an obsolete term still commonly used.

2F-3 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS AND DOCUMENTS	
BS 7671	IET Wiring Regulations – Requirements for Electrical Installations – Part 6 Inspection and Testing
IET On-Site Guide – BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations – Section 9 Inspection and testing and Section 10 Guidance on initial testing of installations and Section 11 Operation of RCDs	
IET Guidance Note 3 – Inspection & Testing	
BS 5458	Specification for safety requirements for indicating and recording electrical measuring instruments and their accessories (Superseded / withdrawn and replaced by BS EN 61010, this is the standard to which some older instruments that are still in use should have been manufactured)
BS EN 61010	Safety requirements for electrical equipment for measurement, control, and laboratory use
BS EN 61243	Live working – Voltage detectors
BS EN 61557	Electrical safety equipment in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. – Equipment for testing; measuring or monitoring of protective measures
HSE (Health and Safety Executive) – Guidance Note GS38 – Electrical test equipment for use on low voltage electrical systems	
HSE (Health and Safety Executive) – The Electricity at Work Regulations – Guidance on regulations – HSR25	
HSE (Health and Safety Executive) – Electricity at Work – Safe working practices – HSG85	
Electrical Safety First – Best Practice Guide 2 – Guidance on the management of electrical safety and safe isolation procedures for low voltage installations	
Electrical Safety First – Best Practice Guide 7 – Test instruments for electrical installations: Accuracy and consistency	
NICEIC / ECA / ELECSA – Inspection, Testing and Certification including Periodic Reporting – Practical advice and guidance	
All standards, guidance and statutory regulations detailed within Section 2E-3	

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

2F-4 STATUTORY REGULATIONS AND BS 7671 IET WIRING REGULATIONS

All persons undertaking the inspection and testing of electrical installations shall comply with relevant requirements of The Electricity at Work Regulations, where particular attention shall be paid to Regulation 12 “Means for cutting off the supply and for isolation’ and Regulation 14 ‘Work on or near live conductors’ and the guidance provided by the HSE (Health and Safety Executive) – Memorandum of guidance on the Electricity at Work Regulations 1989 – Guidance on regulations – HSR25.

The electrical inspection and testing shall be undertaken in accordance with the latest version of BS 7671 IET Wiring Regulations – Requirements for Electrical Installations and all supporting IET documentation.

The Contractor shall be fully responsible for the inspection and testing of the electrical installation, which shall only be undertaken by one or more skilled persons (electrically) as defined in BS 7671 that are competent to undertake the works in such an installation.

Precautions shall be taken to ensure that the inspection and testing of the electrical installation shall not cause danger to persons or livestock and shall not cause damage to property and equipment even if a circuit is defective.

2F-5 ELECTRICAL CONTRACTING CERTIFICATION SCHEMES

The Contractor shall undertake all inspection and testing in accordance with industry best practice and must be registered with an appropriate certification scheme as detailed in Section 2E of this specification. The inspection and testing of the electrical installation shall only be undertaken by persons who meet the minimum requirements to undertake the works as defined by their Electrical Contracting Certification Scheme.

This shall be the National Inspection Council for Electrical Installation Contracting (NICEIC) / ELECSA – Platinum Promise registration scheme, or equivalent.

The Contractor shall directly employ a Qualified Supervisor / Inspector on a full time basis as required by their Electrical Contracting Certification Scheme. The Qualified Supervisor / Inspector shall also meet the minimum requirements as defined by their Electrical Contracting Certification Scheme e.g. relevant education and experience, hold a recognised inspection and testing qualification etc.

The Qualified Supervisor shall oversee the testing and inspection works and shall ensure that the results of inspection and testing are recorded correctly on the appropriate certificates and/or reports. The Qualified Supervisor shall also be responsible for the review, verification, signing and dating of the certification and/or reports.

The person(s) undertaking the inspection and testing works (Inspector) may also be the Qualified Supervisor.

All due allowances shall be made within the tender submission for the Qualified Supervisor and the person(s) undertaking the inspection / testing works (Inspector) to meet on-site when requested by the Engineer at a mutually agreeable time.

2F-6 CERTIFICATION AND REPORTS

Dependent upon the type of works undertaken, certification and reports shall be provided as required by BS 7671 and Electrical Contracting Certification Schemes.

The certification and reports shall be selected from below as required:-

ELECTRICAL INSTALLATION CERTIFICATES

The EIC shall be used for all new installation work, and for all alterations or additions to existing installations where new circuits have been introduced including the replacement of existing main electrical switchgear such as low voltage switch panels, MCCB panel boards, MCB distribution boards, consumer units etc.

The EIC shall include:-

1) Front matter.
2) Schedule of items inspected.
3) Schedule of additional records (these shall be defined and allocated page numbers within the certification e.g. fire alarm system, emergency lighting etc.).
4) Schedule of circuit details.
5) Schedule of test results for every circuit.

It shall not be used for the inspection and testing of an existing electrical installation, where an EICR shall be used.

DOMESTIC ELECTRICAL INSTALLATION CERTIFICATES

The Domestic Electrical Installation Certificate shall be used for all new electrical installation work, and for all alterations or additions to existing installations where new circuits have been introduced including the replacement of existing main electrical switchgear such as MCB distribution boards, consumer units etc.

The certificate shall only be used for new installation work where all of the following conditions apply:-

1) The electrical installation work relates to a single dwelling (house or individual flat).
2) The design, the construction, and the inspection and testing of the electrical installation work are the responsibility of one Contractor with approval by an Electrical Contracting Certification Scheme.
3) The installation forms part of a TT, TN-S or TN-C-S (PME) system.
4) The protective measure for fault protection is provided primarily by Automatic Disconnection of Supply.

The Domestic Electrical Installation Certificate shall include:-

1) Front matter.

2) Schedule of items inspected.
3) Schedule of circuit details.
4) Schedule of test results for every circuit.

It shall not be used for single dwellings where the Engineer is responsible for the design, as the Domestic Electrical Installation Certificate does not include a separate 'DESIGN' section. An EIC shall be used instead.

MINOR ELECTRICAL INSTALLATION WORKS CERTIFICATES

The Minor Electrical Installation Works Certificate shall be used for any alteration or addition to an existing circuit such as:-

1) Addition of a socket-outlet to a ring or radial circuit.
2) Additional of a lighting point.
3) Alterations to lighting switching such as relocation of light switches.
4) Replacement of an accessory or luminaire (not switchgear such as DB's etc.).

It shall not be used for new circuits or the replacement of existing main electrical switchgear e.g. MCB distribution boards, consumer units etc. Further reference shall be made to Electrical Contracting Certification Schemes to clarify the acceptable and non-acceptable works associated with Minor Electrical Installation Certificates.

ELECTRICAL INSTALLATION CONDITION REPORTS (FORMERLY PERIODIC INSPECTION REPORTS)

The EICR shall only be used for reporting on the condition of an existing installation.

The EICR shall include:-

1) Front matter.
2) Schedule of observations and recommendations for actions to be taken.
3) Inspection schedule for distribution boards and circuits.
4) Schedule of test results for every circuit (unless defined sample rates have been provided).

It shall not be used for new installation work.

The agreed extent of the installation covered by the periodic inspection and testing along with any agreed limitations shall be clearly defined and recorded within the EICR. Where agreed periodic inspection and testing sample rates have been applied these shall be clearly defined and recorded within the EICR.

These should be recorded within the 'Extent of the Installation and Limitations on the Inspection and Testing' within the EICR.

GENERAL REQUIREMENTS FOR CERTIFICATION AND REPORTS

The general requirements for certification and reports are as follows:-

1) For new installation work, any defect or omission revealed during the inspection and testing shall be corrected before the certification is issued.
2) For any alterations and/or additions to an electrical installation, any defect or omission that will affect the safety of the alteration or addition that is revealed during inspection and testing shall be corrected before the certification is issued.

   The Contractor responsible for the alteration or addition shall record on the certification any other defects observed during the course of the works that may give rise to danger.
3) For all new installation work, and for all alterations or additions to existing installations where new circuits have been introduced, the certification shall include a recommendation for the interval between initial verification and the first periodic inspection e.g. 'NEXT INSPECTION' entry box.
4) Where parts of an existing installation are not required to be inspected and tested (i.e. do not form part of the works) any observed departures or non-compliances shall be recorded within the 'COMMENTS ON THE EXISTING INSTALLATION' section of the certification.
5) Where existing circuits have not been modified but have been disconnected and re-terminated (e.g. existing final circuits into new or existing MCB distribution boards etc.) they shall be fully inspected and tested as required by BS 7671.
6) They must be completed in accordance with BS 7671, IET Guidance Note 3 and Electrical Contracting Certification Schemes.
7) All entry boxes must be completed and contain accurate information. Where an entry box is not applicable to the works that have been undertaken 'N/A' shall be used.
8) When incomplete they are deemed to be invalid by Electrical Contracting Certification Schemes.
9) All switchgear / equipment reference numbers, circuit references and final circuit references shall be coordinated throughout and be the same as those used in the specification schedules / drawings.
10) Where a location is to be defined it shall be co-ordinated with the architectural drawings and the site room referencing system.
11) Where a documented risk assessment has determined that RCDs are not required as additional protection for socket outlets with a rated current not exceeding 32A, this shall be noted within the 'DESIGN' section and the documented risk assessment shall be appended.
12) 'Schedules of additional records' relating to the electrical installation shall be included and their respective page numbers shall be identified (e.g. fire alarm system, emergency lighting etc.). The requirements for these are detailed in subsequent sections of this specification.
13) The 'Circuit line and number' included within the 'Schedule of test results' shall be co-ordinated with the 'Schedule of circuit details'. The 'Schedule of test results' shall include test results for every circuit tested.
14) The Contractor / Qualified Supervisor shall be responsible for the review, verification, signing and dating of the certification and/or reports. This shall take into account their respective responsibilities e.g. 'CONSTRUCTION', 'INSPECTION AND TESTING', 'DESIGN, CONSTRUCTION, INSPECTION AND TESTING' entry boxes as necessary.

15) On completion they shall be issued to the Engineer for comment. When responsible for the design of the electrical installation the Engineer shall sign and date the 'DESIGN' entry box.

16) They shall be provided as part of the Operation and Maintenance Manual and Health and Safety File as required by the Construction (Design and Management) Regulations.

17) Schedules / charts shall be provided to all:-

a) Low voltage switch panels.

b) MCCB panel boards.

c) MCB distribution boards.

d) Consumer units.

As detailed within Section 2E of this specification.

2F-7 INSPECTION

The electrical installation shall be inspected to ensure all electrical equipment and materials are of the correct type and comply with the appropriate British or Harmonised Standard, or International (IEC) Standard.

The inspection shall verify that the electrical installation:

1) Has been correctly selected and erected in accordance with BS 7671, all supporting IET documentation and manufacturers' instructions.

2) Is not visibly damaged or defective or has deteriorated (existing installations) so as to impair safety.

3) Is ready and safe to be used.

The electrical installation shall be inspected throughout the installation period with particular attention paid to any electrical services that may become inaccessible upon completion e.g. concealed cable support and containments systems, cabling, accessories, busbar trunking and power track systems etc. etc.

On completion of the electrical installation works a further inspection shall be undertaken prior to any electrical testing (dead or live testing) taking place.

Appendix I of this section provides an Electrical Installation Certificate checklist of some of the principal items that shall be inspected as a minimum. However it shall be noted that the checklist is not exhaustive and is provided as a guide. The items included within the schedule shall form the Schedule of Inspections to be included with the certification / reports.

The inspection guidance provided in IET Guidance Note 3 Inspection and Testing shall also be followed:

1) Section 2.5.2 Comments on individual items to be inspected.

2) Section 2.5.3 Inspection checklist.

All items shall also be inspected that are included on the 'Schedules of Items Inspected' list that form part of the certification required by Electrical Contracting Certification Schemes. All entry boxes on the schedules must be completed:

- '✓' shall indicate that an inspection was undertaken and the result was satisfactory.
- 'N/A' shall indicate that an inspection was not applicable to the installation.

Joint formal inspections shall be undertaken at a mutually agreeable time by the Qualifying Manager, the person(s) undertaking the inspection / testing works and the Engineer.

Any departures from or non-compliances with the requirements of this specification and BS 7671 as a result of inspection(s) must be rectified at no additional cost and in a timely manner to suit the construction programme.

2F-8 TEST EQUIPMENT

Test instruments shall be selected in strict accordance with the performance standards detailed in BS EN 61557 and the safety requirements of BS EN 61010. Test instruments shall also be selected to meet the instrument accuracy and performance criteria detailed within IET Guidance Note 3 Inspection and Testing.

A system shall be in place to ensure the accuracy of test instruments as required by Electrical Contracting Certification Schemes.

As a minimum the accuracy of test instruments shall be confirmed by formal calibration / re-calibration at intervals recommended by the manufacturer and shall be supported by calibration certificates provided by laboratories accredited by the United Kingdom Accreditation Service (UKAS).

More frequent re-calibrations may be required if test instruments are exposed to changes in temperature / humidity and also if they are roughly handled and regularly transported / stored in vehicles. It shall be the Contractor's responsibility to ensure that the test instruments meet the required accuracy and performance criteria prior to testing.

The model and serial number for each test instrument shall be recorded on the certification, reports and schedules. A copy of the calibration certificate for each test instrument shall be provided as part of the Operation and Maintenance Manual.

Voltage indicators, test probes, clips and leads shall be selected and used in accordance with the guidance outlined in HSE – Guidance Note GS38.

2F-9 ISOLATION

Inspection and dead testing shall be undertaken with the appropriate part of the installation disconnected from the electrical supply by some form of isolation. The isolation of the electrical supply shall be undertaken in accordance with the guidance outlined in HSE – Electricity at Work – Safe working practices – HSG85.

As a minimum the isolation of the electrical supply shall be verified by the following safe working procedure:-

1) Step 1 – Open the means of isolation and secure the isolation device.

2) Step 2 – Prove the correct operation of the voltage detector / indicator to be used against a known source such as a voltage proving unit.

3) Step 3 – Test all conductors (including protective conductors in case there is a wiring fault) to verify that no dangerous voltage is present and the circuit(s) is safe to be worked upon.

4) Step 4 – Prove the correct operation of the voltage detector / indicator to verify that it was functioning correctly when the circuit(s) where tested.

Inspection and testing shall be undertaken in such a way as to minimise disturbance of the installation and inconvenience to the user.

Where it is necessary to disconnect part or the whole of the installation in order to carry out a test, the disconnection should be made at a time agreed with the Client and for the minimum period needed to carry out the test. Where more than one test necessitates a disconnection, where possible they should be made during one disconnection period.

All shutdowns and disconnections must be agreed with the Client prior to works commencing.

2F-10 TESTING SEQUENCE

The sequence of testing and test methods shall be undertaken in strict accordance with BS 7671, IET Guidance Note 3 Inspection and Testing and the NICEIC / ECA / ELECSA – Inspection, Testing and Certification including Periodic Reporting – Practical advice and guidance.

For new installation works the sequence of initial testing shall be as detailed below (where applicable):-

DEAD TESTING

Before the supply is connected, or with the supply disconnected as appropriate:-

1) Continuity of protective conductors, including main and supplementary equipotential bonding.
2) Continuity of ring final conductors (where present).
3) Insulation resistance.
4) Protection by SELV, PELV or by electrical separation.
5) Basic protection provided by a barrier or an enclosure provided during erection.
6) Insulation resistance / impedance of floors and walls.
7) Polarity.
8) Earth electrode resistance (dependent upon the test method used this may be a live test).

LIVE TESTING

With the supply connected:-

1) Protection by automatic disconnection of supply.
2) Earth fault loop impedance.
3) Prospective fault current.
4) Check of phase sequence.
5) Operation of residual current devices (the test to be independent of any test facility incorporated in the device).
6) Functional testing of residual current devices (RCDs).
7) Functional testing of arc fault detection devices (AFDDs).
8) Other functional testing e.g. functional testing of switchgear and control gear assemblies, drives, controls, interlocks etc.

2F-11 TESTING PROCEDURES

An overview of the testing procedures is provided below:

CONTINUITY OF PROTECTIVE CONDUCTORS, INCLUDING MAIN AND SUPPLEMENTARY EQUIPOTENTIAL BONDING

This is the measurement of one of the following to verify the continuity of the circuit protective conductors:

- Resistance of $R_1 + R_2$ (Test method 1 of BS 7671 – $R_1 + R_2$ method).
- R_2 (Test method 2 of BS 7671 – Wander lead method).

The measurements are to be made by using a low-resistance ohmmeter or by selecting the appropriate range on a multi-function tester. The measurement at the extremity of the circuit (furthest point) for $R_1 + R_2$ in Ω (ohms) shall be recorded on the Schedule of Test Results. The measurements shall verify that electrical continuity has been achieved and confirm correct polarity (✓) for the circuit.

Testing shall also be undertaken to verify the electrical continuity of all bonding conductors and earthing conductors.

All metallic cable support and containment systems shall be equipotential bonded for protective earthing and to avoid / reduce electromagnetic disturbances as detailed within Section 2E of this specification. Test method 2 shall be used to measure the resistance across all joints to verify electrical continuity. The measured resistance across joints shall not exceed 0.05 Ω.

The electrical continuity of cable support and containment systems shall also be verified in accordance with their respective standards, as detailed later within this section of the specification.

Test method 2 shall also be used to verify there is a bonding connection between extraneous conductive parts where it is not possible to see the bonding connection (e.g. where bonding clamps are 'built in' to metallic pipework). The measured resistance shall not exceed 0.05 Ω.

CONTINUITY OF RING FINAL CIRCUIT CONDUCTORS

This is the measurement of:

1) Step 1:- The resistance of r1, r2 and rn to verify the continuity of all conductors.
2) Step 2:- Having made the L-N cross connection, the resistance between line and neutral conductors at each outlet to verify the resistance is substantially the same at each outlet and equates to (r1 + rn) / 4, (subject to outlets wired as spurs from the ring final circuit).

3) Step 3:- Having made the L-E cross connection, the resistance between line and earth at each outlet to verify the resistance is substantially the same at each outlet and equates for (r1 + r2) / 4, (subject to outlets wired as spurs from the ring final circuit).

The measurements are to be made by using a low-resistance ohmmeter or by selecting the appropriate range on a multi-function tester. The measurements for r_1, r_2 and r_n in Ω (ohms) shall be recorded on the Schedule of Test Results. The highest value of resistance recorded from Step 3 is also to be recorded on the Schedule of Test Results as the $R_1 + R_2$ measurement.

The measurements shall verify that electrical continuity has been achieved and confirm correct polarity (✓) for the circuit.

INSULATION RESISTANCE

This is the measurement of the insulation resistance between all of the live conductors and between each live conductor and the protective conductor, to verify that the insulation of conductors provides adequate electrical insulation, is not damaged and that live conductors or protective conductors are not short-circuited.

Voltage sensitive electronic equipment such as RCBOs, surge protective devices, dimmer switches, touch switches, timers, controllers etc. shall be temporarily disconnected so they are not subjected to the test voltage.

The measurements are to be made by applying an appropriate test voltage as indicated below, using an insulation resistance tester or by selecting the appropriate range on a multi-function tester:-

CIRCUIT NOMINAL VOLTAGE (V)	TEST VOLTAGE D.C. (V)	MINIMUM INSULATION RESISTANCE VALUE (MΩ)
SELV and PELV	250	0.5
Up to and including 500 V with the exception of SELV and PELV but including FELV	500	1.0
Above 500 V	1000	1.0

The resistance measurements in MΩ (e.g. >200 MΩ) shall be shall be recorded on the Schedule of Test Results for:-

1) Line / Line.
2) Line / Neutral.
3) Line / Earth
4) Neutral / Earth.

The measurements shall be verified against the minimum acceptable insulation resistance values required by BS 7671 which are also detailed in the above table. For new installation works the following are to be brought to the attention of the Engineer immediately in writing:-

1) Any values recorded below 20 MΩ (which are above the minimum requirements outlined in BS 7671).
2) Where measured values show evident differences between similar circuits.

It is also recommended that insulation resistance testing is undertaken at various stages during the installation works to prove the integrity of the cables and to prevent remedial works towards the end of the contract.

The insulation resistance testing of socket outlets with integral USB (Universal Serial Bus) charging ports shall be undertaken in accordance with manufacturers' recommendations. Generally the measurements shall be made by applying a test voltage of 250 V d.c. using an insulation resistance tester or by selecting the appropriate range on a multi-function tester.

The measurements shall not be less than 1.0 MΩ (as opposed to 0.5 MΩ for SELV and PELV circuits) which is the minimum acceptable insulation resistance value required by BS 7671 where it is not reasonably practical to disconnect the socket outlets.

PROTECTION BY SELV, PELV OR BY ELECTRICAL SEPARATION

1) Protection by SELV, where SELV is used as a protective measure and insulation testing is required.
   a) Basic insulation test

      This is the measurement of the insulation resistance between line conductors and all other circuits including other SELV, PELV and low voltage circuits.

   b) Line to Earth insulation test:

      This is the measurement of the insulation resistance between all SELV line parts and earth.

The measurements are to be made by applying a test voltage of 250 V d.c. using an insulation resistance tester or by selecting the appropriate range on a multi-function tester. The measurements shall not be less than 0.5 MΩ which is the minimum acceptable insulation resistance value required by BS 7671.

2) Protection by PELV, where PELV is used as a protective measure and insulation testing is required.
   a) Basic insulation test:-

      This is the measurement of the insulation resistance between line conductors and all other circuits including other SELV, PELV and low voltage circuits.

The measurements are to be made by applying a test voltage of 250 V d.c. using an insulation resistance tester or by selecting the appropriate range on a multi-function tester. The measurements shall not be less than 0.5 MΩ which is the minimum acceptable insulation resistance value required by BS 7671.

3) Protection by electrical separation.
   a) Basic insulation test:

      This is the measurement of the insulation resistance between the electrically separated live conductors and the transformer secondary live conductors.

b) Basic insulation of the separated conductors:-

This is the measurement of the insulation resistance between the electrically separated live conductors and their corresponding exposed-conductive-parts.

c) Basic insulation of any exposed-conductive-parts associated with separated conductors:-

This is the measurement of the insulation resistance between the any exposed-conductive-parts associated with the electrically separated circuits and any protective conductor, other exposed-conductive-parts or Earth.

The measurements are to be made by applying a test voltage of 500 V d.c. using an insulation resistance tester or by selecting the appropriate range on a multi-function tester. The measurements shall not be less than 1 MΩ which is the minimum acceptable insulation resistance value required by BS 7671.

Additional inspections and tests shall also be undertaken for separated circuits supplying more than one item of current using equipment as required by IET Guidance Note 3 Inspection and Testing. This is to verify that two coincidental faults with negligible impedance will disconnect one of the faulty circuits within the disconnection time required by BS 7671.

BASIC PROTECTION BY A BARRIER OR AN ENCLOSURE PROVIDED DURING ERECTION

These tests only apply to barriers or enclosures constructed on-site during the installation works and do not apply to the barriers or enclosures of factory-built equipment.

Barriers and/or enclosures shall be provided to prevent contact with live parts and shall provide at least the degree of protection (IP code) of IPXXB or IP2X. However a horizontal or top surface of a barrier or enclosure which is readily accessible shall provide at least the degree of protection (IP code) of IPXXD or IP4X.

This is to verify that each barrier / enclosure gives adequate protection against the risk of electric shock through contact with live parts by fingers or foreign objects (e.g. conductive tools).

These degrees of protection shall be tested as follows:-

1) IP2X is defined in BS EN 60529 as protection against the entry of 'Fingers or similar objects not exceeding 80mm in length. Solid objects not exceeding12.5mm in diameter':-

   The test is made with a metallic standard test finger (test finger 1 to BS EN 61032).

2) IP4X is defined in BS EN 60529 as protection against the entry of 'Wires or strips of thickness greater than 1.0mm, and solid objects of 1.0mm diameter or greater':-

The test is made with a straight rigid steel wire of 1.0mm diameter applied with a force of 1 N ± 10 per cent.

INSULATION RESISTANCE / IMPEDANCE OF FLOORS AND WALLS

These tests are not required for standard electrical installations however if required reference shall be made to IET Guidance Note 3 Inspection and Testing.

POLARITY

Polarity testing shall verify:-

1) The polarity of the supply shall at the origin of the installation before the installation is energized.
2) That where single-pole switching devices are not permitted in the neutral conductor the devices are connected in the line conductor(s) only.
3) The wiring has been correctly connected throughout the installation.

Polarity of circuits shall be verified by the visual inspection of all termination points (by checking the core colours) or the measurement of the resistance of $R_1 + R_2$.

Polarity may be verified during the process of testing by:

1) Continuity of protective conductors – Test method 1 ($R_1 + R_2$ method).
2) Continuity of ring final circuit conductors.

Where polarity is verified during the process of testing the measurements are to be made by using a low-resistance ohmmeter or by selecting the appropriate range on a multi-function tester. Upon verification a '✓' shall be recorded on the Schedule of Test Results.

EARTH ELECTRODE RESISTANCE

This is the measurement of the resistance of earth electrodes to verify the resistance is low enough to assist with disconnection times.

One of the following test methods shall be used:-

1) Test method E1: Measurement using dedicated earth electrode tester (fall of potential, three- or four-terminal type)

   The entire installation must be isolated from the supply before the means of earthing is disconnected to perform this test. On completion of testing all bonding and protective conductors must be reconnected prior to the installation being energised (or re-energised).

2) Test method E2: Measurement using dedicated stakeless or clamp-based earth electrode tester.

   The earth electrode under test does not need to be disconnected for this method.

3) Test method E3: Measurement using an earth fault loop impedance tester.

   (Effectively the same method used for testing external earth fault loop impedance Ze).

   The entire installation must be isolated from the supply before the means of earthing is disconnected to perform this test. It shall be noted this method is a live test and the supply shall be re-energised to perform the testing. On completion of testing the supply shall be isolated and all bonding and protective conductors must be reconnected prior to the installation being re-energised.

Generally the measurement shall verify that the earth electrode resistance is less than 200 Ω, however the required automatic disconnection times of RCDs shall also be verified for TT systems. Earth electrode resistance values above 200 Ω may not be stable due to ground conditions.

The measurement of earth electrode resistance R_A shall be recorded in the Supply Characteristics and Earthing Arrangements section of the certification / report. Also the earth electrode type, location and the method of measurement shall be recorded.

PROTECTION BY AUTOMATIC DISCONNECTION OF SUPPLY

The effectiveness of measures for fault protection by automatic disconnection of supply shall be verified for TN systems as follows:-

1) Measurement of earth fault impedance.
2) Visual inspection to confirm that protective devices are suitable.

   (e.g. correct setting, type and ratings for circuit breakers and correct type and ratings for fuses).
3) Where used, RCD testing to confirm disconnection times are achieved.

For TT and IT systems reference shall be made to BS 7671 and IET Guidance Note 3 Inspection and Testing.

EARTH FAULT LOOP IMPEDANCE

Electrically continuity testing (as detailed earlier) must have been undertaken prior to the commenced of any earth fault loop impedance measurements.

This is the measurement of earth fault loop impedance (Z_S) to verify that when an earth fault occurs the resistance of the earth fault loop ($Z_s = R_1 + R_2 + Z_e$) shall be low enough for a large fault current to flow and operate a protective device in the required disconnection time, therefore achieving automatic disconnection of the circuit line conductor.

Note: Z_e may be substituted with Z_{db} when testing at a downstream distribution board or similar as the value measured is not external to the installation.

One of the following test methods shall be used:-

1) Measurement of total earth fault loop impedance (Z_S) using an earth fault loop impedance tester or by selecting the appropriate range on a multi-function tester. It shall be noted that the measured Z_S may be less than R1 + R2 + Ze due to parallel earth return paths.
2) Measurement of (R1 + R2) during continuity testing using a low-resistance ohmmeter and addition to the measured external fault loop impedance (Ze) of the same circuit, using an earth fault loop impedance tester.

The latter method is preferred when determining Z_S for final circuits and distribution circuits.

The measurement at the extremity of the circuit (furthest point) for Z_S in Ω (ohms) shall be recorded on the Schedule of Test Results. For ring final circuits the earth fault impedance (Z_S) shall be measured at every outlet / point and the highest value measured shall be recorded on the Schedule of Test Results.

The measurements shall be verified against the maximum earth fault loop impedance (Z_S) values required by BS 7671 which must be adjusted for temperature by applying a factor of 0.8 (80%).

e.g. for a 20A Type B circuit breaker to BS EN 60898, BS 7671 provides a maximum earth fault loop impedance of 2.19 Ω. However, this is at operating temperature, so the maximum acceptable measured value shall be 2.19 x 0.8 = 1.752 Ω.

It shall be noted that adjusted for the industry recognised 0.8 ‘rule of thumb’ are contained within the IET On-Site Guide / IET Guidance Note 3 and can also be obtained from Electrical Contracting Certification Schemes, which can then be used for verification of measurements.

Under no circumstances shall the measurements be verified against the maximum earth fault loop impedance (Z_S) contained within BS 7671 with no adjustment for temperature.

The maximum permitted earth fault loop impedance (Z_S) values included within the ‘Maximum Z_s permitted by BS 7671’ column of the ‘Schedule of circuit details’ shall include the Z_S values from BS 7671 which have not been adjusted for temperature.

Where supplementary protective equipotential bonding has been provided to satisfy the measured earth fault loop impedance requirements of BS 7671, the effectiveness of the bonding shall be verified.

The external fault loop impedance (Z_e) shall also be measured to verify there is an earth connection and to determine the external earth fault loop impedance (Z_e) which is part of the earth fault loop (Z_s).

The external fault loop impedance (Z_e) shall be measured at:-

1) The origin of the installation.

   The measurement for Z_e in Ω (ohms) shall be recorded in the Supply Characteristics and Earthing Arrangements section of the certification / report.
2) At each item of switchgear within the installation (e.g. LV switch panels, MCCB panel boards, MCB distribution boards, consumer units etc. etc.)

   The measurement for Z_S (sometimes known as Z_s, Z_{db} or similar) in Ω (ohms) shall be recorded on the Schedule of Test Results (top section) for the item of switchgear.

The measurements are to be made by using an earth fault loop impedance tester or by selecting the appropriate range on a multi-function tester.

PROSPECTIVE FAULT CURRENT

This is the measurement of prospective fault current (I_{pf}) under both short-circuit and earth fault conditions to verify that the rated short-circuit breaking capacities of protective devices are greater than the prospective fault current (I_{pf}).

The prospective short circuit current and prospective earth fault current shall be measured at every relevant point of the installation which includes:-

1) The origin of the installation.

The measurement for I_{pf} in kA shall be recorded in the Supply Characteristics and Earthing Arrangements section of the certification / report.

2) At each item of switchgear within the installation where a protective device is required to operate under fault conditions.

The measurement for Ipf in kA shall be recorded on the Schedule of Test Results (top section) for the item of switchgear.

The measurements are to be made by using the prospective fault current range of a suitable earth fault loop impedance tester or by selecting the appropriate range on a multi-function tester. Whichever is the greater measurement of prospective short circuit current (PSCC) and prospective earth fault current (PEFC) shall be recorded.

For three phase supplies where a 230V test instrument is used the prospective fault current line to line can be taken as twice that of the prospective fault current line to neutral.

e.g. line to neutral measurement of 4.6 kA x 2 = 9.2 kA (I_{pf}).

The measurements shall be verified by comparing the measured prospective fault current (I_{pf}) at the terminals of protective devices with their rated short-circuit breaking capacities. The rated short-circuit breaking capacities of protective devices must be greater than the prospective fault current (I_{pf}).

CHECK OF PHASE SEQUENCE

Generally this is verified by checking the polarity and connections at all relevant points throughout the installation. However the phase sequence of all three phase equipment such as rotating machines (e.g. motors) shall be verified to ensure correct rotation. This shall be verified by using a phase rotation tester or by selecting the appropriate range on a multi-function tester.

ADDITIONAL PROTECTION – OPERATION OF RESIDUAL CURRENT DEVICES

This is the measurement of RCD (RCCB or RCBO) operating times to verify the correct operation and required disconnection times are achieved. The measurements are to be made by using an RCD tester or by selecting the appropriate range on a multi-function tester. Loads shall be disconnected during testing. All residual current devices shall be tested at:-

1) 50% of the rated operating (tripping) current and shall not operate / open.

2) 100% of the rated operating (tripping) current (IΔn) and shall operate / open.

The measured operating time in ms shall be recorded (where applicable) in the:

a) Particulars of Installation at the Origin section of the certification / report. If the residual current device has a rated time delay this shall also be included.

b) Schedule of Test Results (top section) for the item of switchgear.

c) Schedule of Test Results for a circuit.

The residual current devices shall have an operating time not exceeding that required by their respective product standards at a residual current of IΔn, as detailed in the table below:-

DEVICE TYPE	NON-TIME DELAYED	WITH TIME DELAY	NOTES
	MAXIMUM OPERATING TIME AT 100% RATED TRIPPING CURRENT, IΔn (ms)	OPERATING TIME AT 100% RATED TRIPPING CURRENT, IΔn (ms)	
BS 4293	200	((0.5 to 1.0) x time delay) + 200	
BS 61008	300	130 to 500	S type
BS 61009 (RCBO)	300	130 to 500	S type
BS 7288 (integral socket-outlets)	200	Non-applicable	

Residual current devices used for additional protection shall also be tested at 5 IΔn (e.g. 150mA for IΔn = 30mA) and the measured operating time in ms shall be recorded in the:-

1) Schedule of Test Results (top section) for the item of switchgear (if applicable).

2) Schedule of Test Results for a circuit.

Residual current devices for additional protection shall have an operating time not exceeding 40ms at a residual current of 5 IΔn.

Measurements shall be taken on both positive and negative half cycles of the supply waveform and the longer operating time shall be recorded.

ADDITIONAL PROTECTION – SUPPLEMENTARY PROTECTIVE EQUIPOTENTIAL BONDING

Where supplementary protective equipotential bonding has been provided for additional protection the effectiveness of the bonding shall be verified.

FUNCTIONAL TESTING OF RESIDUAL CURRENT DEVICES

Functional testing shall be undertaken on all residual current devices. The integral test device shall be operated by pressing the button marked 'T' or 'Test', during testing the residual current devices must be energised.

Upon verification a '✓' shall be recorded on the Schedule of Test Results.

FUNCTIONAL TESTING OF ARC FAULT DETECTION DEVICES (AFDDs)

Functional testing shall be undertaken on arc fault detection devices (AFDDs) when they are provided with a manually operated test facility, in strict accordance with the manufacturers' recommendations.

Upon verification a '✓' shall be recorded on the Schedule of Test Results.

AFDDs that do not have a manually operated test facility cannot be tested for functionality.

OTHER FUNCTIONAL TESTING

All equipment that forms part of the electrical installation shall be subjected to functional testing to verify that it functions correctly and has been properly mounted, adjusted, and installed in accordance with BS 7671.

This shall include:

1) All electrical switchgear used for isolation e.g. main switches, isolators, protective devices etc.
2) All luminaires, switching and control devices, interlocks, adjustable relays, socket-outlets etc.
3) Motors, motor controls and starters, including correct rotation.

It shall be noted the above list is not exhaustive and functional testing must be undertaken on all equipment that forms part of the electrical installation.

2F-12 DEPARTURES FROM AND NON-COMPLIANCES WITH BS 7671

Any departures from or non-compliances with BS 7671 resulting from the inspection and testing of the electrical installation shall be brought to the attention of the Engineer immediately in writing.

2F-13 INSPECTION AND TESTING OF MEDICAL INSTALLATIONS

This section of the specification details the general inspection and testing requirements that shall also apply to medical installations. However it shall be noted that medical installations will have additional inspection, testing and commissioning requirements, for example (but not limited to):

1) Inspection and functional tests of medical IT systems.
2) Measurement of the leakage current for the output circuit and the enclosure of medical IT system isolating transformers.
3) Measurement of the resistance of protective conductors between the earth terminals of any socket outlet (or fixed equipment) and any extraneous conductive parts (e.g. not exceeding 0.2 Ω for Group 1 and 2 locations etc.).

Medical IT systems are also known as medical isolated power supply systems.

Where required the inspection and testing requirements of medical installation shall be detailed within a subsequent section of this specification.

2F-14 CONTINUITY OF CABLE SUPPORT AND CONTAINMENT SYSTEMS

All metallic cable support and containment systems shall be equipotential bonded for protective earthing and to avoid / reduce electromagnetic disturbances as detailed within Section 2E of this specification.

The electrical continuity of cable support and containment systems shall be tested as follows:-

1) Cable ladder rack, cable tray and cable basket shall be tested in accordance with the relevant clauses of BS EN 61537.
2) Cable trunking shall be tested in accordance with the relevant clauses of BS EN 50085.
3) Cable conduit shall be tested in accordance with the relevant clauses BS EN 61386.

It shall also be verified that all connections between cable conduit (e.g. conduit take-off plates, conduit boxes) and cable tray / basket / tray have adequate electrical continuity.

The Contractor shall provide written clarification that the cable support and containment systems have electrical continuity characteristics as defined in the above standards.

2F-15 FIRE BARRIERS / STOPPING

On completion of the fire barriers / stopping works fully detailed completion / compliance certification shall be provided along with record drawings that detail all fire barrier / stopping locations.

2F-16 FACTORY BUILT ASSEMBLIES

The Engineer shall be afforded the opportunity to inspect and formally witness the testing of all bespoke factory built assemblies (e.g. LV switch panels, switchgear etc.) before they are dispatched to site. The required period of notice to attend shall normally be 10 days, but shall be variable at the discretion of the Engineer.

The Engineer shall be provided with a copy of the appropriate inspection and testing certification for each factory built assembly which shall also be included within the Operation and Maintenance Manual.

2F-17 THERMOGRAPHIC SURVEYS

Any requirement for undertaking thermographic surveys shall be detailed within a subsequent section of this specification. The guidelines on thermographic equipment shall be followed within IET Guidance Note 3.

2F-18 FORMAL WITNESSING OF TESTING

The Qualified Supervisor and the person(s) undertaking the inspection / testing works shall give reasonable notice of all tests to permit them to be witnessed by the Engineer. The required period of notice shall normally be 10 days, but shall be variable at the discretion of the Engineer.

Preliminary testing shall be undertaken prior to any formal witnessing by the Engineer. The preliminary test results shall be provided to the Engineer in draft certificates before inviting the Engineer to attend formal witnessing. The Engineer will then witness the formal tests in full or selectively as deemed necessary to verify the draft test results.

The proportion of tests to be witnessed by the Engineer will be 20%, though this could be reduced to 10% at the discretion of the Engineer on very large systems. The Engineer has the right to ask for a higher proportion of witnessing should the verification or witnessing exercise be unsuccessful e.g. the test readings cannot be repeated within a reasonable degree of accuracy. In this instance the Electrical Contractor shall bear all costs associated with this additional work.

2F-19 APPENDIX I – SCHEDULE OF INSPECTIONS (CHECKLIST)

SCHEDULE OF INSPECTIONS (FOR INITIAL INSPECTION AND TESTING)			
1.0	**CONDITION OF ELECTRICAL INTAKE EQUIPMENT (the Distributor should be notified of any unsatisfactory equipment)**		
1.1	Service cable		
1.2	Service head		
1.3	Earthing arrangement		
1.4	Meter tails – Distributor / Consumer		
1.5	Metering equipment		
1.6	Isolator		
2.0	**PARALLEL OR SWITCHED ALTERNATIVE SOURCES OF SUPPLY**		
2.1	Presence of adequate arrangements where generator to operate as a switched alternative		
	a)	Dedicated earthing arrangement independent of that of the public supply	
2.2	Presence of adequate arrangements where generator to operate in parallel with public supply system		
	a)	Correct connection of generator in parallel	
	b)	Compatibility of characteristics of means of generation	
	c)	Means to provide automatic disconnection of generator in the event of loss of public supply system or voltage or frequency deviation beyond declared values	
	d)	Means to prevent connection of generator in the event of loss of public supply system or voltage or frequency deviation beyond declared values	
	e)	Means to isolate generator from the public supply system	
2.3	Presence of alternative / additional supply warning notices at:		
	a)	The origin	
	b)	The meter position, if remote from the origin	
	c)	The consumer unit / distribution board to which the alternative / additional sources are connected	
	d)	All points of isolation of ALL sources of supply	
3.0	**AUTOMATIC DISCONNECTION OF SUPPLY**		
3.1	Presence and adequacy of protective earthing / bonding arrangements as follows:		
	a)	Distributor's earthing arrangement	
	b)	Installation earth electrode (where applicable)	
	c)	Earthing conductor and connections	
	d)	Main protective bonding conductors and connections	
	e)	Earthing / bonding labels at all appropriate locations	
	f)	RCD(s) provided for fault protection	
3.2	Accessibility of:		
	a)	Earthing conductor connections	
	b)	All protective bonding conductors	
3.3	FELV – requirements satisfied		
3.4	Reduced low voltage – requirements satisfied		
4.0	**BASIC PROTECTION**		
4.1	Presence and adequacy of protective measures to provide basic protection		
	a)	Insulation of live parts	
	b)	Barriers or enclosures	

SCHEDULE OF INSPECTIONS (FOR INITIAL INSPECTION AND TESTING)				
	c)	Obstacles*		
	d)	Placing out of reach*		
5.0	**ADDITIONAL PROTECTION**			
5.1	The presence and effectiveness of additional protection methods used, as follows:			
	a)	RCDs not exceeding 30 mA operating current		
	b)	Supplementary bonding		
6.0	**OTHER METHODS OF PROTECTION (insert location in box provided)**			
	The presence and effectiveness of other methods of protection against electric shock where used, as follows:			
6.1	Basic and fault protection			**LOCATION**
	a)	SELV		
	b)	PELV		
	c)	Double insulation / Reinforced installation		
	d)	Electrical separation for one item of equipment		
6.2	Fault protection			**LOCATION**
	a)	Non-conducting location / Earth-free local equipotential bonding*		
	b)	Electrical separation for more than one item of equipment*		
7.0	**DISTRIBUTION EQUIPMENT**			
7.1	Adequacy of working space / accessibility			
7.2	Security of fixing			
7.3	Insulation of live parts not damaged during erection			
7.4	Adequacy / security of barriers			
7.5	Suitability of enclosures for IP and fire ratings			
7.6	Enclosures not damaged during installation			
7.7	Presence and effectiveness of obstacles			
7.8	Presence of main switch(es), linked where required			
7.9	Operation of main switch(es) (functional check)			
7.10	Operation of circuit-breakers and RCDs to prove functionality			
7.11	RCD(s) provided for fault protection, where specified			
7.12	RCD(s) provided for protection against fire			
7.13	RCD(s) provided for additional protection, where specified			
7.14	Confirmation overvoltage protection (SPDs) provided where specified			
7.15	Confirmation of indication that SPD is functional			
7.16	Presence of RCD six-monthly test notice where required			
7.17	Presence of AFDD six-monthly test notice where required			
7.18	Presence of diagrams, charts or schedules at or near each switchgear, where required			
7.19	Presence of non-standard (mixed) cable colour warning notice at or near the appropriate distribution board, where required			
7.20	Presence of next inspection recommendation label			
7.21	Presence of other required labelling			
7.22	Selection of protective device(s) and base(s); correct type and rating			
7.23	Single-pole protective devices in line conductor only			
7.24	Protection against mechanical damage where cables enter equipment			

SCHEDULE OF INSPECTIONS (FOR INITIAL INSPECTION AND TESTING)		
7.25	Protection against electromagnetic effects where cables enter ferromagnetic enclosures.	
7.26	Confirmation that ALL conductor connections, including connections to busbars are correctly located in terminals and are tight and secure	
8.0	**CIRCUITS**	
8.1	Identification of conductors	
8.2	Cables correctly supported throughout their length	
8.3	Examination of cables for signs of mechanical damage during installation	
8.4	Examination of insulation of live parts, not damaged during erection	
8.5	Non-sheathed cables protected by enclosure in conduit, ducting or trunking	
8.6	Suitability of containment systems (including flexible conduit)	
8.7	Correct temperature rating of cable insulation	
8.8	Adequacy of cables for current-carrying capacity with regard to the type and nature of installation	
8.9	Adequacy of protective devices: type and rated current for fault protection	
8.10	Presence and adequacy of circuit protective conductors	
8.11	Coordination between conductors and overload protective devices	
8.12	Wiring systems and cable installation methods / practices appropriate to the type and nature of installation and external influences	
8.13	Cables installed under floors, above ceilings, in walls / partitions, adequately protected against damage	
	a) Installed in prescribed zones	
	b) Incorporating earthed armour or sheath, or installed within earthed wiring system, or otherwise protected against mechanical damage by nails, screws and the like	
8.14	Provision of additional protection by RCDs having a rated residual operating current (IΔn) not exceeding 30mA:	
	a) For mobile equipment with a current rating not exceeding 32 A for use outdoors	
	b) For all socket-outlets of rating 32 A or less, unless exempt	
	c) For cables installed walls / partitions at a depth of less than 50mm	
	d) For cables installed in walls / partitions containing metal parts regardless of depth	
	e) Final circuits supplying luminaires within (domestic) household premises	
8.15	Provision of fire barriers, sealing arrangements so as to minimize the spread of fire	
8.16	Band II cables segregated / separated from Band I circuits	
8.17	Cables segregated / separated from non-electrical services	
8.18	Termination of cables at enclosures	
	a) Connection under no undue strain	
	b) No basic insulation of a conductor visible outside enclosure	
	c) Connections of live conductors adequately enclosed.	
	d) Adequately connected at point of entry to enclosure (glands, bushes etc.)	
8.19	Suitability of circuit accessories for external influences	
8.20	Circuit accessories not damaged during erection	
8.21	Single-pole devices for switching in the line conductor only	
8.22	Adequacy of connections, including cpcs, within accessories and at fixed and stationary equipment	
9.1	Isolators	
	a) Presence and location of appropriate devices	
	b) Capable of being secured in the OFF position	
	c) Correct operation verified (functional check)	

SCHEDULE OF INSPECTIONS (FOR INITIAL INSPECTION AND TESTING)			
	d)	The installation, circuit or part thereof that will be isolated is clearly identified by location and / or durable marking	
	e)	Warning label posted in situations where live parts cannot be isolated be isolated by the operation of a single device.	
9.2	Switching off for mechanical maintenance		
	a)	Presence of appropriate devices	
	b)	Acceptable location (state if local or remote)	
	c)	Capable of being secured in the OFF position	
	d)	Correct operation verified (functional check)	
	e)	The circuit or part thereof to be disconnected clearly identified by location and / or durable marking	
9.3	Emergency switching / stopping		
	a)	Presence of appropriate devices	
	b)	Readily accessible for operation where danger might occur	
	c)	Correct operation verified (functional check)	
	d)	The installation, circuit or part thereof to be disconnected, clearly identified by location and / or marking	
9.4	Functional switching		
	a)	Presence of appropriate devices	
	b)	Correct operation verified (functional check)	
10.0	**CURRENT USING EQUIPMENT (PERMANENTLY CONNECTED)**		
10.1	Suitability of equipment in terms of IP and fire ratings		
10.2	Enclosure not damaged / deteriorated during installation so as to impair safety		
10.3	Suitability for the environment and external influences		
10.4	Security of fixing		
10.5	Cable entry holes in ceilings above luminaires, sized or sealed so as to restrict the spread of fire		
10.6	Recessed luminaires (downlighters)		
	a)	Correct type of lamps fitted.	
	b)	Installed to minimise build-up of heat.	
10.7	Provision of under voltage protection, where specified		
10.8	Provision of overload protection, where specified		
10.9	Adequacy of working space / accessibility to equipment		
11.0	**SPECIAL INSTALLATIONS OR LOCATIONS**		
List below any Special Installations or Locations which are part of the installation to be verified, and confirm that the additional requirements given in the respective section of Part 7 are fulfilled.			

SCHEDULE OF INSPECTIONS (FOR INITIAL INSPECTION AND TESTING)	
11.0 OTHER	
List below any electrical installation works not covered in the above checklist that has been inspected and verified.	

* For use in controlled supervised / conditions only.

NOTES

1) All entry boxes on the schedules must be completed.
2) '✓' indicates that an inspection was undertaken and the result was satisfactory.
3) 'N/A' indicates that an inspection was not applicable to the installation.

The above checklist need not be completed where all of the inspection items above are included on the 'Schedules of Items Inspected' schedules, which form part of the certification provided by Electrical Contracting Certification Schemes.

Section Four

Energy Metering

Contents

4-1 GENERAL REQUIREMENTS

The energy metering systems required for this project shall be designed, installed and commissioned to allow the client to measure and control the utility and energy use to the market stalls.

The energy metering system shall be a standalone system and shall include DigiCard RFID Prepay metering along with the management tools to allow pre payment and tariff charges

The energy metering system shall be fully compliant with all relevant Regulations and Standards as listed below in 'Standards Applicable'.

4-2 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the particular sections, commissioning and standard clauses, all of which define further the requirements for the installations.

The following text advises if the Contractor shall deviate from the preferred materials and standard or utilise one of the alternative materials and standards of construction listed in the 'General Installation Standards' sections detailed earlier in this specification. Agreed alternative materials for the installation from the preferred standard material and standard of construction are:

'General Installation Standards' Sections provides all necessary details on pipework and valve materials and performance requirements that apply to this section.

4-3 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS	
BSRIA Commissioning Codes	Building Regulations, particularly Part L2
CIBSE Commissioning Codes	CIBSE CP1 – Heat Networks Code of Practice
CIBSE Guide H – Control Systems	CIBSE TM39 – Building Energy Metering
Heat Network (Metering and Billing) Regulations	Pressure Equipment Regulations & amendments

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

4-4 SCOPE OF WORKS

The scope of works is detailed in the preliminary section of the specification

4-5 SOFTWARE AND PROGRAMMING

The energy monitoring system shall be provided with all necessary software and software licences for a fully complete and operational system.

The Specialist Contractor shall allow for all necessary programming to calibrate all actual readings with the software and include for a logical easy to understand and interrogate graphical interface on the front end.

4-6 METERING COMMISSIONING AND HANDOVER

For all flow meter installed into pipe work to maintain meter accuracy, the meter manufacturer's minimum number of straight pipe diameters of unrestricted pipe lengths before, and after, the meter to provide LAMINAR flow through the meter must be adhered to.

To comply with Health and Safety along with CDM all meter reads outs are to be installed in easily accessible positions to enable the operator to read the meter face to minimise the risk of working at height or back strain etc. To eliminate the risk, a suitable, permanent access platform may be required in exceptional circumstances for maintenance.

The entire energy metering systems shall be fully commissioned fully in accordance with both CIBSE TM 39 and the energy metering system supplier.

Section Six

Design Standards

Contents

6-1 GENERAL REQUIREMENTS

All the Mechanical and Electrical Services are being tendered on a performance basis for this project. The Contractor shall be responsible for the full adoption of the design concepts and principles provided, detailed design, installation and commissioning of all necessary building services to suit the building layouts and passive fabric principles. This section of the Performance Specification details the design standards that shall be adhered to in the development of the design of the building services, including all passive measures set out by the Client's team for the project. This section should not be taken as being exhaustive, but it is indicative of the quality and standards required for the project.

Note that the drawings issued with the tender are to illustrate the design concepts and principles to be fully adopted and developed into a fully detailed design at the start of the contract period prior to any services being installed on site.

The design requirements for this project are listed below and summarised in the following clauses:

1) Building Control Officer's requirements.
2) All Building Regulations compliance.
3) Compliance with BS 7671 IET Wiring Regulations – Requirements for Electrical Installations, all supporting IET documentation and all British Standards / Statutory Regulations referenced within these documents.

Where discrepancies are found between this specification, relevant standards, room data sheets, drawings, Employer's documentation, Architect's documentation, Structural documentation and Quantity Surveyor's documentation, the tenderer shall allow for the costs associated with the most onerous condition within their returned tender, should the return tender period permit, obtain written clarification regarding any discrepancies from the Engineer.

Where discrepancies have not been clarified prior to the submission of the tender return it shall be assumed that the most onerous condition has been allowed for and no tender qualifications shall be permitted against this item.

6-1-1 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the rest of this specification, all of which define further the requirements for the overall installation.

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6-1-2 FIRE PRECAUTIONS

Due allowance shall be made for the inclusion of all necessary fire and smoke dampers, pipe fire collars/sleeves and the like where services pass through fire and smoke compartments, cavity barriers, void barriers and floors to maintain full fire and smoke integrity of the barriers.

Ensure all items are included to comply with Building Control, Fire Advisor, Client Insurance, Client Fire Advisor and Fire Department requirements.

The provisions for fire detection control and fire extinguishing shall be in accordance with this document, the concept drawings, fire compartment strategy, statutory standards and in addition shall meet any requirements of the local Building Control, local Fire Advisor and Client's Fire Advisor.

The systems shall be designed to provide the following:

All services passing through fire compartments shall be fully fire stopped to maintain the integrity of the same.

6-1-3 ENHANCED CAPITAL ALLOWANCE (ECA)

Where available, plant and machinery shall be selected from the Energy Technology List or the Water Technology List provided on the Government website www.eca.gov.uk.

Products selected must meet the eligibility criteria as detailed on the website.

Where practical, the Contractor is to provide a list of the plant and machinery items included in the tender that Qualify for ECA's.

Provide all supporting information from manufacturers/suppliers as necessary for the claiming of ECA's, together with cost details of all qualifying items.

6-1-4 CHARTERED ENGINEER

The Building Services shall be designed by engineers with suitable qualifications and appropriate experience in accordance with the following:

1) All design work shall be undertaken by Engineers and Technicians with sufficient specific and relevant experience of the engineering systems concerned and the building type in terms of its use, size and complexity.
2) All design work shall be supervised by Engineers with at least 10 years specific and relevant experience of the engineering systems concerned and the building type in terms of its use, size and complexity.
3) Final checking and validation of all design work shall be undertaken by Chartered Engineers, who are members of the Chartered Institute of Building Services Engineers (CIBSE) / The Institution of Engineering and Technology (IET).

The successful contractor shall submit proposals detailing the design process, with CVs for all personnel undertaking supervisory and validation work, to demonstrate compliance with the above. These CVs shall include Technical & Professional Qualifications, years of relevant experience for each type of system, etc.

In addition, the Engineer(s) who have checked/validated the design shall visit site at monthly intervals (minimum) to ensure that the installation is progressing in accordance with the agreed design, review the commissioning process and check all results.

6-1-5 DESIGN DEVELOPMENT

The tender shall be compliant with information detailed within this Performance Specification, information from the Main Contract and any relevant design guides stated, all of which shall not be taken as being exhaustive, but as indicative of the minimum quality and standards required for the project.

Should any of the tender information be found to be incompatible or ambiguous with other design information, then this shall be raised as a query during the tender period, if no response is provided prior to the tender return date, the tender return shall include for the most onerous option available.

A number of project schematic details and layouts have been incorporated within the Tender, these are provided to demonstrate the design intent only. These drawings shall be developed both during the tender period to inform and complete the tender return and during the detailed design stage to provide a completed design.

Include at tender for the contractual requirements including:

1) Design, installation and commissioning to achieve specified requirements.
2) Lead mechanical and electrical co-ordination role shall be undertaken by the Mechanical Contractor for all mechanical and electrical services except for services installed into the reflected ceiling or suspended from the structural soffit (where not suspended ceiling is proposed), which shall be managed by the Electrical Contractor (due to the importance of the lighting design uniformity, et cetera). Overall co-ordination shall be managed by the Main Contractor, unless agreed otherwise, with the Main Contractor, during the tender period. The party undertaking role of service coordination duties shall be advised at tender return.
3) Develop a fully co-ordinated 3D services model in Revit. 2D fabrication / fully co-ordinated fabrication drawings shall be extracted from this model for onsite installation for all areas. Enhanced detail shall be provided in the format of 3D drawings for co-ordination within plant rooms, ceiling and floor voids, risers and other congested areas of services.
4) Production of detailed design drawings, installation drawings, record drawings, builder's work drawings and 'As Fitted' drawings as detailed elsewhere in this Specification.
5) Design of the building services, including mechanical, electrical, plumbing, et cetera and join the Main Contractor's design team consisting of a Main Contractor, Structural Engineer and Architect (and all other design professionals), all with full design responsibility.
6) Detailed design work associated with producing builder's work drawings and all builder's work information associated with the mechanical and electrical installations.
7) Attending all meetings necessary to provide full detailed design and co-ordination of the services with all other trades.
8) Obtain from the Main Contractor, during the tender period, the latest room data sheets for the design and costing processes to ensure that the tender submission is fully compliant with the latest information available.
9) Allow for full co-ordination with the fabric of the building, user ergonomic requirements, structure of the building, existing trees, landscaping etc. and co-ordinating the installation with other trades. Where services routes or similar are shown on the drawings, these are indicative routes only.
10) Assess at tender all plant room sizes, riser sizes, ceiling and floor void depths and service routes ensuring that the Architect and Main Contractor are fully aware of their requirements and accommodate them. All voids, risers and service routes shall offer suitable access in compliance with current CDM requirements and are suitably sized for periodic maintenance to be successfully performed.

6-1-6 CONTRACTOR DOCUMENTATION PRODUCTION, REVIEWING PROCESS AND DRAWING STATUS DEFINITIONS

The requirements for producing, submitting and reviewing Contractor documentation, including design submissions, are given in Section 1B. Some additional detail regarding the content of design submissions is given in this section.

6-1-7 REVIEW OF SERVICE ZONES

The various zones detailed on the tender drawings are those that have been agreed with the Client and design team as representing the minimum number of zones according to orientation and occupancy profiles, the final design shall review these zones, and if necessary further sub-divide, if determined necessary during the detailed design stage of the project.

Any additional costs incurred for the building services to be contained within the provided service zones shall be included at tender.

6-1-8 LOCATION OF SERVICES

All plant and equipment shall be located in plant rooms and risers provided for this purpose. Services distribution shall be generally concealed in risers, in ceiling voids and floor voids. Services that are exposed at high level have been detailed on the tender and architectural drawings

Exposed distribution pipework / ductwork / containment shall not be accepted except for where specifically indicated on the Tender drawings or detailed elsewhere in this specification.

All rooms where services are planned to be exposed under the Architectural Philosophy and as detailed on the tender drawings shall be installed to a high standard and shall be set out in a logical manner to provide an acceptable symmetry. Fully detailed 3D CAD modelling, using Revit model, shall be provided prior to installation, within a sufficient time frame, for the design team to comment. The routing of the services to meet this requirement shall not have a negative effect of the energy consumption of the building.

<u>Mechanical services final design shall ensure:</u>

1) All pipework shall be run in ceiling voids, service ducts, floor voids and discreetly hidden from view.
2) Good access shall be required to all main valves and commissioning stations.
3) All ductwork to run within ceiling voids and to drop and rises in given riser locations only.
4) General routing of services is to be undertaken in accordance with other sections of this Document maximising use of voids and rising shafts.
5) Sanitary accommodation is indicated on the Architect's Drawings, these shall be served by hot and/or cold services as required.
6) Louvres shall only be permitted in the areas indicated on the tender drawings.

7) Full co-ordination with all other services, building fabric, structural designs and architectural aesthetic requirements.

Summarised below are some of the items that require liaison with other trades, this list is not exhaustive and is provided to indicate the type of items that require detailed co-ordination.

Electrical services final design shall ensure:

1) Co-ordination of all services in boxings, risers and external ducts.
2) Co-ordination of all services within false ceiling.
3) Interfaces with fire alarm.
4) Co-ordination of wall mounted equipment to ensure common heights.
5) Location of mains electrical supplies.
6) Capacity and type of power supplies to mechanical control panels.
7) Co-ordination with luminaires within the suspended ceiling with special attention to positions of diffusers, pipework and ductwork due to ceiling void restrictions.

Building final design shall ensure:

1) Access to services in risers, voids, etc.
2) Boxing requirements for pipework, etc.
3) Weights and structural implications.
4) External trenches.
5) Location and finish of all exposed equipment and pipework etc.

The coordinated drawings shall include for providing fully co-ordinated reflected ceiling plans (Scale 1:50).

6-1-9 HIDDEN SERVICES

Where services are concealed which required either regular maintenance or provide emergency isolation within ceiling voids and at access panels et cetera circular coloured plastic labels be secured by screw fixing in a discrete but readable position. Labels shall typically be affixed to suspended ceiling tee bars or access door frames. The final design and locations of the labels shall be agreed with the Architect, Client and Engineer prior to installation.

The following services colour indication is provided for tender only:

ORANGE	Fan coil units
BLUE	Variable air volume dampers
BLACK	Fans
GREEN	Main / zonal commissioning stations
MAGENTA	Main / zonal isolation valves
LIGHT BLUE	Void mounted smoke detectors
YELLOW	Lighting control modules

Prior to purchasing the above disks, the Mechanical Contractor shall liaise with Engineer and Client to confirm colour selection and fixing locations.

6-1-10 PRE-TENDER ENQUIRIES

Prior to issue of this tender enquiry to the marketplace, Couch Perry & Wilkes LLP have in some cases received quotations and budget costs from suppliers, manufacturers and specialist installers etc. If for any reason the tenderers receive a copy of this correspondence, please be aware that the contents of these have not been checked technically or commercially so shall be considered inaccurate and out of date.

All quotation enquiries to suppliers, manufacturers, specialist suppliers etc. shall be based on the tender design carried out by each tenderer.

6-1-11 NUMBER REFERENCING SYSTEMS

A number referencing system shall be established with the Engineer and Client, and where applicable be based upon the Client's facilities management System, for the switchgear, distribution boards, main plant, valves etc.

Individual circuit identification shall also be developed with the Engineer and Client.

6-1-12 LIFE EXPECTANCY OF THE INSTALLATIONS

The different systems provided for this project, including all equipment selected and installed, shall be chosen to at least meet the target life years listed in CIBSE Guide M section 12. Equipment which has obviously been selected purely on low capital cost shall not be permitted.

The preferred manufacturers list has been provided to indicate the type and standard of equipment required to be installed on this project. This preferred manufacturer's list shall not be deviated from unless agreed in writing from the design team.

6-2 AVOIDANCE OF WATER SERVICES AND ELECTRICAL ROOMS AND HUB ROOMS

No wet services shall be installed or pass through rooms that are either electrically intensive or house electronic panels / racks, this includes, but is not limited to, data rooms, hub rooms, data centres, high voltage (HV) rooms and low voltage (LV) rooms.

To clarify this point, no piped rainwater or soil drainage, DHWS, heating or chilled water pipes shall be within these areas, with the exception of refrigerant and condensate piped that serve local cooling installed to cool these rooms only. With regards to

refrigerant and condensate services that must be brought into some of these rooms, these will take a direct route in e.g. will enter the room back entry into the wall mounted units.

6-3 ELECTRICAL SERVICES

6-3-1 BS 7671 IET WIRING REGULATIONS

The electrical installation shall be designed, selected, installed, inspected and tested in strict accordance with the latest version of BS 7671 IET Wiring Regulations – Requirements for Electrical Installations and all supporting IET documentation.

6-3-2 ELECTRICAL CONTRACTING CERTIFICATION SCHEMES

The Contractor shall undertake all works in accordance with industry best practice and must be registered with an appropriate certification scheme for the electrical installation works being undertaken. The certification scheme shall provide a six year guarantee on completion of the works to rectify any non-compliance with the Building Regulations and electrical installation standards (including BS 7671 IET Wiring Regulations).

e.g. the National Inspection Council for Electrical Installation Contracting (NICEIC) / ELECSA – Platinum Promise registration scheme.

6-3-3 SECTION 2E ELECTRICAL WORKMANSHIP AND MATERIALS

Section 2E of this specification provides standard requirements for the installation. Where several possible installation methods / materials are available this section sets default requirements which shall be included.

These default requirements shall be followed unless there is explicit instruction to the contrary in a subsequent section dealing with the relevant system in more detail. Where such instruction is unclear or only inferred, written confirmation from the Engineer shall be obtained prior to submission of tender costs to clarify the requirements, and in the absence of such the more onerous requirements shall be included.

6-3-4 VOLT DROP

The volt drop between the origin of the installation and any load point shall not be greater than the values detailed within Appendix 4 of BS 7671, with respect to the value of the nominal voltage of the installation. The calculated volt drop shall include any effects due to harmonic currents.

6-3-5 LV DISTRIBUTION

The LV distribution shall be designed, selected, installed, inspected and tested in strict accordance with the standards and guidance detailed within the LV Distribution section of this specification.

Mains and sub-mains cabling shall be sized in strict accordance with the latest version of BS 7671 IET Wiring Regulations – Requirements for Electrical Installations and all supporting IET documentation.

The competed design shall be coordinated with all other services and the building requirements. The design shall be fully compliant with the entire documentation package issued.

Detailed design drawings shall be provided showing the setting out of all equipment included underground services, ducts and cable pits. The Electrical Contractor shall advise on the design of pits and cableways and these shall be provided in such a manner to prevent water ingress and to allow removal and re-installation of all services. In principle, cables shall be installed in ducts below all road and pathways and shall be suitably de-rated to suit.

Undertake cable sizing calculations to achieve full compliance with BS 7671 with the following assumptions:

1) Cables to be installed “flat touching” on tray/ladder (in practice larger cables shall be spaced by at least the width of the cable cleat.)
2) All protective devices shall be from a common manufacturer
3) Devices with standard trip characteristics shall be used where possible
4) RCDs shall NOT be relied upon to achieve the required disconnection time
5) Compliance with clause 521 of the IET Wiring Regulations shall be demonstrated using 70 degree cable data as necessary
6) All equipment shall be sized with spare capacity for future growth of 25%

Undertake a detailed protection study for the complete LV distribution network to verify all cables sizes and protective devices to fully comply with the BS 7671 IET Regulations. This shall include, but not be limited to, analysis of prospective short circuit currents, operating times, discrimination, allowed voltage drop, withstand current of devices and switchboards, protection settings. The completed study shall be issued to the Employer for comment before implementation.

Where the incoming supply is provided by the DNO the Contractor shall be responsible for all necessary liaison, including programme, timing, technical coordination etc. and for obtaining any necessary consents for co-generation.

6-3-6 UTILITY POWER

The utility power shall be designed, selected, installed, inspected and tested in strict accordance with the standards and guidance detailed within the Utility Power section of this specification.

Final circuit cabling shall be sized in strict accordance with the latest version of BS 7671 IET Wiring Regulations – Requirements for Electrical Installations and all supporting IET documentation. Additionally the following minimum parameters shall be adhered to when undertaking the final selection of cables:-

FINAL CIRCUIT TYPE	MINIMUM LINE AND NEUTRAL CONDUCTOR CROSS-SECTIONAL AREA	MINIMUM CIRCUIT PROTECTIVE CONDUCTOR CROSS-SECTIONAL AREA
32A Ring Circuit	4 x 2.5mm^2	2 x 1.5mm^2
32A Radial Circuit	2 x 4.0mm^2	1 x 2.5mm^2
20A Radial Circuit	2 x 2.5mm^2	1 x 2.5mm^2

FINAL CIRCUIT TYPE	MINIMUM LINE AND NEUTRAL CONDUCTOR CROSS-SECTIONAL AREA	MINIMUM CIRCUIT PROTECTIVE CONDUCTOR CROSS-SECTIONAL AREA
10A Lighting Circuit	2 x 1.5mm^2	1 x 1.5mm^2

The quantities of sockets on each circuit shall be selected based on the load, the likely use of circuit, the likely leakage current of connected equipment and to ensure nuisance tripping does not occur.

6-3-7 INTERNAL LIGHTING

The internal lighting is to be retained and rewired as described in the preliminary's section of the specification

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6-3-8 MISCELLANEOUS ELECTRICAL SYSTEMS

The miscellaneous electrical systems shall be designed, selected, installed, tested and commissioned in strict accordance with the standards and guidance detailed within the Miscellaneous Electrical Systems section of this specification.

6-4 ENERGY METERING SYSTEMS

The design criteria for the energy metering systems are detailed in the Energy Metering Section of this Specification as the metering shall be designed by the energy metering specialist.

Section E1A

Low Voltage Distribution

Contents

E1A-1 GENERAL REQUIREMENTS

This section details the requirements for the Low Voltage (LV) distribution systems and gives the minimum standards of materials and workmanship that are required.

E1A-2 DEFINITIONS

Refer to Section 2E / Section 1B of this specification and Part 2 of BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations for further details regarding definitions, symbols and abbreviations.

E1A-3 REFERENCES TO OTHER SECTIONS OF THIS SPECIFICATION

This section shall not be read in isolation and must be read in conjunction with all other sections of this specification which define further requirements for the electrical installation.

Section 2E details the default requirements for electrical workmanship and materials which shall apply fully to this section of the specification.

E1A-4 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS AND DOCUMENTS	
BS 7671	IET Wiring Regulations – Requirements for Electrical Installations, including all IET Guidance Notes and the IET On Site guide
BEAMA Guide to forms of separation of LV Switchgear and Assemblies to BS EN 61439-2	
All standards, guidance and statutory regulations detailed within Section 2E	
BS EN 61439-1	Low Voltage Switchgear and Control Gear Assemblies – General Rules
BS EN 61439-2	Low Voltage Switchgear and Control Gear Assemblies – Power switchgear and controlgear assemblies
BS EN 61439-3	Low Voltage Switchgear and Control Gear Assemblies – Distribution Boards intended to be operated by ordinary persons
BS EN 61439-6	Low Voltage Switchgear and Control Gear Assemblies – Bus bar trunking systems
BS EN 60898-1	Circuit breakers for overcurrent protection for household and similar installations AC operation
BS EN 60898-2	Circuit breakers for overcurrent protection for household and similar installations AC and DC operation
BS EN 60947-2	Circuit breakers for industrial applications
BS EN 60947-3	Switches, disconnectors, switch-disconnectors and fuse combination units
BS EN 61009	Residual current operated circuit breakers
BS EN 60831	Power Capacitors
BS EN 61558	Safety of Power Transformers
BS EN 60529	Degrees of protection provided by enclosures
BS EN 62040	Uninterruptable Power Supplies
BS EN 62053	Electricity Metering Equipment (a.c.)
BS EN 62305	Protection against Lightning
BS IEC 61000	Electromagnetic Compatibility Limits
IEEE-519	Harmonic Limits
BS EN 60529	Degrees of Protection provided by enclosures
HTM 06-01	Electrical Services Supply and Distribution (Healthcare only)

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

E1A-5 SCOPE OF WORKS

The LV systems installation shall include the provision of the three new external supplies and the supply to 17B from 17A, please see section 01B for further details

E1A-6 METERS

DigiCard RFID prepayment Electricity energy meters shall be provided capable of displaying, logging and outputting the following:

1) Consumption in kWh
2) kW maximum demand peak
3) kVA maximum demand peak

All meters shall be provided with purchase payment cards and supplied to the council

4) Distribution boards – Schneider Acti 9 iRM3000 range or similar and approved

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E1A-7 SUB-MAINS CABLING

A complete system of mains and sub-mains distribution cabling shall be provided in accordance with this specification and the associated drawings.

The required standards for sub-mains cabling are given in Section 2E

It shall be noted that the submains calculations have been carried out based on the grouping factor assumptions detailed below and care shall be taken to ensure that the installation maintains these spacings:

E1A-8 FINAL DISTRIBUTION BOARDS

Provide final distribution boards for final circuits as detailed on the drawings and this specification, in particular the requirements of Section 2E and of BS EN 61439 Parts 1 & 3.. They shall be from a single manufacturer, with MCB/RCBOs from the same manufacturer.

All boards shall be provided with a main isolator/switch disconnector breaking all phases present AND the neutral.

Where three phase boards are provided these shall be of a type and pattern to allow three phase outgoing breakers to be fitted.

Miniature circuit breakers shall be of the same manufacturer the ACB/MCCB's and shall comply with BS 60898. They shall have a minimum short circuit withstand rating of 10kA.

Residual current circuit breakers with overcurrent (RCBO) shall comply with BS EN 61009 and shall be interchangeable with MCBs, thus taking up a single outgoing single pole way on the board. For tendering purposes it shall be assumed that all outgoing ways may need to be fitted with RCBOs.

A selection of both standard and split load distribution boards shall be provided to enable separate metering of lighting and power loads in accordance with the metering strategy.

All boards shall be fitted with sufficient neutral bar terminals to allow separate connection of the neutral conductor from each outgoing way, including spare ways. All boards shall be fitted with duplicate earth terminal bars to allow separate connection of two circuit protective conductors from each outgoing way, including spare ways.

All boards shall be provided with 25% spare ways which shall be fitted with MCBs of mixed ratings.

All distribution boards shall preferably by mounted at a height to allow access to all devices without operatives needing to stoop or use stepladders. Any situations where this is not possible shall be brought to the attention of the Engineer.

Where necessary to accommodate the cable sizes detailed, extension chambers and/or additional terminal capacity shall be provided.

E1A-9 EARTHING AND BONDING

Supply, install and test an earthing installation as detailed in this specification as the associated drawings.

A main earth bar shall be provided adjacent to the main LV panel. This shall be interlinked to the panel earth bar using cables sized as indicated on the drawings. The earth bar shall be 50mm x 6mm flat tinned copper appropriately labelled, including labelling of all bonds. The earth bar shall be provided with test links to allow external earth fault loop impedance testing.

Provide main equipotential bonds from the main earth bar to each of the main services detailed in section 2E.

Section E2

Utility Power

Contents

E2-1 GENERAL REQUIREMENTS

This section details the requirements for utility power installations and shall be read in conjunction with all other sections of this specification and the associated drawings.

E2-2 DEFINITIONS

Refer to Section 2E / Section 1B of this specification and Part 2 of BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations for further details regarding definitions, symbols and abbreviations.

E2-3 REFERENCES TO OTHER SECTIONS OF THIS SPECIFICATION

This section shall not be read in isolation and must be read in conjunction with all other sections of this specification which define further requirements for the electrical installation.

Section 2E details the default requirements for electrical workmanship and materials which shall apply fully to this section of the specification.

E2-4 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS AND DOCUMENTS	
BS 7671	IET Wiring Regulations – Requirements for Electrical Installations – Part 6 Inspection and Testing
IET On-Site Guide – BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations	
All IET Guidance Notes – BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations, in particular:-	
IET Guidance Note 1 – Selection & Erection	
BS 1363	13A plugs, socket-outlets, adaptors and connection units
BS 4177	Specification for Cooker control units
BS 4573	Specification for 2-pin reversible plugs and shaver socket-outlets
BS 5733	General requirements for electrical accessories – Specification
BS 7288	Specification for Socket-outlets incorporating residual current devices (s.r.c.d's)
BS 8300	Design of buildings and their approaches to meet the needs of disabled people – Code of practice
BE EN 50428	Switches for household and similar fixed electrical installations – Collateral standard – Switches and related accessories for use in home and building electronic systems (HBES)
BS EN 60309	Plugs, socket-outlets and couplers for industrial purposes
BS EN 60669	Switches for household and similar fixed electrical installations
BS EN 60947	Low voltage switchgear and controlgear
BS EN 61558-2-5	Safety of transformers, reactors, power supply units and combinations thereof – Part 2-5: Particular requirements and tests for transformer for shavers, power supply units for shavers and shaver supply units
IEC 60950-1	Information technology equipment – Safety – Part 1: General requirements

STANDARDS AND DOCUMENTS	
IEC 61000-6-1/3	Electromagnetic compatibility (EMC) – Generic standards
IEC 61558-2-16	Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V – Part 2-16: Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units
The Building Regulations – Approved Document M	
The Building Regulations – Approved Document P	
All standards, guidance and statutory regulations detailed within Section 2E-3	

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

E2-5 SCOPE OF WORKS

The utility power installation shall include the provision of the following:-

Splitting of the existing circuits and rewiring to the new distribution boards and making good

It shall be noted the above lists are not exhaustive and reference must be made to all sections of this specification and the associated drawings.

All due allowances shall be made within the tender submission to ensure all necessary power supplies, wiring accessories, final connections and associated equipment is provided for the electrical installation, with particular attention paid to electrical systems where the Contractor has design responsibility (where it shall be the Contractor's responsibility to provide all necessary power supplies e.g. additional power supplies for security systems / fire-fighting and life safety systems).

Where discrepancy is found between the utility power requirements detailed within this specification / drawings and Specialist specifications / drawings (e.g. Kitchen / Laboratory Specialists), written clarification shall be obtained from the Engineer prior to submission of tender. Where a discrepancy has not been clarified prior to tender submission the most onerous requirements shall be included within the tender price.

E2-6 CABLE SUPPORT AND CONTAINMENT SYSTEMS / CABLING AND WIRING SYSTEMS

Refer to Section 2E of this specification.

Final circuiting for the utility power installations shall be provided in strict accordance with the low voltage distribution schematic(s) and distribution board schedules provided within this specification. The information provided on the low voltage distribution schematic(s) and distribution schedules shall take precedence over the information provided within this specification e.g. where XLPE/SWA/LSZH armoured cables are to be used for final circuits etc.

E2-7 INSTALLATION RESPONSIBILITY

Appendix II of this section provides a Utility Power – Installation Responsibility Schedule which details the installation responsibilities and methods of connection for the utility power installations.

The Electrical Contractor shall provide all:-

1) Power supplies (including wiring, terminations and cable support / containment systems).
2) Wiring accessories.
3) Final connections from wiring accessories to fixed equipment (including wiring, terminations and cable support / containment systems).

All final connections shall be undertaken using LSZH (LSOH, OHLS) cabling with emissions of hydrogen chloride gas < 0.5%.

Fire-fighting, life safety and security final connections must be installed concealed and / or recessed within the building fabric to provide a flush finish.

Installation responsibilities and final connection details provided within subsequent sections of this specification or detailed on the drawings, shall take precedence over the information provided within Appendix II – Utility Power – Installation Responsibility Schedule.

Where discrepancy is found between the installation responsibilities / methods of final connection detailed in Appendix II and Specialist specifications / drawings, written clarification shall be obtained from the Engineer prior to submission of tender. Where a discrepancy has not been clarified prior to tender submission the most onerous requirements shall be included within the tender price.

E2-8 INSPECTION AND TESTING

The utility power installations shall be inspected and tested in strict accordance with BS 7671 and Section 2F of this specification.

Section E3

Internal, External and Emergency Lighting

Contents

E3-1 GENERAL REQUIREMENTS

The preliminary section of the specification covers the scope of works

E3-2 REFERENCES TO OTHER SECTIONS OF THIS SPECIFICATION

This section shall not be read in isolation and must be read in conjunction with all other sections of this specification which define further requirements for the electrical installation.

Section 2E details the default requirements for electrical workmanship and materials which shall apply fully to this section of the specification. Wiring accessories shall match the appearance of those associated with utility power, voice / data and the like.

E3-3 SCOPE OF WORKS

The lighting systems installation shall be retained and the circuits split to suit the new DB's

E3-4 COMMISSIONING, MAINTENANCE FAMILIARISATIONS AND TRAINING

All equipment shall be tested and inspected prior to the systems being offered to the Engineer and the Client. A fully functional test shall be demonstrated before any certification is accepted on behalf of the Client.

The lighting systems and associated controls will require a considerable period of time to commission. The Electrical Contractor shall ensure that sufficient time is allowed in the Main Contractor's programme to fully commission the systems in line with this specification and to the satisfaction of the Engineer. The control system manufacturer (specialist) shall be employed to set up and commission their controls and it is emphasised that this shall not be undertaken until all other works in the spaces have been completed, (thus allowing the spaces to be cleared of other workers.)

The Contractor shall, immediately following handover, carry out familiarisations and training to Client staff and maintenance personnel. At least 2 full days shall be allowed for both the Electrical Contractor and their specialists to carry out systems familiarisations (Day 1), followed by system training (Day 2). The Contractor shall co-ordinate these dates with the Client, and to supervise each training day session given. The Contractor shall also manage his specialists on each day, provide an agenda for training to be given 1 week prior to the site visit, and on each day formally record all those in attendance, and at the end of each session record Q&A.

The Contractor shall also allow for 2 whole day visits by the controls specialist for any programming modification/adaptation to the installed systems around the time just after handover. This will enable any Client fine tuning required to complete the system. After this a further 3 days float shall be allowed for. These 3 days may not be taken up immediately after handover and allowance should be made for them during the first year. These are for any Client adaptations that are currently unforeseen as the Clients' energy policies adapt to ever changing climates. This is described above in the Lighting Control section.

E3-5 INSPECTION AND TESTING

The lighting system(s) shall be inspected, tested and commissioned in strict accordance with manufacturer's recommendations and the standards detailed earlier within this specification as appropriate.

The electrical installation works associated with the lighting system(s) shall be inspected and testing in strict accordance with BS 7671 and Section 2F of this specification. All circuits / test results shall be recorded on the 'Schedule of circuit details / Schedule of test results' provided within the Electrical Installation Certificates).

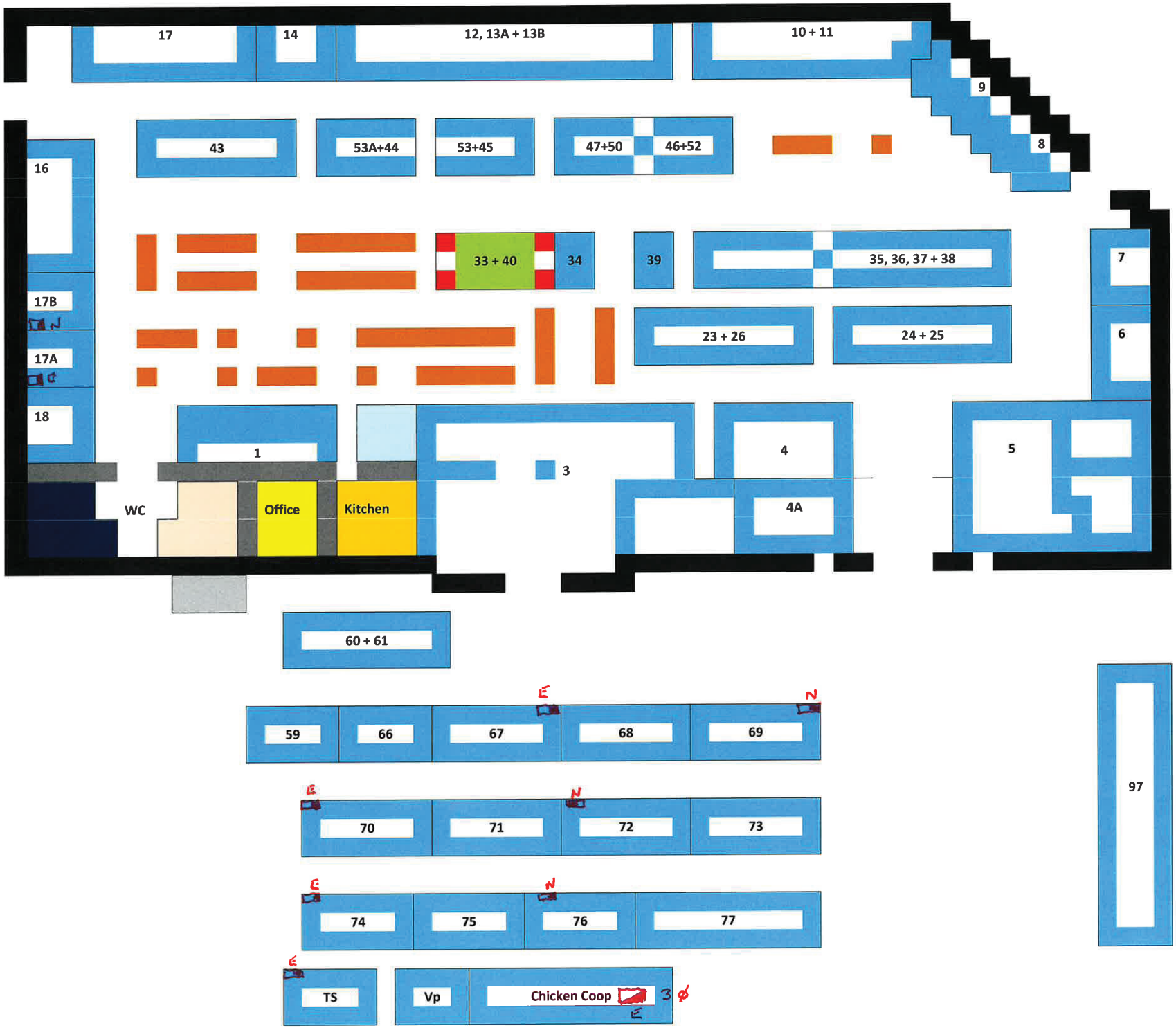
Formal witnessing of testing and commissioning shall be undertaken in strict accordance with Section 2F of this specification.

Upon completion the system(s) shall be demonstrated to the Engineer and the Client. The Contractor / Lighting Specialist(s) shall provide training to the Client until they fully understand the operation of the system.

Commissioning certification shall be provided to verify the correct installation and operation of the lighting system(s). The commissioning certification and as-installed drawings for the lighting system(s) shall be included within the O&M manual.

Appendix 1

Stall Numbering Drawing


17
14
12, 13A + 13B
10 + 11
9
8
43
53A+44
53+45
47+50
46+52
16
17B
17A
18
33 + 40
34
39
35, 36, 37 + 38
7
6
23 + 26
24 + 25
1
3
4
4A
5
WC
Office
Kitchen
60 + 61
59
66
67
68
69
70
71
72
73
74
75
76
77
97
TS
Vp
Chicken Coop
3 ϕ
E
N
1 ϕ OB
E = EXISTING
N = NEW

couchperrywilkes
engineering change

Rossendale Borough Council

Rawtenstall Market

210447

Electrical Tender Analysis

DOCUMENT REVISION HISTORY			Ref:	210447
Rev	Author	Verification By	Date	Comments / Status
1	TS	GM	May 21	For Tender

Contents

1-0 PROJECT TENDER COSTS

PROJECT TENDER COSTS				
Item		**Description**	**Item Cost**	**Section Cost**
1	For all costs associated with Section 1 – Preliminaries			
	a)	General requirements	£	
	b)	Soft landing requirements	£	
		Section Total	£	£
2	Standard Installation Clauses			
2E	For all costs associated Section 2E – Electrical Workmanship and Materials		£	
2F	For all costs associated Section 2F – Electrical Inspection and Testing		£	
		Section Total	£	£
4	For all costs associated with Section 4 – Pre pay Energy Metering			
		Section Total	£	£
5	For all costs associated with Section 4 – Standard Metering			
	a)	Reduction for Standard Metering add to section 3 below do not add in this section	£	
	b)		£	
	c)		£	
	d)	Other	£	
		Section Total	£	£
6	For all costs associated with Section 6 – Design Standards			
	a)	Electrical	£	
		Section Total	£	£
E1A	For all costs associated Section E1A – LV Distribution			
	a)	Supply and Installation of Submains	£	
	b)	Supply and installation of RCBO's etc	£	
		Section Total	£	£
E2	For all costs associated Section E2 – Utility Power modifications			
		Section Total	£	£
E3	For all costs associated Section E3 – Internal Lighting modifications			
	a)	Internal Lighting	£	
	b)		£	
	c)		£	
		Section Total	£	£
For any other electrical costs not detailed above, add description / cost below:				
	A		£	
	B		£	
	C		£	

PROJECT TENDER COSTS			
Item	Description	Item Cost	Section Cost
	Sub Total	£	£
	SUB TOTAL CARRIED FORWARD TO TENDER SUMMARY		**£**

2-0 PROVISIONAL SUMS

PROVISIONAL SUMS			
Item	Description	Item Cost	Section Cost
1)	Unforeseen sub circuit rewiring	£1,500.00	
2)	Unforeseen Lighting rewiring	£1,500.00	
3)	If new mains panel is required	£10,000.00	
4)			
5)			
	Sub Total	**£13,000.00**	£
	SUB TOTAL CARRIED FORWARD TO TENDER SUMMARY		**£13,000.00**

3-0 SPECIFIED COST OPTIONS (NOT TO BE INCLUDED WITHIN TENDER SUM)

SPECIFIED COST OPTIONS		
Item	Description	Item Cost
1	Reduction for standard Metering	
	TOTAL	£

SCHEDULE OF DAY WORK RATES

Work agreed to be carried out as daywork will be paid for at the following rates and such payment will only be for the net time worked on the Site. The rates are to include for overheads and profit, all supervision (being the cost of full-time foremen or additional rates paid to chargehands etc.), insurances, holidays with pay, bonus, pension schemes, subsistence allowances, fares and travelling time, imported labour costs, non – productive overtimes costs, tools of all descriptions and other payments made under the Working Rule Agreement or any Regulation, Bye-law or Act of Parliament.

The total of this Daywork Schedule shall be expended or deducted in whole or in part as directed by the Architect.

The Tenderer is to insert against the hours shown the hourly rates required, calculated in accordance with the above, for the various categories of labour.

SCHEDULE OF DAYWORK RATES	
Trade	Rate per hour
Foreman	£
Site Supervisor / Working Supervisor	£
Certified Engineer / Approved Electrician	£
Engineer / Fitter / Electrician	£
Technician	£
Apprentice	£
% Addition for non productive overtime	%

ADDITION FOR OVERHEAD & PROFIT FOR MATERIALS USE	
Include for the total hire and running costs of plant in use in dayworks, including fuel, spares, and transport to and from the site, unloading and loading.	%
Include for the total cost of materials for use in dayworks including any associated transport costs.	%
Sub-contractors	%

4-0 CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS 2015

We confirm that we are able to allocate sufficient and adequate resources to perform the duties as assigned to the Contractor under the Construction (Design and Management) Regulations 2015.

We have enclosed evidence which demonstrates our competence to perform the duties as set in Appendix 4 of the Construction (Design and Management) Regulations 2015 Approved Code of Practice.

SCHEDULE OF ENCLOSED DOCUMENTATION
Stage 1, Organisation and Arrangements for Health & Safety Management: -
Stage 2, Experience and Track Record : -

5-0 SCHEDULE OF ADDENDUMS

During the course of preparing our tender for the Works details in this Tender Analysis and described in the Associated Specification and drawings, the following Addendums were issued by the Engineer.

We hereby agree that all costs have been included in our tender for the items detailed in the Addendums, including any costs associated with Sections 1 and 2 of this Specification.

SCHEDULE OF ADDENDUMS	
Addendum Number	Date Issued

6-0 SCHEDULE OF WORK TO BE SUB-LET

The Tenderer shall indicate below the names of all Firms for which he proposes to sub-let any part of the works.

SCHEDULE OF WORKS TO BE SUB LET	
Work to be sub-let	Name of Sub Contractor

7-0 TENDER SUMMARY

We, the undersigned, do hereby offer to carry out the whole of the work described in this Specification, and the associated drawings for the project as referenced above, in strict accordance with the terms and conditions thereof, for the following sums of money: -

TENDER SUMMARY		
Item	**Description**	**Total Cost**
1	Project Tender Costs	£
2	Provisional Sums	£13,000.00
	Total Fixed Price	**£**
	State any inclusion for Main Contractors Discount (MCD)	**£**
	Total	**£**
3	Enter “Specified Cost Options”	**£**

ACTIONS	
Complete?*	**Description**
YES / NO	Schedule of Day Work Rates COMPLETED?
YES / NO	CDM - Evidence of Competence ENCLOSED?
YES / NO	Material Schedule COMPLETED?
YES / NO	Schedule of Alternative Materials (refer Clause 1B-5) ENCLOSED?
YES / NO	Schedule of Addendums COMPLETED and INCLUDED?
YES / NO	Schedule of Work to be Sub-Let COMPLETED?
YES / NO	Lift Appendix 1 – deviation from specification requirement ENCLOSED?
YES / NO	Lift Appendix vi – Compliance Schedule COMPLETED and ENCLOSED?

** Delete as necessary*

TO BE COMPLETED AT TIME OF TENDER	
FIRM	
ADDRESS	
SIGNED	
DATE	