



**SPECIFICATION FOR
ELECTRICAL SERVICES
AT
38-42 MOSLEY STREET
GRADE 2* LISTED BUILDING CAT A
REFURBISHMENT**

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E01 SCOPE OF WORK**E010100 INTRODUCTION**

- (a) The following specification is for the Cat A refurbishment of 38-42 Mosley Street, in central Manchester. The building is a six-storey Grade 2* listed building that was formerly a retail bank and includes a ground floor Banking Hall that will be let out as a Food & Beverage (F&B) offering.
- (b) The building includes old bank vaults at basement level that are constructed of substantial reinforced concrete walls and the Electrical Services Installer (ESI) shall recognise that builders' work openings at basement level will need to be carefully coordinated with main contractor.
- (c) The Banking Hall at ground floor and the basement area immediately below will form part of a F&B tenant. The rest of the basement area will be used for tenant services including bike store, gym and associated toilets, showers and changing facilities as well as including the main LV switchroom and comms rooms.
- (d) Ground floor includes the main entrance and reception with a lounge area for tenant with the remainder of the ground floor, 1st, 2nd & 3rd floors office accommodation. The scope of this works is for the Cat A refurbishment only with a subsequent contract planned for the Cat B fit out of the office areas on behalf of the tenants.
- (e) 38-42 Mosley Street shares certain elements with the adjacent building 57 Spring Gardens and a new access is to be created linking the buildings at basement level. In addition to this, the main building supply serving Mosley Street is fed from the main switchboard and ENWL substation located in the basement of Spring Gardens. Both buildings are owned by the same landlord.
- (f) Due to space restrictions within 38-42 Mosley Street, the proposed new mist sprinkler system plant and tank, detailed separately, will be located in the basement of 57 Spring Gardens with electrical works including power and fire alarms to serve this included.
- (g) Mosley Street is currently vacant, and the Cat A refurbishment will be completed whilst the building is empty. However, the ESI shall be aware that the staircase adjacent to both buildings is used as a means of escape from 57 Spring Gardens at all levels and this will need to be retained during the project, maintaining the lighting and fire alarm systems, that are fed from Mosley Street.
- (h) The electrical installations within the building have recently been partially isolated, disconnected and stripped out. The scope of works shall include the full isolation, disconnection, strip-out and disposal of the remaining existing electrical installations throughout. Where appropriate, existing services have been indicated on the drawings for reference only and the tenderer shall review these as part of the tender site visits arranged via the Main Contractor.
- (i) The ESI shall be expected to undertake a full intrusive survey of the building, as well as the roof, to verify the design Specification and associated design drawings prior to commencing their Stage 5 installation drawings and shall bring to the Engineer's attention in writing any issues with the existing installation that may affect the scope of works.

- (j) The ESI's attention is brought to the project preliminaries, issued by others, and the tender schedules included separately. The tenderer shall ensure that these schedules are completed and included as part of their tender submission in addition to any requirements of the contract preliminaries.
- (k) The ESI's attention is drawn to the approved manufacturers schedule within a separate document. Alternative manufacturers shall not be used or tendered without prior written confirmation from the Engineer. Any proposed alternative manufacturers or sub-contractors to be used shall be fully detailed and submitted at the time of tender.
- (l) At each stage of the construction works the ESI shall develop and submit detailed Risk Assessments and Method Statements (RAMS) for completing their works, particularly where this involves isolation of existing electrical services or potentially affects the operation and/or security and/or safety of the adjacent building and its occupants. The ESI shall develop the RAMS in conjunction with the Main Contractor and allow a minimum period of 4 weeks for review and approval.
- (m) As part of the tender it is essential that the tendering ESI visit site and acquaint themselves with the existing building
- (n) This Specification describes the particular requirements for the Electrical Engineering Installations and shall be read in conjunction with the following documents.
 - i) General Electrical Schedules, reference E970000 including the drawings referenced therein
 - ii) Schedule of Luminaires, reference E975700
 - iii) Distribution Board Schedules, reference E979000
- (o) The ESI shall be responsible for the development of their Stage 5 installation drawings, together with any Contractor Design Portion (CDP), as detailed elsewhere in this Specification, the electrical services based on this Specification and associated design drawings as well as other design and contract documents issued by the Architect, QS, Project Manager and Employer.

E010400 DEFINITIONS

- (a) The following terms are used within this specification and shall be construed accordingly:
 - i) **Contractor** - Contractor shall mean the person or persons appointed to carry out the Main Contract Works and shall have the same meaning as is defined in the Conditions of Contract. They may also be referred to as Principal Contractor, which shall have the same meaning.
 - ii) **Employer** - Employer shall mean the person or persons employing the Contractor to carry out the Contract Works and shall have the same meaning as is defined in the Conditions of Contract
 - iii) **Engineer** - Engineer shall mean the person or persons appointed by the Employer to represent him in connection with the installation of the works described in this specification

- iv) **Electrical Services Installer (ESI)** - For the purposes of the Tender, the Electrical Services Installer shall be the person or persons invited to prepare a Tender for the Works described within this specification, including all ancillary work and information requirements. Where the successful Tenderer is appointed to carry out the Works as a Domestic Sub-Contractor the instructions as to the extent of the work shall be agreed with the Contractor, who shall ensure that the installation is complete and in accordance with this specification
- v) **Responsible Person** - For the purposes of the tender shall be the person or persons appointed by the client who manages the installation and its component parts and is able to determine that the configuration of the installation is such that when used it complies with the essential requirements of the Electromagnetic Compatibility Regulations

E010700 GENERAL

- (a) This specification sets out the standards of materials to be used and standards of workmanship to be adopted for the electrical services installation.
- (b) The specification, including the technical schedules, is to be read in conjunction with the drawings, which jointly describe the contract works. Where a discrepancy is identified between the requirements of the specification and the drawings, the specification is to take precedence and the discrepancy notified to the Engineer for the necessary action to be implemented.
- (c) The contract documentation is to be read as a whole. It is the responsibility of any party issuing any part of the documentation to others to ensure they provide recipients with all parts of the contract documentation, (including but not limited to the specification clauses, technical schedules and drawings) relevant to their scope or involvement and that they comply with the contract requirements in all respects. The issuing party will be responsible for any discrepancies caused by a failure to comply with this clause.
- (d) Where the Contractor elects to split the engineering services into separate Works Packages, it shall be the Contractors responsibility to identify the scope of works for each individual package and ensure the interfaces between packages are coordinated.
- (e) Materials and equipment shall comply with current issues, including amendments, of relevant British Standard specifications. Where a British Standard has been superseded by a European Standard adopted within the United Kingdom (BS EN) then the replacement standard shall take precedence. Wherever possible, metric dimensioned equipment shall be employed.
- (f) Manufacturers and specialists shall be advised of the full details of any equipment, including the relevant Standards and any appropriate conditions with the enquiry.
- (g) The requirements of all applicable United Kingdom and European Legislation current at the time of execution and applicable to the works shall be complied with including but not limited to the following:
 - i) Health and Safety at Work Act, including recommendations, regulations and Statutory Instruments issued by the Health and Safety Executive
 - ii) Construction Design and Management Regulations

- iii) Building Regulations including approved documents and guidelines
 - iv) The Electricity at Work Regulations
 - v) Electricity Safety, Quality and Continuity Regulations
 - vi) The Electromagnetic Compatibility regulations
 - vii) The Energy Related Product Directive and associated UK legislation
 - viii) The Construction Product Regulations and associated UK legislation
 - ix) Measuring Instruments Directive and UK Certification requirements where such instruments may be used for the resale of energy
- (h) The works shall also be carried out in accordance with the standards, recommendations and guidelines of the following:
- i) Local Planning Authority's requirements including any specific requirement pursuant to the works.
 - ii) Local Environmental Health Authority's requirements including any specific requirement pursuant to the works.
 - iii) Requirements of the Local Building Control Officer or Approved Inspector
 - iv) British Standards Institute
 - v) Any requirements of statutory authorities providing utility connections or services to the works including the Distribution Network Operator, Water Authority, Gas Provider, Drainage Provider and Communications Systems Providers.
 - vi) Chartered Institution of Building Services Engineers
 - vii) Building Services Research and Information Association
 - viii) Engineering Networks Association.
 - ix) Electrical installation work shall only be undertaken by contractors approved by the National Inspection Council for Electrical Installation Contracting and/or are members of the Electrical Contractors Association and shall comply with the requirements of BS 7671.

E011000 ASSOCIATED DOCUMENTATION

- (a) The following specifications will also form part of this building contract and the Electrical Services Installer shall satisfy himself that he has understood and included any interfaces required with works described in the current versions of these specifications:
- i) Specification for Mechanical Services, Ref 27618-HM-ZZ-ZZ-SP-ME-001
 - ii) Specification for Fire Protection Services, Ref 27618-HM-ZZ-ZZ-SP-FE-001
 - iii) General Electrical Schedules, reference E970000 including the drawings referenced therein
 - iv) Schedule of Luminaires, reference E975700

- v) Distribution Board Schedules, reference E979000
- (b) The following documents have also been prepared by the professional team in connection with this project and should be reviewed to ensure their contents relevant to this technical specification are understood by the Electrical Services Installer:
 - i) Acoustic Consultants Report
 - ii) Fire strategy report

E011300 HEALTH AND SAFETY

- (a) Work shall comply with the requirements of the Health and Safety Executive including Statutory Instructions and Recommendations issued by them.
- (b) The Construction (Design and Management) Regulations shall be complied with in the execution of the work. The instructions of the Principal Contractor and the requirements of the Health and Safety Plan shall be followed.
- (c) The works shall incorporate every reasonable precaution and provision for the safety of all those concerned in the installation, operation and maintenance of the Works and of associated works supplied and installed by others.

E011600 SERVICES TO BE PROVIDED

- (a) The Works shall comprise the supply, delivery, positioning, installation, setting to work, testing and commissioning of the Engineering Services. Including but not limited to the following systems:
 - i) Surveys and validation of existing
 - ii) Low voltage distribution including main and sub main distribution
 - iii) Life safety power generation and distribution
 - iv) Zero and low carbon energy generation systems (tbc)
 - v) Power to mechanical services control panels and where specified distribution directly to plant
 - vi) Electrical and Energy Metering Systems
 - vii) Structured data cabling (containment systems only)
 - viii) General, emergency and external lighting systems
 - ix) Lighting control systems
 - x) Automatic emergency lighting control systems
 - xi) Small power systems
 - xii) Fire detection and alarm systems
 - xiii) Power and containment only for security installations
 - xiv) Ancillary services as described within the specification
 - xv) Earthing and bonding including lightning protection

- xvi) Commissioning and setting to work
- xvii) Documentation
- xviii) Training
- (b) Costs involved in negotiations for Licences, Police Attendances, Notices and the like involved in temporary road closures in connection with plant deliveries etc. shall be included. Arrangements shall comply with the requirements of the Health and Safety Executive.
- (c) Inspection and approval of equipment by the Employers Insurance Company, required by British Standard specifications and by this specification shall be provided.
- (d) The works shall include but not be limited to the following:
 - i) Production of working drawings, builders work drawings and any other detail drawings necessary to fully describe the extent of the works including all liaison and coordination necessary with other trade contractors and members of the Professional Team
 - ii) Equipment data and samples for comment
 - iii) Materials and equipment procurement
 - iv) Installation of Services as noted within the specification and detailed on the drawings
 - v) Completion of Contractor Design elements as noted within the specification
 - vi) Fabrication, erection and installation of the works described in this specification, including secondary steelwork supports where necessary
 - vii) Testing at works where specified
 - viii) Shipping, delivery and storage and transportation between storage and site
 - ix) Lifting, setting out, positioning and fixing
 - x) Removal of rubbish and surplus materials
 - xi) Protection of the works against damage and misuse and removal of the protection at completion
 - xii) Pre-commissioning testing
 - xiii) Testing and setting to work
 - xiv) Commissioning
 - xv) Maintenance until practical completion of the project
 - xvi) Demonstration of systems as required to the:
 - Engineer
 - Building Control Officer
 - Client
 - xvii) Demonstration and Instruction of systems as required to the:

- Client
 - Building Operator
 - Maintenance Team
- xviii) Health and safety file including record drawings, Maintenance Manuals and Building Log Book
- xix) Seasonal commissioning where specified
- xx) Any other specific requirements stated within this specification

E011900 TENDERS

- (a) Tenders shall be submitted on the format required by the tender documentation. The Tenderer shall complete the technical schedules (and appendices where included) attached to the rear of this Specification as part of the tender submission.
- (b) Tenders shall comply with the requirements of this Specification. Where the Tenderer wishes to submit an alternative for consideration it shall be submitted in an accompanying letter with a full description, including full details of any variation from the specification and the cost effect of the proposal.

E012200 SPECIALIST SUPPLIERS

- (a) Where equipment from specialist suppliers has been selected and specified within this Contract, the Contractor and Electrical Services Installer shall be responsible for ensuring that the equipment provided complies with the specification in terms of services requirements, connections and interfaces etc. to other services and spatial coordination.

E012500 MANUFACTURERS

- (a) Equipment shall only be selected from the manufacturers listed in this specification as these have been selected from Hilson Moran's Recognised Suppliers List (RSL).
- (b) Manufacturers listed in this specification and within the RSL have been subjected to a technical vetting procedure as part of their inclusion on the Hilson Moran Recognised Supplier List (RSL).
- (c) Where the Engineer considers equipment to be critical to the quality and or resilience of the services installation, no deviation from the RSL will be accepted.
- (d) The Engineer will confirm further acceptable Manufacturers beyond those listed in this specification and which are currently listed on the RSL upon request by the Electrical Services Installer.
- (e) Where the Electrical Services Installer wishes to offer an alternative manufacturer which is not included on the RSL, they will be required to participate in an equivalent vetting. Any reasonable additional costs or expenses expended by the Engineer or Client in connection with undertaking such vetting shall be the responsibility of, and borne by, the Electrical Services Installer with the appropriate time being allowed in the installation programme to allow this vetting to be undertaken. No claims for delays will be entertained.

- (f) Where the Electrical Services Installer wishes to put forward an alternative equipment manufacturer for consideration, it shall be the Electrical Services Installer's responsibility to ensure that all associated and consequential aspects are considered and accounted for, including any impact on Part L compliance. Alternative proposals must be accompanied by full technical details, including a specification compliance statement. Any deviations from the specification are to be clearly identified. In the absence of a full submission, requests for alternative manufacturers will be rejected.
- (g) The Engineers acceptance of an alternative manufacturer shall not relieve the Electrical Services Installer of any obligations under the Building Contract.
- (h) Any costs or consequential changes necessary to the design resulting from the acceptance of the alternative manufacturer shall be the responsibility of the Electrical Services Installer.
- (i) The Electrical Services Installer will either be required to provide a design warranty for any changes to the design or may be required to pay reasonable costs for the Engineer to review the changed design information in order for it to be included within the Engineers Professional Indemnity Insurance or Design Warranty. .
- (j) Alternative Manufacturers shall not be accepted unless specifically agreed by the Engineer and Employer in writing.

E012800 CONTRACTOR DESIGN

- (a) The Engineer has designed the Engineering services as described by the Tender Documentation. Selection of particular plant and installation methodology will impact upon this design. The Electrical Services Installer shall therefore be responsible for designing the following to take account of this:
 - i) Brackets, supports, fixings and clamps
 - ii) Life safety generator installations including fuel oil storage, and supply, air distribution, acoustic attenuation etc. in order to meet the design criteria specified
 - iii) Carry out a full Protection Study (Discrimination Study) and fault analysis of the electrical infrastructure to verify correct selection of equipment in order to meet the design criteria
 - iv) Development of the design of the Energy Metering System
 - v) Layout and sizing of all wire ways including conduit, trunking, tray and ladder
 - vi) Fire alarm software and equipment selection to achieve the performance criteria specified, including full development of cause-and-effect schedules
 - vii) Final layout of general and emergency lighting including illuminated escape signage to plant rooms and service corridors to meet design criteria
 - viii) Lighting control system to meet the specified performance criteria
 - ix) Selection of plant and equipment to meet the specified criteria including all services design and co-ordination required to modify connections, services to facilitate the plant and equipment selected

- x) Production of working drawings and co-ordination as required by the specification
 - xi) Design of steel walkways, cat ladders, (where specified)
 - xii) Expansion and contraction
 - xiii) Detailed design of interfaces based on the specific equipment selected to meet the specified performance
 - xiv) Builders work in connection
 - xv) Selection and installation of surge protection devices
 - xvi) Fire alarm system cause and effect matrix
 - xvii) Photo voltaic systems
- (b) The Electrical Services Installer shall enter a design warranty with the employer for the above if requested.

E013100 ENHANCED TECHNOLOGY LIST

- (a) The Electrical Services Installer shall, wherever possible, incorporate qualifying high-performance energy efficient equipment into the Works, selected from the Energy Technology List (ETL), that will support a claim for accelerated tax relief such as Annual Investment Allowance (AIA). A list of qualifying equipment and requirements for qualification can be found on the Governments Department for Business, Energy & Industrial Strategy website (<https://etl.beis.gov.uk/>).
- (b) The Electrical Services Installer shall agree with the Contractor the lines of communication between Suppliers, Sub-Contractors, Employer and his Financial Advisers to collate the necessary information to support any claim on behalf of the Employer.

E013400 ENVIRONMENTAL ASSESSMENT

- (a) It is the responsibility of the Electrical Services Installer to establish whether an environmental assessment (BREEAM, LEED, WELL, HQM or similar) is being carried out on the project and if so, to obtain a copy of the Assessors current report and comply with it. Complying with and achieving credits relating to construction activities shall deem to be included within the tender. Where the Electrical Services Installer has a design responsibility, credits relating to design activities shall also deem to be included within the tender.
- (b) Where an Environmental Assessment is being undertaken, this technical specification may include a specific section relating to these requirements, which is to be read in conjunction with all other sections of the specification and complied with in all respects.
- (c) The Electrical Services Installer shall at all times undertake his work to ensure targeted credits are achieved in the final Post Construction /Post Fit Out Assessment and shall provide the appropriate evidence as required by the Assessment method being followed. Any “at risk” credits shall be discussed with the Assessor and Engineer at the earliest opportunity.

E015000 SERVICES DESCRIPTION**E015001 GENERAL INTRODUCTION**

- (a) The ESI shall be responsible for and include all costs for the supply, delivery, positioning, installation, setting to work, testing and commissioning of the Electrical Engineering Services, as detailed within this Specification and associated design drawings, including but not limited to:
- i) Intrusive survey/investigation of existing electrical services to validate the design requirements.
 - i) Isolation, disconnection and strip-out of remaining electrical services.
 - ii) Attendance to Main Contractor for associated building works
 - iii) New low voltage standby generator and automatic transfer switches for life safety plant
 - iv) General small power, including power to mechanical services plant and equipment
 - v) General and emergency lighting systems
 - vi) Lighting controls
 - vii) Automatic fire detection and alarm system, including aspirated smoke detection system for specific locations
 - viii) Emergency voice communication system (EVCS)
 - ix) Containment for LV and ELV wiring installations, including for specialist installations such as structured data cabling, security and audio-visual designed and installed by others
 - x) Earthing and bonding in accordance with statutory requirements, including alterations to lightning protection system
 - xi) Builders' work in connection with the electrical installations.
 - xii) Testing, commissioning and setting to work
 - xiii) Record documentation and certification
 - xiv) Instruction / training of maintenance / client staff
- (b) The ESI shall be expected to liaise closely with the Main Contractor throughout the project within an occupied building, particularly the life-safety and security installations.

E015030 INTRUSIVE SURVEYS & INVESTIGATION

- (a) The ESI shall undertake an intrusive survey of the electrical installations within the specific areas of the building, including the main electrical switchroom and associated electrical risers, prior to completing the strip out and installation works to enable the tender scope of works to be validated, the working/installation drawing production to commence and the project programme developed.
- (b) Intrusive investigations shall be provided to enable the design to be validated and shall include investigation of the main switchboard within 38-42 Mosley Street to confirm existing fuse ratings and the capability of the existing fuse carriers to include the fuses detailed on the design drawings. The ESI shall arrange for this investigation to be carried out with the Engineer in attendance.
- (c) The ESI shall allow for intrusive investigations of the main switchboard to assess the feasibility of installing a mains failure relay to provide a signal to the standby generator. A provisional sum has been included for the work to install the mains failure relay, if feasible. The ESI shall arrange for this investigation to be carried out with the Engineer in attendance.
- (d) The ESI shall allow for intrusive investigations of the existing Banking Hall lighting to enable the Engineer and Specialist Lighting Manufacturer to confirm the scope of works necessary to refurbish the luminaires with new LED sources and drivers. The scope will include high level access to remove the luminaires and taking them apart to establish what can be undertaken. The ESI shall arrange for this investigation to be carried out with the Engineer and Specialist Lighting Manufacturer in attendance.
- (e) The ESI shall allow sufficient resources to inspect the electrical services, and shall liaise with the Main Contractor and their sub-contractors for access to electrical cupboards, risers etc.
- (f) Where such intrusive investigations require a shut-down/isolation of plant and equipment this shall be arranged out of normal working hours with the Project Manager and Engineer.
- (g) Where existing electrical installations have been retained, including sub-mains installations to sub-distribution panels and final circuit distribution boards, these shall be tested in accordance with BS 7671 and any defects identified in writing to the Engineer. Final circuit cables serving retained equipment including the fire alarm panel or mechanical plant shall also be tested in accordance with BS 7671 and any defects identified in writing to the Engineer.
- (h) The ESI shall submit a written report to the Engineer and Employer within 5 working days advising of any faults or concerns that they have with the existing installation, ***as it relates to the scope of works***, with budget costs to rectify.

E015050 DESIGN AND DESIGN DOCUMENTATION

- (a) This section shall be read in conjunction with Section E92 & E94 of this Specification.
- (b) The ESI shall, within 4 weeks of appointment submit their first draft of their installation drawings, allowing the Engineer up to 2 weeks for review and commenting.

- (c) Orders for main plant and equipment shall not be placed until the technical submissions, installation drawings and, where appropriate, i.e. for standby generators and automatic transfer switches (refer to general schedules for further details), manufacturer's drawings have been received and commented on by the Engineer.

E015060 STRIP OUT OF EXISTING SERVICES

- (a) The ESI shall be responsible for the isolation, disconnection and strip out of the remaining existing/redundant electrical installations as generally indicated on the drawings including, but not limited to, the following:
 - i) Mains, sub-mains and final circuit distribution equipment, cabling and components
 - ii) General lighting, emergency lighting and lighting controls
 - iii) Fire alarm system including control panel, devices and cabling (note existing fire alarm control panel in 38-42 Mosley Street is to be relocated to 57 Spring Gardens)
 - iv) Security installations, unless required to maintain the security of the building
 - v) Containment
- (d) The ESI shall investigate those electrical installations that are identified to be removed to assess any impact on installations outside of the project area. In these situations, the ESI shall bring the issue to the Engineer's attention and seek advice as to the requirements.
- (e) The ESI shall liaise with the building management via the Project Manager and Engineer, for any isolations outside of the Employer's demise, i.e. isolation of main rising busbar tap-off to distribution boards. The ESI shall provide fully detailed risk assessments and method statements at least 4 weeks in advance of the isolation to ensure that this can be reviewed by the Engineer and Employer and their representative.
- (f) The ESI shall liaise with the Main Contractor for the isolation, disconnection and strip out of electrical installations within elements of the building fabric that are to be demolished, as detailed by others, to ensure that they are isolated to meet the programme of works.
- (g) The ESI shall, at the time of tender, liaise with the Main Contractor to ascertain the extent of attendance required to meet the programme for the strip out of existing electrical installations, generally as detailed on the drawings. The ESI shall ensure adequate numbers of site visits and durations are allowed for within the contract to meet the Contractors programme.

E015060 TEMPORARY & ENABLING WORKS

- (a) There are no temporary or enabling works envisaged for this project.
- (b) The ESI shall ensure that lighting and fire alarm call points within the shared emergency escape stairs used by both 57 Spring Gardens and 38-42 Mosley Street must

015100 INCOMING UTILITIES

E015101 General Requirements

- (a) 38-42 Mosley Street is served from an existing 1000kVA ENWL substation located in 57 Spring Gardens that serves a main switchboard in that building that in turn serves the main switchboard in Mosley Street via a 630A fused metered supply, as generally indicated on the drawings.
- (b) The existing electrical supply will be retained with modifications only at the main switchboard located in Mosley Street, which generally shall involve the upgrade of existing fuses.
- (c) As part of the ESI's intrusive survey they shall inspect and verify the ratings of all existing fuse-carriers and fuse ratings against the design drawings, including:
 - i) The Spring Gardens main switchboard fuse rating serving Mosley Street, and
 - ii) Each fuse-carrier and fuse rating of each outgoing way of the main switchboard in Mosley Street.

E015130 Telecom Ducts

- (a) Existing telecom ducts enter Mosley Street via the LV switchroom and these will be retained for the building.
- (b) Bruntwood, through AH Connections, are arranging for the existing incoming telecoms services to be disconnected and the service provider's equipment recovered, and they will also arrange the new incoming services for the building.

015200 MAINS LOW VOLTAGE DISTRIBUTION

E015201 General Requirements

- (a) This section shall be read in conjunction with Section E31 & E34 of the General Materials and Workmanship Specification for providing new MCCB panelboards and MCB distribution boards
- (b) The ESI shall engage the services of a Specialist Distribution Board Manufacturer and Supplier as referenced below and within the Schedule of Recognised Specialist Suppliers (E970004) for the supply of all new distribution boards and panelboards.

Specialist Distribution Board Manufacturer & Supplier

Schneider Electric

Stafford Park 5, Telford, Shropshire, TF3 3BL

Contact: Takalani Mbayela

Tel: 0870 608 8608

Mobile: 07881 330161

Email: takalani.mbayela@se.com

- (c) The existing main LV switchboard located in the basement LV switchroom will be retained to serve the refurbished building. The remaining electrical distribution infrastructure including distribution boards and associated sub-mains cabling shall be isolated, disconnected, stripped out and disposed of offsite, and replaced with new as generally detailed on the drawings.

- (d) As stated previously, the ESI shall undertake an intrusive survey to investigate and confirm the size of fuse-carriers and fuse ratings detailed on the design drawings, bringing to the attention of the Engineer in writing any discrepancies.

E015210 Power Quality

- (a) Mosley Street has no existing power factor correction equipment or harmonic filters and no new power factor correction shall be installed as part of the refurbishment.
- (b) On completion of the refurbishment and with all new plant installed, commissioned and operational the power factor shall be recorded.

E015220 Life Safety LV Panelboard

- (a) The ESI shall liaise with the Specialist Generator Supplier & Installer to coordinate the supply and installation of the life-safety panelboard that shall either be installed as part of the generator factory assembly or installed on site in a space allocated within the purpose-built acoustic enclosure, detailed elsewhere in this Specification.
- (b) A new 6-way 630amp MCCB panelboard shall be installed within the life-safety standby generator enclosure to serve essential power to life safety equipment via automatic transfer switches detailed elsewhere in this Specification.
- (c) The MCCB panelboard shall be taken from the Schneider Electric Powerpact range, or equivalent and accepted.
- (d) The switchboard shall be provided with MCCB's as indicated on the drawings taken from the Schneider Electric NSX range and fitted with Micrologic 6.2E electronic trip units.

E015230 Tenant LV MCCB Panelboard

- (a) A new 5-way 250amp MCCB panelboard shall be installed within basement level riser north for the future F&B tenant, as generally detailed on the drawing.
- (b) The MCCB panelboard shall be taken from the Schneider Electric Powerpact range, or equivalent and accepted.
- (c) The switchboard shall be provided with MCCB's as indicated on the drawings taken from the Schneider Electric NSX range and fitted with Micrologic 5.2E electronic trip units.

E015240 MCB Distribution Boards

- (a) Single-section and split-section MCB distribution boards shall be supplied and installed as generally detailed on the drawings and in the distribution board schedules accompanying this Specification. The distribution boards shall be manufactured to allow future metering by the Schneider Electric Powertag system.
- (b) The MCB distribution boards shall be taken from the Schneider Electric Acti9 range, or equivalent and accepted.
- (c) The distribution boards shall be provided with MCB's taken from the Acti9 range, or equivalent and accepted.

- (d) All distribution boards shall be provided with sub-meters as indicated for connection to the energy metering system, as detailed elsewhere in this Specification.
- (e) All new MCB distribution boards shall be fitted with a bottom extension kit that shall be fully installed and ready for connection to the energy metering system including:
 - i) 230V AC Acti9 Smartlink device
 - ii) Distribution block
 - iii) RJ45 industrial ethernet connector for connection to the metering system
- (f) Refer to distribution board schedules for outgoing circuits that shall be fitted with Powertag wireless energy sensors.

E015250 METERING**E015251 General Requirements**

- (a) This section shall be read in conjunction with Section E39 of the General Materials and Workmanship Specification for an energy metering system.
- (b) The ESI shall engage the services of a Specialist Metering Supplier & Installer as referenced below and within the Schedule of Recognised Specialist Suppliers (E970004) on either a “supply and commission only” or “supply, install, test and commission” basis but in either case the ESI shall be responsible for ensuring that the works are completed in accordance with this Specification and to the contract programme.

Specialist Metering Supplier & Installer

Green World Solutions

Contact: Mark Owen / Luke Owen

Tel: 0161 703 2242

Mobile: 07908 051637 / 07931 154241

Email: mark@greenworldsolutions.com.uk /
luke@greenworldsolutions.co.uk

- (c) The energy metering system shall provide automatic meter readings (AMR) via a central gateway/data logger to be supplied and installed by the Specialist Metering Supplier & Installer and shall record the meter data based on the sub-metering detailed on the drawings. The system shall meet the requirements of the Bruntwood Technical Standard for Utility Metering, revision 0 and provide electrical sub-metering as follows:
 - i) Lighting
 - ii) General small power
 - iii) Mechanical services
 - iv) HVAC condenser units
 - v) HVAC air handling units
 - vi) HVAC domestic hot water generation

- (d) As detailed above sub-meters shall be provided to all new MCB distribution boards and MCCB panelboards, as detailed on the drawings including Schneider Electric "Powertag" energy sensors to monitor outgoing final circuits.
- (e) Each electrical energy meter shall be uniquely identified with the manufacturer's serial number with a traffolyte label, or similar, in a readily visible location. Meters shall provide the following information to a minimum Class 1 accuracy; voltage, current, power, power factor, energy (kWhr).
- (f) All meters shall be provided with Modbus connectivity.
- (g) Due to the limitations of the existing infrastructure electrical metering shall be limited to the new electrical distribution infrastructure only.
- (h) Full details of the proposed energy metering system are still to be developed with the Employer's specialist company and so a provisional sum has been included for the energy metering system itself, however the ESI shall allow for all new metering as detailed on the drawings and elsewhere in this Specification.

015300 LIFE SAFETY STANDBY DIESEL GENERATOR

E015301 General Requirements

- (a) This section shall be read in conjunction with Section E41 of the General Materials and Workmanship Specification for standby generation plant.
- (b) The ESI shall engage the services of a Specialist Generator Manufacturer and Installer as referenced below and within the Schedule of Recognised Specialist Suppliers (E970004) on either a "supply and commission only" or "supply, install, test and commission" basis but in either case the ESI shall be responsible for ensuring that the works are completed in accordance with this Specification and to the contract programme.

Specialist Generator Manufacturer & Installer

DT Gen
Cadder House, 160 Clober Road
Milngavie, Glasgow, G62 7LW

Contact: Chris Connors

Tel: 0141 956 7764

Mobile: 07734 227367

Email: Chris.Connors@dtgen.co.uk

- (c) ***Note. The generator rating is based on the mist system pumps being frequency controlled. The ESI shall liaise with the Main Contractor and Specialist Mist System contractor to confirm the pump duty prior to ordering the generator set. Change of the pump starting method may affect the generator rating.***
- (d) The ESI shall be responsible for the supply, delivery, positioning, installation, setting to work, testing and commissioning of a new life safety generator set and LV distribution panelboard as generally detailed on the drawings and comprising the following:
 - i) Standby diesel generator, nominal standby rating 250kVA, 400V, 50Hz with 8 hours minimum fuel in local belly tank
 - ii) 6-way 630amp MCCB panelboard for life safety distribution
 - iii) Auto-transfer switches

- iv) Interconnecting mains and sub-mains cabling and signal cabling
- (e) The ESI shall, at the time of tender, liaise with the tendering Main Contractor to confirm the responsibility for the crane lift of the standby generator on to the roof. The Specialist Generator Manufacturer and Installer shall be responsible for delivery of their respective components to site. The ESI and Main Contractor shall be responsible for delivery and positioning to the final locations on the roof.
- (f) The ESI shall appoint the Specialist Generator Manufacturer and Installer to carry out the design, manufacture, installation and commissioning of the standby generator including, as detailed, factory and site acceptance tests.

E015310 Standby Diesel Generator

- (a) The ESI & Specialist Supplier shall supply, deliver to site, position, install, set to work, test and commission the standby generator as detailed within this Specification, including Section E41, and the drawings.
- (b) The design of the standby generator has been based on the F G Wilson P250-5 set and associated acoustic enclosure as supplied by the Specialist Generator Manufacturer and Installer detailed above. Alternative manufacturers and installers may be submitted at the time of tender and shall be fully supported with technical submissions that verify the proposal is equivalent to the tender design system, prior to being accepted by the Engineer.

Generator Set Performance Parameters

Emergency Standby Power (ESP) rating as defined in BS ISO 8528	250kVA, 400V, 50Hz 200kW at 0.8 power factor (engine rated at 236kW)
Length	2662mm
Width	1071mm
Height	1818mm
Weight (dry/wet)	2035kg / 2068kg (4878kg including acoustic enclosure)
Engine	Perkins 1506A-E88TAG2
Alternator	Leroy Somer LL5114H
Control Panel	Power Wizard 1.1+
Fuel Tank Capacity (Fuel Consumption)	528 litres (50.7 litres / hour)

Acoustic Enclosure Performance Parameters

Level 2 Enclosure to meet EC Directive 2000/14/EC	
Sound Pressure Level (dBA) at 15m	75% load – 61dBA 100% load – 62dBA
Sound Pressure Level (dBA) at 7m	75% load – 67dBA 100% load – 68dBA
Sound Pressure Level (dBA) at 1m	75% load – 75dBA 100% load – 76dBA
Length*	3975mm
Width*	1400mm
Height	1950mm
Weight	2810kg (4878kg including generator)

* Standard acoustic enclosure, will increase slightly to incorporate life safety panelboard

- (c) The generator set shall be provided with a fuel tank mounted underneath the generator set, i.e. a “belly” tank with sufficient fuel for 8 hours minimum at the design load. The tank shall be fully banded and complete with leak detection that will report on to the main control panel and a remote status indicator panel. The tank shall be suitable for automatic and manual filling with all necessary bands as required to contain any spillage.
- (d) The generator set shall be enclosed within its own weatherproof acoustic enclosure to limit the generator noise level to 76dBA at 1m. The enclosure shall be finished in a standard RAL colour.
- (e) The generator shall be provided with a local automatic circuit breaker of the correct current and voltage rating:
 - i) Operational voltage 690V AC, 50Hz
 - ii) Breaking capacity (Icu) 4-pole 50kA
 - iii) Micrologic electronic trip unit 6E
 - iv) Rating 400A
- (f) A 16A single phase and neutral supply shall be installed to the generator enclosure for the parasitic load including internal lighting, controls, engine heater and battery charger.

- (g) An emergency power-off stop button shall be installed on the generator acoustic enclosure and shall isolate the control circuits from the battery supply, fuel supply to the generator and stop and lock out the set.
- (h) The generator enclosure shall be fitted with a fusible link that shall shut down and isolate the generator in event of a fire or similar over heating event. The fusible link shall provide a signal to the fire alarm panel.

E015320 Generator Operation

- (a) The generator set shall only operate in the event of a fire. A fire alarm interface shall be installed to the generator set and, on activation of the fire alarm system the generator set shall start.
- (b) The generator shall receive mains/phase failure signals from the new automatic transfer switches to be installed as part of the new life safety installation including:

- i) Mist system
- ii) Smoke extract fan 1
- iii) Smoke extract fan 2

A provisional sum has been included for mains failure sensing on the existing main switchboard, which will be subject to intrusive investigation as to whether this is feasible or not.

- (c) The generator set shall be commissioned to operate as follows:
 - i) The generator set shall start in the event of a fire alarm activation **and** mains failure sensed at any of the three automatic transfer switches that serve the smoke extract fans or mist control system
 - ii) In the event of the mains supply failing a “generator start” control signal shall be sent to the generator control panel; this shall have a delay timer of between 0 to 30 seconds and shall be set at 0 seconds.
 - iii) The generator shall maintain supply to the life safety equipment via the automatic transfer switches for as long as the mains has failed.
 - iv) On restoration of the mains power, the supply shall be monitored for a period of time, adjustable between 0 and 10 minutes. In the event that mains power is restored for a period to be set at 5 minutes the supply shall change back to the normal mains supply.
 - v) The generator set shall continue to operate for up to 30 minutes in “cool down” mode on restoration of mains power.

E015330 Fuel Delivery

- (a) Fuel delivery will be manual only using the lift and stairs in 38-42 Mosley Street. The ESI and Specialist Generator Manufacturer and Installer shall ensure that the tank is left 100% full following completion of the site acceptance tests.

E015340 Generator Remote Status Indicator

- (a) A remote status indicator panel shall be installed adjacent to the fire alarm repeater panel at the entrance to the building to indicate the status of the standby generator parameters including, but not limited to, the following:
 - i) Generator available / online
 - ii) Generator tripped / offline (common fault?)
 - iii) Generator running
 - iv) Fire alarm operated
 - v) Mains failed to mist system
 - vi) Mains failed to smoke extract fan 1
 - vii) Mains failed to smoke extract fan 2
 - viii) Fuel level status
 - ix) Low level fuel alarm
 - x) Leak detection

E015350 Factory & Site Acceptance Tests

- (a) The ESI shall arrange for both factory and site acceptance testing, as generally detailed in section E417300 of this Specification.
- (b) The ESI shall include for all costs associated with travel, subsistence and accommodation for up to three persons to attend the factory acceptance tests.

E015400 AUTOMATIC TRANSFER SWITCHES**E015401 General Requirements**

- (a) This section shall be read in conjunction with Section E35 of the General Materials and Workmanship Specification for automatic change over systems.
- (b) The ESI shall supply, install, test and commission automatic transfer switches to each item of life safety plant or equipment as generally indicated on the schematic drawing and detailed elsewhere in this Specification. The ATS shall be rated for the equipment that they serve.
- (c) Automatic transfer switches shall be provided for life safety equipment for compliance with BS 8519 and BS 9999.
- (d) The automatic transfer switches and controls shall conform to the requirements of:
 - i) IEC 60947-6-1
 - ii) Utilisation category AC33A
 - iii) International Standards Organization ISO 9001:2000.
- (e) Automatic transfer switches shall be ASCO 4000 Series with accessory Single Way Bypass, utilising their Group 5 Control Panel, or equivalent and agreed with the

Engineer. Any alternative system or supplier shall be submitted for approval to the Engineer at the time of tender or prior to completion of detailed design. Alternative system or supplier must be submitted with a technical submittal, as detailed elsewhere in this Specification and list any deviations from this specification.

- (f) Automatic transfer switches shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include over current disconnect devices; Linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, primary or secondary supply.
- (g) All automatic transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
- (h) Automatic transfer switches shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
- (i) Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
- (j) Designs utilising components of moulded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources, are not acceptable.
- (k) Where neutral conductors must be switched, the ATS shall be provided with fully rated overlapping neutral transfer contacts. The neutrals of the primary and secondary power sources shall be connected together only during the transfer and retransfer operation and remain connected together until power source contacts close on the source to which the transfer is being made. The overlapping neutral contacts shall not overlap for a period greater than 100milliseconds. Neutral switching contacts which do not overlap are not acceptable. ATS units with late-make early-break neutral contacts are not acceptable.
- (l) The controller's sensing and logic shall be provide by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communications module. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operation parameters. Control panels that do not monitor all three phases of the Normal and Emergency supplies are not acceptable.
- (m) The ATS unit is to include a non-automatic electrically operated transfer switch wired to provide a maintenance bypass facility to comply with BS 8519.

E015410 Remote Indication Units

- (a) In accordance with the requirements of BS 9999, all fire-fighting ATS shall provide a remote supply condition indicator panel of whether they are served from mains or secondary power (generator) at the lowest entry level of the building, generally ground floor (Level 00). This indication shall be recessed within the lift lobby.
- (b) Each supply condition indicator panel shall be fitted with four lamps providing the following status information:

- i) Supply 1 Available, [Green Lamp]
- ii) Supply 2 Available, [Red Lamp]
- iii) Switch connected to Supply 1, [Green Lamp]
- iv) Switch connected to Supply2, [Red Lamp]
- (c) There should be a lamp test facility.
- (d) Each automatic transfer switch shall be supplied with ATS position and source available contacts. An ELV supply shall be provided within the ATS enclosure to power the supply condition indicator panel.
- (e) Fire rated multi-core cabling shall be installed between each ATS and the remote supply condition indicator panel, located either in the fire-fighting lobby or ground floor control room.

E015420 Microprocessor Controller

- (c) The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.
- (d) A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to $\pm 0.2\%$. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.
- (e) The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.
- (f) All customer connections shall be wired to a common terminal block to simplify field-wiring connections.
- (g) The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
 - i) EN 55011:1991 Emission standard - Group 1, Class A
 - ii) EN 50082-2:1995 Generic immunity standard, from which:
 - iii) EN 61000-4-2:1995 Electrostatic discharge (ESD) immunity
 - iv) ENV 50140:1993 Radiated Electro-Magnetic field immunity
 - v) EN 61000-4-4:1995 Electrical fast transient (EFT) immunity
 - vi) EN 61000-4-5:1995 Surge transient immunity
 - vii) EN 61000-4-6:1996 Conducted Radio-Frequency field immunity

E015430 Generator Operation Signalling

- (a) The ATS shall provide under-voltage and/or mains failure signals of the normal supply to signal the standby generator to start and provide power to the emergency supply, via the LV distribution system, described elsewhere.
- (b) The signal cabling shall be installed between the ATS and the generator control panel using a multi-core enhanced fire rated cable.

E015440 ATS Enclosure

- (a) The ATS shall be furnished in an IP31 enclosure unless otherwise shown on the plans. The enclosure shall consist of two sections, one for the bypass unit and one for the ATS unit.

E015450 Sub-mains Electrical Distribution

- (a) All primary and secondary cables shall be enhanced fire rated and installed on diverse routes as far as reasonably practical up to the ATS that shall be located as close to the plant or equipment as possible.

E015500 GENERAL SMALL POWER**E015501 General Requirements**

- (a) This section shall be read in conjunction with Section E63 of the General Materials and Workmanship Specification for general small power installations.
- (b) The ESI shall supply, install, test and commission the general small power as generally detailed on the drawings and described within this Specification including:
 - i) General power for cleaner's sockets
 - ii) Power for audio-visual equipment and associated services (currently a provisional sum due to unknown requirements)
 - iii) Power for security equipment and associated services (currently a provisional sum due to unknown requirements)
 - iv) Power for Comms Room equipment cabinets etc
 - v) Gym power
 - vi) Cycle store power
 - vii) Electrical power supplies for mechanical plant and equipment, including roof mounted condenser units
 - viii) Electrical power supplies for tea point equipment including coffee machine, water boilers/heaters, fridge/freezers, dishwasher etc
- (c) The location of general small power outlets and the like referenced within this Specification and on the drawings are indicative and the ESI shall be responsible for co-ordination of these services with the Architect, Engineer, Employer as well as the Main Contractor, Mechanical Services Installer (MSI) and other specialist suppliers and manufacturers.

- (d) Where general small power outlets are to serve equipment supplied and installed by others the ESI shall liaise and co-ordinate the final setting out of these outlets to ensure they are within at least 500mm of the equipment.
- (e) All outlets shall be installed at the heights indicated on the drawings, within this Specification or detailed on the Architect drawings and, with outlets such as general purpose socket outlets or similar devices, in accordance with Building Regulations and BS 8300.
- (f) The positioning of all floor service boxes and grommets with sockets shall be co-ordinated and set out with the furniture layout.
- (g) The ESI shall allow to submit physical samples of wiring accessories other than MK Logic Plus, for review and approval by the Architect and Employer.

E015202 Finishes & Accessories

- (a) The installation shall generally be concealed flush within the fabric of the building or within surface mounted trunking with the exception of plant rooms and service risers. These areas shall be provided with surface fixed outlets.
- (b) The electrical accessories within the ceiling voids shall be metalclad type. White plastic type recessed accessories shall be provided in all other internal areas, unless specified otherwise. The electrical accessories shall generally match the light switches within the particular area.
- (c) Electrical supplies to lighting control equipment, security equipment, FA equipment etc, shall be via local fused connection units at high level/within ceiling void with flex outlets to adjacent equipment. Supplies located within ceiling voids are to be made accessible.
- (d) All accessories are to be a common manufacture and be of a common design, such as Honeywell MK Electric, or equivalent and accepted.
- (e) All socket outlets in the building shall have two earth terminals in order to comply with the requirements of Section 543 of BS 7671. For additional safety, all socket outlets shall be complete with a 3-pin operated shutter system.
- (f) All Socket and Power Outlets shall be labelled using a Dynotape tape label to show actual circuit reference. All fused connection units shall be engraved with the use/duty i.e. 'WATER BOILER', 'HAND DRYER' and actual circuit reference. All double-pole switches shall be engraved with the equipment they serve, i.e. "FRIDGE", "DISHWASHER".
- (g) All equipment provided within the contract shall have a minimum parts availability of 10 years and not be an end of line product.
- (h) Un-switched and switched fused connection units shall be provided for connection to serve (but not limited to):-
 - i) Mechanical services equipment
 - ii) Security system panels

E015202 Final Circuits

- (a) Wherever possible, all final circuit cabling shall be either concealed within the building fabric or enclosed within conduit or trunking, unless otherwise stated. The small power circuits shall generally be supplied from the local sub-distribution boards serving the dedicated area on that floor.
- (b) The general small power installations shall be wired using a minimum of 2.5mm² cables, seven stranded, LSF insulated, and sheathed cable, or equivalent YY type cable as manufactured against a BASEC Certificate of Assessed Design.
- (c) All internal small power wiring shall be contained within its own dedicated trunking and conduit system. The ESI shall co-ordinate all routes with the building structure/fittings along with the M & E installations.
- (d) Fire barriers shall be provided in all areas where trunking penetrates a fire zone. The ESI shall ensure that only proprietary containment systems (i.e. cable tray, ladder, trunking etc) angles, bends, sets, sections etc shall be used to provided a complete system.

E015210 Audio Visual Power

- (a) The ESI shall supply, install and test twin switched socket outlets for audio-visual equipment, including LED screens, as generally indicated on the drawings. Final setting out of the sockets shall, for the purpose of tender, generally be 1550mm above finished floor level and 300mm off centre of the screen. Final setting out shall be confirmed with the architect.
- (b) The twin switched socket outlet shall be positioned adjacent to the back-box for AV and data cabling, as indicated on the drawings.
- (c) The requirements for AV are unknown at the time of tender and a provisional sum has been included.

E015220 Power for Security Installations

- (a) The ESI shall supply, install and test general small power for security installations equipment including CCTV, access control and intruder alarms.
- (b) The requirements for the security installations are unknown at the time of tender and a provisional sum has been included.

E015230 Electrical Installations in Connection with Ancillary Services

- (a) The ESI shall supply, install, test and commission new power supplies for ancillary/ specialist services, including but not limited to:
 - i) Basement Comms Room Equipment cabinets
 - ii) Aspiration smoke detection system control panels
- (b) The ESI shall supply and installed 2nr BS EN 60309-2 “commando” sockets, as indicated on the drawings, at high level to serve the equipment cabinets. The final positioning of the sockets shall be co-ordinated on site with the Engineer when the equipment cabinet setting out is confirmed.

- (c) The scope of electrical works in connection with the ancillary services installation includes the provision of power supplies for the control panels, including attendance for the final connection between the electrical installation and the control panel.
- (d) The Electrical services Installer shall be responsible for ensuring that the correct size and type of cable terminations are provided.
- (e) The position of all electrical outlets on the tender design drawings are indicative only. The ESI shall liaise with the specialist contractors and Employer to co-ordinate the final positions of all electrical outlets to be within 500mm of the control panel.
- (f) The ESI shall test and verify the electrical outlet prior to the specialist contractor or Employer making the final connection. The ESI shall be in attendance when the final connection between the control panel and electrical outlet is being made, arranging to isolate the supply and re-energise it for the specialist contractor or Employer to undertake their final testing and commissioning
- (g) The ESI shall liaise with the specialist contractor or Employer and Main Contractor to ensure that all power for control panels are completed to allow final testing and commissioning of the mechanical services by the specialist contractor to meet the overall refurbishment project programme

E015240 Electrical Power Installations in Connection with Tea Point

- (a) The ESI shall supply, install, test and commission new power supplies for equipment within the lounge kitchenette, as generally indicated on the drawings, including but not limited to:
 - i) Fridge/freezer; 13amp un-switched socket at low level behind unit fed via engraved double-pole isolator located above worktop
 - ii) Dishwasher; 13amp un-switched socket at low level behind unit fed via engraved double-pole isolator located above worktop
 - iii) Water boilers, i.e. Zip Tap or similar; 13amp switched socket outlet under counter mounted adjacent to the unit
 - iv) Coffee machine; 20amp double pole switch below worktop with flex outlet plate above worktop
 - v) 2nr twin switched 13A sockets for general purpose use, located above the worktop
- (b) The tea point equipment shall be served from the local distribution board, as generally detailed on the drawings.
- (c) The ESI shall liaise with the Main Contractor and Mechanical Services Installer (MSI) during the production of working/installation drawings stage to confirm setting out of all electrical services, particularly any sockets to be co-ordinated with wall finishes above the worktop, i.e. tiles, glass etc. Refer also to architect drawings for setting out details.

E015250 Electrical Installations in Connection with Mechanical Services

- (a) The ESI shall supply, install, test and commission new power supplies for mechanical services plant and equipment, including but not limited to:

- i) External condenser units
- ii) Air handling units, supply and extract fans
- iii) Smoke extract fans
- iv) Mechanical services control panel panels
- v) Air conditioning unit(s) serving the basement Comms Room
- vi) Fan coil units and BC boxes located on the office floors
- (b) Mechanical services equipment shall be served from the local MCB distribution boards, as generally detailed on the drawings.
- (c) The ESI shall liaise with the Mechanical Services Installer (MSI) during the production of working/installation drawings stage to confirm all mechanical plant and equipment, electrical requirements and locations.
- (d) The scope of electrical works in connection with the mechanical services installation includes the provision of power supplies for mechanical plant and equipment, including attendance for the final connection between the electrical installation and mechanical plant and equipment.
- (e) The Electrical services Installer shall be responsible for ensuring that the correct size and type of cable terminations are provided.
- (f) The position of all electrical outlets on the tender design drawings are indicative only. The ESI shall liaise with the Mechanical Services Installer (MSI) to co-ordinate the final positions of all electrical outlets to be within 500mm of the mechanical equipment cable termination box/position.
- (g) The ESI shall test and verify the electrical outlet prior to the MSI making the final connection. The ESI shall be in attendance when the final connection between the mechanical equipment and electrical outlet is being made, arranging to isolate the supply and re-energise it for the MSI to undertake their final testing and commissioning
- (h) The ESI shall liaise with the MSI and Main Contractor to ensure that all power for mechanical installations are completed to allow final testing and commissioning of the mechanical services by the MSI to meet the overall refurbishment project programme

E015600 TELECOMMUNICATIONS & LANDLORD STRUCTURED DATA CABLING**E016601 General Requirements**

- (a) The structured data cabling for the refurbished building has been designed by others and do not form part of this Specification.
- (b) The ESI shall be responsible for the installation of containment and general small power on behalf of the structured data cabling installation and shall liaise with them and the Main Contractor to develop the installation drawings based on the design information provided on the drawings and elsewhere in this Specification.

E015700 LIGHTING**E015701 General Requirements**

- (a) This section shall be read in conjunction with Section E57 & E58 of the General Materials and Workmanship Specification for providing facilities for incoming utilities including
- (b) All new lighting and emergency lightingshall be supplied and installed by the ESI, as generally detailed on the drawings and in the Luminaire Schedule. The luminaire supplier contact details, if required are as follows:

<u>General Luminaire Supplier</u> LDL Lighting Unit 3 Stonehouse Road, Wigan, WN5 0LE	Contact: James Wilkinson Mobile: 07435 552084 Email: james@ldl.lighting
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<u>Feature & Specialist Luminaire Supplier</u> Delta Light 86-88 Great Suffolk StreetLondon, SE1 0BE	Contact: Edmunds Kalnins Mobile: 07469 858048 Email: Edmunds@deltalight.co.uk
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- (c) A new lighting control system shall be installed to control the lighting within the refurbished parts of the building. The design is based on hard-wired lighting control panels located within the risers and is based on the Simmtronic system. The lighting controls supplier contact details are as follows:

<u>Lighting Controls Supplier</u> Simmtronic 6th Floor Lowry House,17 Marble Street Manchester, M2 3AW	Contact: Mario Costanzo Tel: 0161 406 0529 Mobile: 07768 400772 Email: mario.costanzo@simmtronic.com
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E015710 General lighting

- (a) All new lighting, including feature lighting pendants shall be supplied and installed by the ESI, as generally detailed on the drawings and in the Luminaire Schedule.
- (b) Some of the architectural feature luminaires including pendants and wall mounted fittings have not been selected by the architect and a supply-only allowance has been included in the Luminaire Schedule. The ESI shall allow for all other costs associated with the installation of these luminaires based on the supply cost,
- (c) Setting out of all luminaires shall generally be as detailed on the drawings. For luminaires within exposed soffit locations refer to architect setting out details. Where pendants are to be installed to suit the acoustic ceiling or furniture the ESI shall liaise with the Main Contractor to ensure that the pendants are correctly positioned.
- (d) The exposed ceiling means that cabling between the hard-wired LCMs and luminaires/control devices will be exposed and shall therefore be routed on new containment to ensure a neat installation, the ESI shall refer to elsewhere in this Specification regarding installations for exposed services.

E015720 Emergency Lighting

- (a) The ESI shall supply, install, test and commission new emergency lighting and exit signage as generally detailed on the drawings and to comply with BS 5266 and BS EN 1838.
- (b) The new emergency lighting system shall generally include self-contained maintained DALI luminaires and shall be capable of reporting on the lighting control system head-end. Exit signage shall generally include self-contained, non-maintained luminaires with suitable ISO legends to suit the direction of escape. All emergency luminaires shall be provided with 3-hour battery autonomy.
- (c) The emergency lighting shall be incorporated on to the lighting control system to provide automatic testing and reporting to meet the requirements of BS 5266.
- (d) The emergency lighting system shall be fully tested in accordance with BS 5266 and Practical Completion shall be subject to receiving emergency lighting test certificates and emergency lighting levels completed during hours of darkness.

E015730 Lighting Controls

- (a) The ESI shall supply, install, test, commission and set to work a programmable DALI lighting control system to the new offices as generally detailed on the drawings, including:
 - i) Head end PC processor
 - ii) Area controllers
 - iii) Hard-wired lighting control modules
 - iv) Sensors and light switches
- (b) The design is based on the Simmtonic lighting control system and includes a DALI emergency lighting test system.
- (c) The head-end processor shall be located in the basement Comms Room. As the equipment cabinets may not be available at the time of installation and commissioning the ESI and Lighting Controls Specialist shall allow for temporary installation of the processor to allow the lighting control system to be fully commissioned to meet the requirements of the design.
- (d) The lighting control system shall provide controls to meet the requirements of Approved Document Part L2 and for the users of the space.
- (e) The ESI shall submit fully detailed working drawings including layout plans, schematics and manufacturing drawings to the Engineer and Architect for approval prior to commencing installation on site.
- (f) In the event of a mains failure during “out of hours” the lighting control system shall be commissioned such that the lighting control system does not bring lighting back on as a default position. The system should be installed to ensure the lights return to the state they were in prior to loss of mains supply. This should not in any way affect the emergency lighting

E015740 Lighting Control Modes of Operation

- (a) The lighting control system shall generally operate as detailed on the drawings and summarised below.

Open Plan Office Areas

Open plan offices to be switched using presence detection in zones to comply with Part L. Adjacent areas to be held-on when unoccupied and dimmed to a minimum of 50% to ensure that “light pools” are avoided. Luminaires to switch off after pre-set time (20 minutes) when no presence detected.

Perimeter luminaires to be daylight controlled where natural daylight is available.

2nd Floor Boardroom

The 2nd floor Boardroom shall have a scene set switchplate due to the limited ability to install presence detectors within the space.

It shall be possible to switch one and off the luminaires within this room from the switchplate, as well as dim them manually (scene sets are not required at this stage). After a preset time period (60 minutes) the luminaires shall dim down to 75%.

In the event of no further action with a period of 30 minutes the luminaires shall dim down to 50%.

In the event of no further action with a period of 10 minutes the luminaires shall dim down to 10%.

In the event of no further action with a period of 10 minutes the luminaires shall switch off completely.

Circulation

Circulation spaces shall generally be controlled via presence detectors but with “corridor hold” function to maintain the illumination in the event of adjacent areas being occupied.

Within the corridors on the 2nd and 3rd floors where no PIRs are to be installed these luminaires shall be controlled from PIRs in adjacent spaces and held on when the adjacent offices are occupied.

Main Reception

The main reception and lounge area shall be independently controlled to ensure the space is illuminated when the space is occupied.

A manual 6-scene control panel shall be installed behind the reception desk to enable the reception and lounge to be controlled as follows:

Scene 1 – 100% reception, 100% lounge

Scene 2 – 100% reception, 75% lounge

Scene 3 – 75% reception, lounge switched off
Scene 4 – 25% reception, lounge switched off

The above scenes are for tender purposes and shall be confirmed prior to final commissioning

E015750 System Design

- (a) The system shall be designed by the Specialist Lighting Control Contractor and shall generally include the following system components, to meet the requirements detailed above:
 - i) Lighting area control panels to provide power to non-DALI controlled luminaires as well as the DALI controls, or
 - ii) Lighting control modules providing power and DALI controls to individual or groups of luminaires
 - iii) Intelligent local control devices including sensors, switch plates and other interfaces. Note sensors shall be recessed in ceilings. Switches shall be recessed in to partition walls or glazing mullions (architrave).
- (b) The lighting control system shall be capable of offering the following functionality, as generally detailed above:
 - i) Manual control and override via switch plates.
 - ii) Presence detection with programmable group control.
 - iii) Automatic dim control in response to the light levels from photocell measurement.
 - iv) Cascaded presence linking (e.g. corridor hold).
 - v) Fire Alarm override of light levels.
 - vi) Emergency lighting test including a fully integrated DALI solution.
- (c) The lighting control system shall enable a lighting group consisting of any luminaire combination or individual luminaires within the installation to be controlled by any combination of local control sensors within the installation; this shall be achievable at any time without the need for additional equipment.
- (d) Where the solution employs a Lighting Control Panel this shall provide power to non-DALI luminaires only as well as the DALI control signals. Mains power for DALI luminaires shall be derived from local MCB distribution boards.
- (e) The Lighting Control Modules (LCM's) shall provide a means to marshal both power and data (e.g. DALI) to the luminaires; they shall typically control small groups of luminaires via plug and socket connectivity and shall be mounted within the vicinity of the luminaires to be controlled, or at the nearest permanently accessible location.
- (f) The system shall interface as standard to a range of lighting control gear including dimmable extra low voltage, dimmable fluorescent, mains filament, cold cathode and LED light sources

E015760 Installation, Testing & Commissioning

- (a) The Electrical Services Installer shall install the lighting control system, make all connections and pre-test the installation; however the lighting control system shall be fully commissioned, set to work and demonstrated by the lighting control system supplier.
- (b) The Electrical Services Installer shall ensure that the lighting control system is installed in accordance with the tender drawings and electrical specification including the installation drawings and instructions provided by the lighting control system supplier.

E015800 FIRE ALARM & EVCS SYSTEM

E015801 General Requirements

- (a) This section shall be read in conjunction with Section E70 & E72 of the General Materials and Workmanship Specification for fire alarm and emergency voice communication systems.
- (b) The ESI shall engage the services of a LPS 1014 registered Specialist Fire Alarm Contractor as referenced below and within the Schedule of Recognised Specialist Suppliers (E970004) on either a “supply and commission only” or “supply, install, test and commission” basis but in either case the ESI shall be responsible for ensuring that the works are completed in accordance with this Specification and to the contract programme.

Specialist Fire Alarm Contractor

Commercial Fire Systems

Contact: Neil Holroyd

Mobile: 07483 843915

Email: neil@commercialfire-systems.co.uk

- (c) The supplier shall be approved to BS EN ISO 9001 Quality System standards for the design and manufacture of the fire alarm systems equipment.
- (d) The Specialist Fire Alarm Contractor shall be responsible for the contractor’s design portion (CDP) as detailed in E012800.
- (e) 57 Spring Gardens is served by a multi-loop Protec analogue-addressable fire alarm control panel, located at the main entrance to the building. The fire alarm panel is obsolete with limited support by Protec only.
- (f) A temporary Protec fire alarm control panel was recently installed in 38-42 Mosley Street to maintain limited fire alarm coverage of the building whilst it was vacant. This panel shall be relocated to replace the existing fire alarm control panel in 57 Spring Gardens and a new analogue-addressable fire alarm control panel installed in Mosley Street, as detailed on the drawings.
- (g) The ESI and Specialist Fire Alarm Contractor shall supply, install, test, commission and set to work a new fire alarm system throughout 38-42 Mosley Street to meet the requirements of a Category L2 system as detailed in BS 5839-1 including automatic detection, manual call points and sounders as detailed on the drawings.
- (h) An emergency voice communication system (EVCS, or disabled refuge intercom system) shall be installed at each of the disabled refuges indicated on the drawings

within common circulations areas. The system shall be expandable to enable future tenants to install within their own disabled refuges, as required.

E015810 Replacement Fire Alarm Control Panel in 57 Spring Gardens

- (a) The ESI and Specialist Fire Alarm Contractor shall relocate the existing Protec fire alarm control panel from Mosley Street to Spring Gardens. The existing fire alarm control panel shall be isolated, disconnected, stripped out and disposed of off-site, including the batteries all in accordance with the WEEE regulations.
- (b) The existing loop circuits shall be disconnected and reconnected to the new fire alarm control panel that shall be installed in the same location.
- (c) The existing cause-and-effect of Spring Gardens shall be maintained and the relocated Protec fire alarm control panel software programmed to maintain this operation.
- (d) The works to relocate the fire alarm control panel shall be completed outside of normal working hours either at a weekend or the evening, depending on the duration that the fire alarm system will be out of service. During this time the ESI and Main Contractor shall arrange for a "fire watch" to be implemented throughout Spring Gardens, ensuring that the whole building is inspected at least once each hour during the transition period.

E015820 New Fire Alarm Control Panel in 38-42 Mosley Street

- (a) The ESI and Specialist Fire Alarm Contractor shall supply, install, test and commission a new fire alarm control panel as generally detailed on the drawings. The 4-loop panel shall be taken from the Advanced MxPro or Fireclass FC600 range of fire alarm control panels.
- (b) The system shall be designed as a single stage evacuation strategy, although this may be altered subject to discussions with the Building Control Authorities. The full cause-and-effect shall be developed by the Specialist Fire Alarm Contractor and submitted to the Engineer and Employer for comment and approval by the Building Control Officer prior to commencing final programming of the system.
- (c) The system shall be designed to allow the minimum additional devices in the future as follows:
 - i) 30%, with a minimum capacity for 4nr additional sounders
 - ii) 10%, with a minimum capacity for 2nr additional manual call points
 - iii) 20%, with a minimum capacity for 4nr additional automatic detectors
 - iv) 20%, with a minimum capacity for one additional zone
- (d) In addition to zone indicators on the panel a framed zone chart shall be provided adjacent to the main fire alarm control panel.
- (e) Aspirated smoke detection systems shall be installed to protect areas indicated on the drawings including the lift cores and the 2nd floor boardroom. The system shall be based on the Xtralis VESDA range or equivalent and accepted.
- (f) Interface units shall be supplied to interface with mechanical services and other installations as follows. The ESI and Specialist Fire Alarm Contractor shall liaise with

the MSI to ensure that the appropriate rated and NO/NC contact is provided and the final setting out agreed.

- i) Lifts
 - ii) Mechanical services control panels to ensure that the fresh air ventilation systems shut down in the event of a fire
 - iii) Air conditioning unit control panel
 - iv) Public entrance powered doors
 - v) Smoke extract system, including the fire damper controls
- (g) The Specialist fire alarm contractor shall install the interface unit adjacent to the item of equipment with a coil of cable for final connection into the equipment that shall be coordinated with the MSI and/or Main Contractor.
- (h) Interfaces shall be provided from the mist system to the fire alarm system as per the following schedule.

Level	Description	Source	Signal
Water Mist Pump Room			
B1	Isolating Valve Supply 1	Tamper	Fault
B1	Isolating Valve Supply 2	Tamper	Fault
B1	Upstream Isolating Valve	Tamper	Fault
B1	Downstream Isolating Valve	Tamper	Fault
B1	Bypass Isolating Valve (N/C)	Tamper	Fault
B1	Tank No. 1 Infill Isolating Valve	Tamper	Fault
B1	Tank No. 2 Infill Isolating Valve	Tamper	Fault
B1	Tank No. 1 Outlet Isolating Valve	Tamper	Fault
B1	Tank No. 2 Outlet Isolating Valve	Tamper	Fault
B1	Tank No. 1 High Level Alarm	Level switch	Fault
B1	Tank No. 1 Low Level Alarm	Level switch	Fault
B1	Tank No. 2 High Level Alarm	Level switch	Fault
B1	Tank No. 2 Low Level Alarm	Level switch	Fault
B1	Electric Pump No.1 Suction Valve	Tamper	Fault
B1	Electric Pump No.1 Delivery Valve	Tamper	Fault
B1	Electric Pump No.2 Suction Valve	Tamper	Fault
B1	Electric Pump No.2 Delivery Valve	Tamper	Fault
B1	System activated	Pump Panel	Fire
B1	System on Demand	Pump Panel	Fault
B1	Pump Start Failure	Pump Panel	Fault
B1	Electric Power Failure	Pump Panel	Fault
B1	Pump Test Isolating Valve	Tamper	Fault
B1	System Low Pressure	Press Switch	Fault
B1	System General fault	Pump panel	Fault
Installation Control Valve			
B1	Basement Valve (common up tamper switches)	Tamper	Fault
B1	Basement Valve System Operated	Flow Switch	Fire
B1	Trace Heating	Controller	Fault

- (i) The main control panel shall be supplied with facilities to transmit the fire alarm signal to a remote Alarm Receiving Centre.
- (j) A smoke extract system has been designed for the basement area only. The system uses a number of smoke & fire dampers to open & close to enable smoke to be cleared from each room independently. Full details of the smoke control system are unavailable at the time of tender and a provisional sum has been included for this purpose.

E015830 New Emergency Voice Communication System

- (a) The ESI and Specialist Fire Alarm Contractor shall supply, install, test and commission a new emergency voice communication system (EVCS) with outstations located in the common parts disabled refuges as generally detailed on the drawings.
- (b) The system shall operate automatically by simply activating one of the remote outstations, located in the areas specified in the scope of works section and indicated on the drawing.
- (c) The system shall allow for the quantities indicated on the drawings and up to six minimum additional Type B outstations for installation by future tenants, if required.
- (d) The system shall be based on the Baldwin Boxall Omnicare or C-Tec SigTel ranges, or equivalent and accepted. All outstations shall be recessed into the wall.
- (e) The main control and communication panel shall be located adjacent to the fire alarm repeater panel located at the rear entrance.

E015840 Drawings and Technical Information

- (a) The drawings produced by the Engineer are for Tender purposes only and are essentially schematic in nature. The ESI and Specialist Fire Alarm Contractor shall be responsible for the provision of all fire alarm equipment required to comply with this specification in compliance with the FOC requirements, the local Fire Officers recommendations and the appropriate British Standards.
- (b) At the time of tendering, the ESI and Specialist Fire Alarm Contractor shall fully and accurately describe the proposed fire detection and alarm system and its design concepts, providing a complete set of layout drawings and a specification describing all aspects of the system, including:
 - i) Detailed component and equipment lists with model and manufacturers part numbers
 - ii) Product sheets for each item of equipment
 - iii) Theory of operations with description of system functions
 - iv) Written confirmation that a manufacturer trained representative will provide on-site supervision during system installation, perform all final testing and commissioning of the installed system and instruct operating personnel on all system operations
- (c) The ESI and Specialist Fire Alarm Contractor shall provide a complete set of contract documents describing the system and its design concepts, installation, final testing,

commissioning, and required operating and maintenance procedures. These shall include the following documentation:

- i) System description
 - ii) Checklist of equipment and components
 - iii) Installation instructions
 - iv) Equipment connection diagrams showing wiring detail of Addressable Device positions with addresses
 - v) Standby battery calculations showing system power requirements and formulas used to calculate specified power
 - vi) Final testing instructions
 - vii) Commissioning instructions
 - viii) Certification documents
 - ix) Logbook
 - x) System operating instructions
 - xi) Routine maintenance instructions and schedules
 - xii) Remote monitoring link description and operating instructions (if this option is being provided)
- (d) As a minimum, the following drawings shall be provided for the system:
- i) System schematic diagram
 - ii) Cabling and wiring diagram
 - iii) Detailed equipment connection diagrams
 - iv) Building plan showing zoning and location of fire controller, detectors, call points, sounders and ancillary devices
- (e) Prior to Practical Completion, Record Drawings with operating and maintenance instructions for the installation shall be provided along with the system logbook suitably completed for issue to the operator. A full address chart indicating each device type, address, location and text programmed shall be provided.
- (f) Drawings and technical information shall comply with the Drawings and Documentation Section including numbers of copies, preliminary and final issues. Two additional sets of all issues shall be provided to the Engineer for issue to the Employer's Insurers.

E015850 Installation

- (a) The installation shall be in accordance with the recommendations of BS 5839: Pt 1 and BS 7671.
- (a) The fire alarm system shall be wired throughout utilising pliable (soft skin), enhanced grade fire resistant cable, as defined in BS 5839-1. The cables shall be tested in accordance with BS EN 50200 including Annex E and BS 8434-2. The cable

manufacture shall be selected from those specified in the schedules referenced elsewhere in this specification.

- (b) The wiring installation shall comply with the wiring systems section of the specification. Call points shall have conductors with a minimum size of 1.5 mm². Bell and sounder wiring shall have a minimum size of 2.5 mm². All wiring shall be of adequate section to prevent excessive volt drop in accordance with the requirements of BS 7671. The cables shall be installed in compliance with BS 7671 and associated codes of practice, elsewhere in this specification and shall use metal support clips throughout.
- (c) The ESI and Specialist Fire Alarm Contractor shall be responsible for the correct siting of all equipment and components of the system in accordance with previously agreed plans and drawings.
- (d) All cabling and wiring shall be tested before they are connected to the fire controller and its associated devices.

E015860 Testing and Commissioning

- (a) The fire alarm system shall be installed, completed, commissioned and witnessed by the Engineer at least one week before Practical Completion. Practical Completion will not be granted until the system has been operating faultlessly for at least one week. A system logbook shall also be handed to the Client suitably completed
- (b) On completion of the fire alarm system and prior to handover the ESI and Specialist Fire Alarm Contractor shall demonstrate the system operation to the Engineer, BCO and client representative and maintenance engineer who will complete the PF&S Fire Alarm Systems Compliance Checklist, **which must be completed before handover.**
- (c) The fire controller and associated devices and modules shall be tested in accordance with the guidelines set out in BS 5839-1 and the testing instructions provided by the manufacturer. These tests shall include the following:
 - i) Witness tests on the Fire Alarm Cables for insulation resistance and electrical continuity
 - ii) Test the functional operation of the break glass units and smoke/heat detectors
 - iii) Battery discharge test with a full 30-minute operation at the end of the specified battery autonomy period with the system in its quiescent state
- (d) The ESI and Specialist Fire Alarm Contractor shall test all functions of the system, including the software, to ensure that it operates in accordance with the requirements of the design specification and relevant standards.
- (e) The ESI and Specialist Fire Alarm Contractor shall carry out audibility tests in order to demonstrate the suitability of the system installed. This shall involve an element of out-of- hours working, which shall be included for in the tender submission.
- (f) Following the satisfactory completion of installation, testing and start-up, the ESI and Specialist Fire Alarm Contractor shall demonstrate to the customer that the system successfully performs all of the functions set out in the design specification.

- (g) The ESI and Specialist Fire Alarm Contractor shall provide the customer with an agreed quantity of spare parts testing equipment and consumables, which are to be used during routine maintenance, and testing of the system.
- (h) The ESI and Specialist Fire Alarm Contractor shall provide a customer appointed fire system supervisor with on-site training in the use, operation and maintenance of the system and explain the procedures to be followed in the event of fire and false alarms. The system supervisor shall also be shown how to carry out routine maintenance and testing procedures, and how to keep the logbook. (Also see Section 9).
- (i) The ESI and Specialist Fire Alarm Contractor shall prepare a report detailing all tests performed during installation and commissioning of the system. The report shall include the results of the tests and details of any specific settings or adjustments made. Any outstanding tasks or activities, which are to be completed at another time, shall also be included in the report.

E015870 Maintenance

- (a) The ESI and Specialist Fire Alarm Contractor shall not include for any normal service and maintenance required during the Defects Liability Period as this will be carried out by RMG's own fire alarm maintenance contractor.
- (b) However, the Specialist Fire Alarm Contractor shall provide emergency contact details should they be required to attend to a fault during the 12 months defects liability period, including any reference that may be required to identify the site/project.

E015900 SECURITY SYSTEMS**E015901 General Requirements**

- (a) The security systems for the refurbished building have been designed by others and do not form part of this Specification.
- (b) The ESI shall be responsible for the installation of containment and general small power on behalf of the specialist security installer and shall liaise with them and the Main Contractor to develop the installation drawings based on the design information provided on the drawings and elsewhere in this Specification.

E016100 MISCELLANEOUS ELECTRICAL INSTALLATIONS**E016101 General Requirements**

- (a) The ESI shall supply, install, test and commission a standalone accessible disabled persons toilet alarm kit as the C-Tec NC951, or equivalent and accepted, and as generally indicated on the drawings.
- (b) The alarm system shall be installed in accordance with BS 8300 and as generally indicated on the drawings and include:
 - i) Pull Switch – ceiling mounted pull cord with fully compliant 'G' pulls
 - ii) Reset Point – reset button and LED to reset calls locally
 - iii) Light/Sounder – over door triangular lens with integral sounder
 - iv) Power supply unit and controller

- (c) The system shall provide a local alarm only and shall be demonstrated on completion of the installation.
- (d) All components shall be available in a white or stainless steel finish.
- (e) Components shall be available separately enabling a combination of white and stainless steel finish to be fitted.
- (f) The alarm system shall be capable of being connected to the house fire alarm system via an interface unit where a fire telephone or disabled refuge system is not installed.
- (g) The disabled toilet alarm shall be fully compliant to BS 8300.
- (h) It shall also be possible to connect an additional ceiling pull – to enable connection of two ceiling pulls to each reset and over door light, allowing the ability to use for rooms with two points of call.
- (i) The toilet alarm system shall be powered from the controller which shall be either directly powered or powered from the local lighting circuit via a dedicated fused connection unit.
- (j) When the ceiling mounted cord is pulled, the over door light/sounder shall operate. The alarm shall be raised locally and also on either the fire alarm system or disabled refuge if connected.
- (k) A disabled WC door sign shall be included with the system.

E016200 EARTHING & BONDING**E016201 General Requirements**

- (a) This section shall be read in conjunction with Section E86, E87 & E88 of the General Materials and Workmanship Specification for earthing and bonding, lightning protection and transient overvoltage protection.

E016210 General Earthing & Bonding

- (a) The building general earthing and bonding systems shall be retained, modified and extended to suit the revised installations.
- (b) The ESI shall be responsible for the supply, installation and testing of earthing and bonding of the electrical systems in accordance with elsewhere in this Specification, BS 7671 and BS 7430.
- (c) Generally, the main earthing systems of the building shall be retained and extended as generally detailed on the drawings with only those parts of the installation that need to be modified to facilitate the refurbishment. The scope of works shall include:
 - i) Bonding of 2nr equipment cabinets within basement Comms Room
 - ii) Earthing of standby generator
 - iii) Alterations to bonding of mechanical services, where they have been replaced
- (d) The existing earthing systems to the building are expected to comply with current standards and regulations. However, where, in the opinion of the ESI this is considered not to be the case the ESI shall provide details in writing to the Engineer, including costs to rectify prior to undertaking any works.

- (e) The ESI shall complete full earth continuity tests as detailed elsewhere in this Specification prior to completion of the project.
- (f) The ESI shall ensure that the main equipotential bonding of the building is compliant with BS 7671 and elsewhere in this Specification.
- (g) The ESI shall ensure that the supplementary bonding of metalwork is completed as detailed elsewhere in this Specification including de-bonding the suspended ceiling that is no longer considered to be either exposed-conductive-parts or extraneous-conductive-parts.

E016220 Lightning Protection

- (a) The building is protected by an existing lightning protection system that shall be maintained and modified to suit the new works.
- (b) The ESI shall arrange for a Specialist Lightning Protection System contractor to attend site and undertake a detailed inspection and test of the existing lightning protection system. Any defects shall be confirmed in writing with costs to rectify for consideration by the Employer.
- (c) The ESI shall supply, install and test an extension of the lightning protection system to cross bond new plant installed as part of the refurbishment including:
 - i) Standby generator
 - ii) External air conditioning units
 - iii) New containment installed as part of the refurbishment
- (d) The new lightning protection cables shall be copper PVC sheathed 25mm x 6mm tape.
- (e) On completion of the lightning protection system the Electrical Services Installer shall carry out a complete test of the earthing and lightning protection system and provide a completion certificate

E015230 Generator Earthing

- (a) The ESI shall supply, install and test the generator earth cable to the main earthing terminal located in the basement main LV switchroom. For the purpose of tender the ESI shall assume a 120mm² single-core XLPE/LSF green/yellow earth cable and allow 80m between the roof generator and the earth terminal.

E015240 Comms Room Equipment Cabinet Earthing

- (a) The ESI shall supply and install a new 6-hole earth bar within the basement Comms Room, to be located within the room. The earth bar shall comprise 25mm x 6mm thick copper and be bonded to the main supply earth.
- (b) From the main earth bar single-core 10mm² XLPE/LSF green/yellow earth cables shall be taken to each of the equipment cabinets. The ESI shall be responsible for termination of the earth cables to the equipment cabinets.

E016250 Transient Overvoltage Protection

- (a) Type 1 and Type 2 surge protection devices shall be installed in all new MCB distribution boards and MCCB panelboards, generally as detailed in section E88.

E016300 CONTAINMENT**E016301 General Requirements**

- (a) This section shall be read in conjunction with Section E10 of the General Materials and Workmanship Specification for containment.
- (b) The ESI shall supply and install new containment for all cabling systems for the sub-mains and final circuit LV cabling, ELV cabling for lighting controls, fire alarm and EVCS as well as for the structured cabling installations and security cabling designed and installed by others.
- (c) The tender drawings indicate the requirements for the containment and the ESI shall be responsible for the detailed design (forms part of the contractor's design portion), supply, installation and co-ordination of all new containment including but not limited to:
 - i) Medium duty galvanised steel cable tray for armoured sub-mains cabling
 - ii) Galvanised steel cable tray and trunking for final circuit cabling.
 - iii) Cable basket for final circuit cabling for the general small power and lighting circuit cabling installations.
 - iv) Cable tray or basket for ELV services including fire alarm, security and structured data cabling
 - v) 3-compartment skirting cable trunking for final circuit power and structured data cabling
 - vi) Surface and recessed conduit
- (d) All cable containment shall be taken from the suppliers referenced within the accompanying Schedule of Recognised Suppliers (E970004).
- (e) The ESI shall be responsible for developing the containment design, including sizes of the containment, as part of their working/installation drawings and as detailed elsewhere in this Specification and to meet the requirements of the Employer's standards.
- (f) Cable trays may be installed above one another on a common unistrut suspension system where it is appropriate to do this and where co-ordination with other services, including ductwork routes and fan coils necessitates it. However, the ESI shall take in to account any weight/loading conditions on the building structure that this may involve.
- (g) Where containment is installed for the installation of cables by Specialist Suppliers, including fire alarm, security, audio-visual and mechanical controls etc, access shall be provided for wiring these systems including the provision of draw-wires within conduits.

- (h) The ESI shall install containment for structured data cabling that will be installed by the Employer direct. Containment shall include cable basket or tray for main runs of data cabling. The ESI shall also install back boxes within perimeter dado trunking where data outlets are indicated on the drawings and shall install back boxes and conduit, complete with draw-wires, where data outlets are indicated on walls.
- (i) All containment systems, except conduits, shall be designed to accommodate a minimum of 25% spare capacity for future wiring installations.
- (j) Where different category cables are installed the ESI shall allow to install cable dividers to maintain separation between the ELV cables (LV and ELV cables shall be routed on separate containment) including fire alarm cables, lighting control cables, data and audio-visual cables.
- (k) ELV services, including fire alarm cabling may be routed on the same containment system but must be physically segregated from each other and the services uniquely identified and be otherwise in compliance with statutory requirements including BS 7671 and BS 5839 Part 1.
- (l) ELV cables shall be routed along the entire length within or on containment, including conduits to final outlet boxes. The position of final outlets, terminations shall be co-ordinated between the ESI and the Specialist Contractors.
- (m) High level outlets may be supported from the side of the containment systems provided that they do not impede access for future access for re-wiring and do not affect the installed cables.
- (n) The ESI shall design, supply and install multi-compartment dado trunking for power and data to the office areas as detailed on the drawings.
- (o) A vertical section of trunking shall rise to high level to link to the high level containment carrying the power and data cables. The distance between the two separate containment systems shall be kept to an absolute minimum and no more than 100mm with the cables between installed within a fabric flexible conduit to ensure they are neatly installed where they pass into the trunking.

E016400 BWIC**E016401 General Requirements**

- (a) This section shall also be read in conjunction with Section E06 of the General Materials and Workmanship Specification.
- (b) The ESI shall be responsible for all builders' work in connection with the electrical installations and for co-ordinating builders' work with the Main Contractor and other specialist sub-contractors to ensure that the electrical installations meet the design requirements.
- (c) Builders' work in connection with the electrical installations include, but are not limited to the following:
 - i) Forming of holes through structural and non-structural walls. Where holes greater than 50mm diameter are to be formed through structural walls (load bearing) advice may be required from a Structural Engineer).

- ii) Opening up and reinstatement of fire barriers through partition walls and floor slabs.
- iii) Chasing of walls for installation of conduits and conduit boxes.
- iv) Wooden pattresses for the fixing of equipment to the ceiling or walls
- (d) The ESI shall provide setting out of all ceiling mounted devices in the way of a reflected ceiling layout, as detailed elsewhere in this Specification to enable the Engineer and Architect to approve setting out of all ceiling devices. The ESI shall liaise with the Mechanical Services Installer to obtain details of ceiling mounted mechanical equipment including, but not limited to ventilation grilles.

E016500 INSPECTION & TESTING**E016501 General Requirements**

- (a) This section shall be read in conjunction with Section E90 of the General Materials and Workmanship Specification for inspection and testing, including as detailed separately above.
- (b) The ESI shall arrange a sample installation of high-level electrical services within one office suite for review and comment by the Engineer, Architect and others as necessary to agree a benchmark standard for the exposed services installation throughout the building. This benchmark installation shall be completed at least 1 month before the first fix installation in these areas is due to commence to allow time for review and alterations to be made for final acceptance.
- (c) The ESI shall arrange for works tests of the new life-safety generator, as detailed elsewhere in this Specification. The ESI shall provide a minimum of two weeks' notice of this date to allow the Engineer and any other client representative to arrange travel and accommodation.
- (d) The ESI shall undertake final testing and commissioning of the new electrical services installations in accordance with elsewhere in this Specification, British Standards and manufacturer's recommendations including:
 - i) Electrical circuit tests in accordance with BS 7671
 - ii) Emergency lighting tests in accordance with BS 5266
 - iii) Lighting and emergency lighting installation including light levels and controls
 - iv) Fire alarm tests in accordance with BS 5839 including audibility test record drawings
 - v) Testing the emergency voice communication system
 - vi) Integrated system test including detailed cause-and-effect of the fire alarm system with the mist system, smoke extract system and other mechanical services installations.
 - vii) Commissioning tests of miscellaneous systems including disabled toilet alarm
- (e) The electrical installations shall be inspected and tested regularly during the works to ensure that services to other parts of the building are unaffected by the fit-out scope of works.

- (f) The ESI shall refer to elsewhere in this Specification regarding the Inspections and Witnessing by the Engineer and particularly the “Benchmark Standards” section that ensures the exposed services installations meet the requirements of the Engineer, Employer and Architect.

E016600 RECORD DOCUMENTATION & CERTIFICATION**E016601 General Requirements**

- (a) This section shall be read in conjunction with Section E92 and E94 of the General Materials and Workmanship Specification for design and construction documentation and record documentation respectively.
- (b) The ESI shall provide documentation at the various stages of the project, generally in accordance with the BSRIA Guide BG6 “A Design Framework for Building Services”, as detailed elsewhere in this Specification, and generally as follows:
 - i) Detailed design and co-ordinated drawings (RIBA Stage 5)
 - ii) Co-ordinated installation drawings (RIBA Stage 5)
 - iii) Manufacturer’s drawing (where necessary)
 - iv) Builders’ work in connection drawings
 - v) Energy performance certification
 - vi) Asset register
 - vii) Building logbook
 - viii) Building user guide
 - ix) Record documentation including O&M manuals and as-installed drawings
- (c) The ESI shall provide the record documentation as generally detailed elsewhere in this Specification, at the end of the project to include the following details:
 - i) Manufacturer’s drawings of the electrical installations, where appropriate.
 - ii) Layout drawings of the new installations
 - iii) Electrical test certification in accordance with BS 7671, i.e. NICEIC
 - iv) Emergency lighting test certification in accordance with BS 5266, i.e. NICEIC
 - v) Fire alarm test certification in accordance with BS 5839 Part 1, i.e. NICEIC
 - vi) Fire alarm audibility test result drawings
 - vii) Specialist systems commissioning test certificates
- (d) The ESI shall provide record documentation as generally detailed elsewhere in this Specification and shall include 2nr paper copies and 1nr electronic copy. The record documentation shall be submitted in draft format no later than 1 month prior to practical completion with the final copy, to include all test certificates and record drawings to be issued no later than 2 weeks following practical completion.
- (e) The ESI shall include to instruct the Employer and/or their representative as detailed elsewhere in this Specification. This instruction can be arranged to coincide with the

final testing and commissioning but this must be agreed with the Engineer and Employer to ensure the appropriate persons are available.

- (f) The ESI shall refer to the section regarding working in existing buildings, as generally detailed elsewhere in this Specification. Whilst existing information regarding the building is limited the ESI shall undertake the intrusive surveys detailed elsewhere and shall appoint the appropriate Specialist Contractors who have knowledge of the building

E03 DESIGN AND PERFORMANCE PARAMETERS

E030100 BASIS OF DESIGN

- (a) This section of the specification set out the principal design parameters applicable to the Electrical Services Installation.

E030400 POWER SUPPLY

E030401 General

- (a) The incoming supply will be derived from the Distribution Network Operator.
- (b) The power supplies and distribution equipment have been sized to cater for the under noted loads. The low voltage distribution has been designed for a 11000/400/230 Volts. 50 Hz AC supply with a variation of +10% -6% in voltage and $\pm 1\%$ in frequency. Equipment shall be selected to operate with the above supply unless otherwise specified.

- (c) Supply Voltage

Note that the voltage definitions for alternating current utilised within this specification are in accordance with BS EN 50160 and BS 7671:

- i) Extra low voltage – 50 Volts (50 Vac) or less
- ii) Low voltage – Greater than 50 Volts (50 Vac) and less than or equal to 1000 Volts (1k Vac) between conductors
- iii) Medium Voltage – Greater than 1000 Volts (1 kV) and less than or equal to 36000 Volts (36 kV) between Conductors.
- iv) High voltage – greater than 36000 Volts (36 kV) and less than or equal to 150000 Volts (150 kV) between Conductors
- v) Extra high voltage – Although not detailed in BS EN 50160 shall refer to any voltage in excess of 150 kV between Conductors

E030404 Landlord's areas:

Lighting	6 W/m ²
Small power	15 W/m ²
HVAC plant	50 W/m ²

E030405 Tenants areas:

Lighting	6 W/m ²
Small power	25 W/m ²
HVAC plant	70 W/m ²

E030410 Power factor:

Corrected value = 0.95 lagging

E030413 Standby Supplies for Life Safety

- (a) Standby supplies for life safety shall be provided in accordance with BS 9999 and BS 8519.
- (b) Life safety Generators shall comply with ISO 8528-12
- (c) Fuel Oil Storage – 8 hours minimum

E030416 Photovoltaic Generation

- (a) Photovoltaic systems shall be designed and installed in accordance with the IET Code of Practice for Grid Connected Photovoltaic Systems
- (b) Photovoltaic systems shall be designed and installed to meet the following criteria
 - i) Approximate nett area: XX m²
 - ii) Peak generation: XX kWp
 - iii) Performance Per Unit: XX kWh/kWp
 - iv) Annual Generation Rate XX kWh/m²
 - v) Module degradation shall not exceed XX%/annum
 - vi) Standard Module Efficiency shall be equal to or better than 18%
 - vii) Thin Film Module Efficiency shall be equal to or better than 16%
 - viii) Inverter efficiency shall be equal to or better than 95%

E030700 CABLE SIZING

- (a) The design of the sub-mains cable routes and associate containment is based on the assumption of the cables touching.

E031000 STANDARDS

- (a) Electrical design shall comply with the requirements of:
 - i) British Standard BS 7671
 - ii) Energy Networks Association Recommendations G5
 - iii) Energy Networks Association Recommendations P28
 - iv) Building Regulations
 - v) BS 9999
 - vi) BS 8519
 - vii) The Energy Related Product Directive (ErP) as set out in the European Commission regulations EU/327/2011

- viii) The Construction Product Regulations (CPR) as set out in the European Commission regulations EU/305/2011
- ix) EMC Directive 2014/30/EU and associated UK statutory regulations

E031300 LIGHTING

E031301 Internal lighting

- (a) The design of the internal lighting is in accordance with the best practice guidance contained within the following documents:
 - i) CIBSE LIGHTING Guides
 - ii) BS EN 12464-1 Light and Lighting of Work Places
 - iii) BCO Guide to Lighting - Best Practice for lighting of offices
 - iv) SLL Lighting Handbook

Area	E _m (Lx)	U _{GR}	U _o	R _a	Efficacy W/m ² /100lx	Method of Control
Office areas	300*	19	0.6	80	1.6	Occupancy/day light linking/ timed/ corridor hold
Conference rooms and meeting rooms	500	19	0.6	80	2.5	Dimming with scene set control
Toilets and cleaners	200	25	0.4	80	3	Occupancy sensing
Plant rooms and switchrooms	200	28	0.4	60	1.75	Manual control
Stairways	100	25	0.4	40	2.5	Occupancy sensing
Lift lobbies	200	25	0.4	40	2.5	Occupancy sensing
Entrance hall	100	22	0.4	80	3.5	Dimming with scene set control
Reception desk	300	22	0.6	80	3.5	Dimming with scene set control
Enclosed/internal cycle racks	100	25	0.4	40	3.5	Occupancy sensing

** Lighting to office suites has been designed to meet the future Cat B furniture / fit out and light levels cannot be guaranteed.*

For Cat B Installations, BS EN 12464-1, defines specific levels of illumination for specific tasks such as writing, typing, reading and data processing and this may be as high as 500lux. The lighting shall therefore be designed to achieve this level; however the lighting shall generally be operated below this level, where appropriate, in order to achieve the required efficacy figures by dimming the luminaire output.

- (b) The office area lighting installation has been designed in accordance with the guidance given in The Society of Light and Lighting Guide LG7.
- (c) The following reflection factors have been used for lighting level calculations:
- | | | | |
|-------|--|----------|-------|
| i) | Plain metal tile | RAL 9010 | 86% |
| ii) | Metal tile, ultra-micro perforated | RAL 9010 | 85% |
| iii) | Perforated metal tile (16% open area) | RAL 9010 | 73% |
| iv) | Perforated metal tile (22% open area) | RAL 9010 | 70% |
| v) | Fibre tile – fine fissures | | 83.5% |
| vi) | Fibre tile – standard fissures | | 80% |
| vii) | Wall | | 50% |
| viii) | Floor | | 20% |
| ix) | Account has been taken of glazed areas | | |
- (d) The office lighting design has used a minimum maintenance factor of **0.7**, unless otherwise stated within this specification. The design intent has been to maximise the maintenance factor in accordance with the following BCO Guide to Lighting recommendations:
- Good quality lamps LLMF > 0.9
 - Spot and bulk replacement of lamps LSF = 1
 - Yearly cleaning of luminaires
 - Yearly cleaning of room surfaces
 - LMF x RSMF = 0.89*
- (e) * This assumes a variable interval cleaning regime rather than fixed interval. CIE 97 suggests that such an approach would allow higher maintenance factors approaching 0.8 to be used.
- (f) The Electrical Services Installer shall ensure the maintenance instructions identify the requirement to clean the luminaires and room surfaces when the light levels drop below the design maintained illuminance level.
- (g) Where LED lighting is used the design has followed the guidance given in the BCO Guide to lighting, rather than utilise the L70 at 50,000 hours classification, the lumen depreciation figures for 37,500 hours has been utilised, which equates to a standard lease term of 15 years, based on the assumption of 2500 hours per year.

E031304 Emergency Lighting

- (a) Emergency lighting installations shall comply with the requirements of BS EN 1838 and BS 5266. They have been designed to maintain the following levels of illumination for a minimum period of three hours:
- | | |
|------------------|-------|
| Open plan areas: | 1 lux |
| Escape routes: | 1 lux |

Firefighting equipment / call point	5 lux
Fire Alarm Panel / first aid room (vertical plane)	15 lux
Plant rooms / switchrooms / lift motor rooms (for equipment task areas)	15 lux

- (b) The requirements of the Building Regulations approved document B regarding escape lighting shall be met.

E031600 ANCILLARY SERVICES

E031601 Lightning Protection

- (a) Lightning protection shall comply with BS EN 62305.

E031604 Fire Alarms

- (a) Fire alarm equipment shall comply with BS 5839, BS 6266, BS EN 54.

E031900 RADIO INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY

- (a) Equipment shall be designed so as to minimise radio interference in the frequency range 0.15 MHz to 30 MHz.
- (b) All equipment supplies, prefabricated and installed shall be designed manufactured and installed to fully comply with the European Electromagnetic Compatibility Directive 2014/30/EU, the CE marking directive and the United Kingdom's Electromagnetic Compatibility Regulations.

E06 GENERAL WORKMANSHIP AND MATERIALS**E060100 GENERAL**

- (a) This section of the specification describes standards of materials and workmanship applicable to all classes of installations. Particular requirements shall be as described elsewhere in this specification.

E060400 DESIGN AND STANDARDISATION

- (a) Materials shall be of the best quality and class most suitable for the conditions specified. They shall withstand variations of temperature and atmospheric conditions arising under working conditions without distortion, deterioration or undue stress and without affecting the strength and suitability of the parts for the work, which they have to perform.
- (b) No welding, filling, plugging or jointing of defective parts will be permitted without the agreement in writing of the Engineer.
- (c) Equipment shall operate without undue vibration and with the least practicable amount of noise.
- (d) Equipment shall be suitably selected, designed, manufactured and installed for the environmental conditions in which it will be installed.
- (e) Equipment shall be suitably protected against corrosion.
- (f) Outdoor apparatus shall be designed to avoid pockets in which water can collect.
- (g) Connections to equipment shall be made in accordance with the manufacturer's instructions and in a manner such that any connection does not reduce the equipment's stated rating of ingress protection.
- (h) Electrical connections and contacts shall be of ample section and surface for carrying continuously the specified currents without undue heating. They shall be secured by bolts or set screws of ample size, fitted with locking devices of an agreed type and material.
- (i) Rubbing or wearing surfaces shall be machined faces. Joints employing a gasket material shall be so constructed that the packing is maintained under sufficient compression in all parts to provide an efficient joint without the use of jointing compound. Gasket material shall be of the minimum thickness necessary and of an agreed composition.
- (j) Equipment shall be designed to obviate the risk of accidental short circuit due to animals, birds and vermin.
- (k) Equipment incorporating doors shall be erected so that the doors can be opened to at least 90° after adjacent equipment has been installed and shall be easily removed.
- (l) Openable doors on equipment shall not impede emergency egress.
- (m) Precautions shall be taken to ensure that no chemical or electrolytic action takes place where dissimilar metals or materials are used together. The number of points of contact of dissimilar metals shall be kept to a minimum. Where possible inert barriers

shall be provided. Aluminium or aluminium alloy surfaces shall be avoided or protected.

- (n) The Works shall be designed and installed to permit inspection, cleaning and repairs, and for operation in which safety and continuity of service shall be the first consideration.
- (o) Systems shall be designed to ensure satisfactory operation under the atmospheric conditions prevailing and under such sudden variations of load and voltage as may be met under working conditions on the system.
- (p) Equipment shall also be of adequate strength to withstand the electro-mechanical forces that may be set up by the prospective short circuit currents that could occur under fault conditions within the electrical infrastructure, including any contribution that rotating equipment may add to the fault.
- (q) Where it is intended to synchronise any rotating generating equipment with the incoming utility supply for either short term or long term paralleling operations protection shall be provided in accordance with the requirements of Energy Networks Associations recommendations G99 and equipment shall be of adequate strength to withstand the electro-mechanical forces that may be set up by the prospective short circuit currents that could occur under fault conditions within the electrical infrastructure when the system is in parallel with the utility supply.

E060700 MANUFACTURING STANDARDS

- (a) Except where specified otherwise, all materials and equipment associated with the installation shall be handled and installed strictly in accordance with the manufacturer's recommendations. Operatives shall have had previous experience of the equipment and materials and, where necessary, attended a manufacturer's course on use and installation.
- (b) Any demonstration by manufacturers or others required for operatives who are to install the materials and equipment shall be provided. Special tools recommended by manufacturers for the installation of the material and equipment shall be used by the operatives.
- (c) BS EN ISO 9001 Quality Assurance shall be complied with in relation to design and manufacture of equipment.

E061000 DELETERIOUS MATERIALS

- (a) None of the following materials or products shall be incorporated into the Works:
 - i) Sea dredged aggregates, unless they have been tested in accordance with BS EN 1097; and conform in all respects to BS EN 1992
 - ii) Asbestos based products
 - iii) Resin coated blocks
 - iv) Calcium silicate bricks or tiles
 - v) Slipbricks
 - vi) High alumina cement

- vii) High alkali cement not conforming with British standards
 - viii) CFC's or any product using CFC's in its manufacture
 - ix) Chloride based mixtures
 - x) Glass fibre reinforced concrete
 - xi) Tricovite concrete
 - xii) Chipcrete
 - xiii) Woodcrete
 - xiv) Timber which is not obtained from a managed regulated sustainable source
 - xv) Lead, except where particularly specified for connection to existing cast iron drainage pipes
 - xvi) Asbestos substitutes or any naturally occurring or manmade mineral fibres which generally have a diameter of 3 microns or less and a length of 200 microns or less or which contain fibres not sealed or otherwise stabilised to prevent fibre migration
 - xvii) Vermiculite plaster
 - xviii) Extruded polystyrene other than low ozone depletion material
 - xix) Polyurethane Foam
 - xx) Urea-formaldehyde polyurethane, isocyanurates, polyisocyanurates in foams or materials which may release gases in quantities which may be hazardous, with reference to the limits set from time to time by the Health and Safety Executive
 - xxi) Woodwool slabs in permanent formwork or in structural elements
 - xxii) Aggregates suitable to alkali silica reaction
 - xxiii) Any products containing cadmium which are referred to in SI 2006/3311 Controls on dangerous substances and preparation regulations 2006 (including 2007 corrections) or any amendment or re-making thereof
 - xxiv) Any timber treated with pentachlorophenol
 - xxv) Polytetrafluorethylene (known as PTFE) except when used as non-stick sealing with valves or as an isolating tape
 - xxvi) Materials, which emit Radon gas
- (b) Other substances which have been publicised by the Health and Safety Executive, Building Research Establishment, British Standards Institution or other Specialist Authority as being deleterious to Health or Safety, shall not be incorporated into any part of the Works.
- (c) Substances which have been similarly publicised as being deleterious to the durability of property shall not be used, nor shall any substance which has been publicised as being damaging to the environment unless the Engineer has agreed to such use in writing. The Engineer will only agree to the use of any such material where it can be

shown that the use is essential in connection with the Works and that no suitable alternative exists.

E061600 STATUTORY APPROVALS

- (a) The Services Installer shall obtain all necessary approvals including but not limited to:
 - i) Building Control
 - ii) Distribution Network Operator
 - iii) Building Network Operator where appointed

E061900 SAMPLES

- (a) Such samples of workmanship, finishes, materials or equipment as the Engineer or Employer may require shall be submitted for comment. Samples of any items requested shall be forwarded in sufficient time to allow the Engineer to consult with the Architect and Employer before advising of any comments.
- (b) Where in the opinion of the Engineer the samples submitted are not of a high enough standard or are unsuitable for use in the proposed circumstances, alternative samples shall be obtained from such a source as the Engineer shall decide.
- (c) Samples, after comment shall, as the Engineer decides either, remain in the possession of the Engineer until the expiry of the maintenance or guarantee period, whichever is the longer, be embodied in the installation, or be returned to the Manufacturer.
- (d) Where a finish is described in the specification as being for the Architects agreement or comment it shall be to a BS or RAL colour and gloss factor advised by the Architect in writing. Samples of the correct colour and gloss factor shall be provided, prior to placing the equipment on order, either as part of a general sample described above, or as specially prepared plates of the same basic material as the equipment and with the same protection and undercoating.

E062200 SPARE PARTS

- (a) Where described within the specification, spares, replacement parts or consumables shall be provided. They shall be direct replacements of the same manufacture and quality as the original component, properly protected in the Manufacturer's original packing.
- (b) Spares and replacement consumables shall be clearly identified by a reference cross-indexed to a spares list within the Operation and Maintenance Manuals, identifying the equipment to which the spare refers.
- (c) The Services Installer shall provide a schedule of additional spare parts recommended by the manufacturers, together with their individual prices. Such parts may or may not be ordered.

E062500 PROTECTION AND STORAGE

- (a) The Services Installer shall ensure that all components of the installation, including those provided by specialist or novated suppliers, are adequately protected from

mechanical damage, ingress of moisture and foreign bodies, until such time as the installation is handed over to the Employer.

- (b) The Services Installer shall ensure all equipment including that provided by specialist and novated suppliers is, where necessary by the prevailing site conditions, manufactured in sections or modular form, such that it may be delivered, installed, reassembled and re-tested at site.
- (c) Adequate and safe storage and protection of all materials, plant and equipment shall be provided. Equipment shall be stored in accordance with the relevant British Standard or Code of Practice. Where materials, plant and equipment cannot be stored in purposely built dry and ventilated storage facilities they shall be raised and supported clear of the ground. They shall be protected against frost or damage due to building work with waterproof covers or other appropriate protection.
- (d) Conduits, pipes and similar materials shall be stored on properly made racks to prevent bending and distortion. Ends shall be closed and threads protected by means of purpose made end caps. Storage of pipes, conduits or other materials directly on earth will not be permitted.
- (e) Machined and bright surfaces shall be protected in accordance with the manufacturer's instructions. Items shall be inspected regularly by the Services Installer to ensure that any applied protection has not become damaged either in transit or storage. On completion, surfaces so coated shall be cleaned and where appropriate, polished.
- (f) Plant and equipment shall be left in a condition ready for painting where painting is required. Parts liable to corrode shall be painted immediately after removal of the temporary protection.
- (g) Electrical cables shall be protected from any physical damage and their ends sealed using methods and materials recommended by the cable manufacturer.
- (h) Protection applied to installed equipment shall be non-conductive and fire-retardant.

E062800 EQUIPMENT & MATERIALS

- (a) A complete schedule of materials and equipment included shall be submitted with the Tender. The Schedule shall indicate manufacturer, material, description and identifying reference.
- (b) Materials and Equipment of any one type shall be provided by the same manufacturer throughout the Contract. Components provided as part of any equipment shall be of the same type and manufacture throughout all items provided by one manufacturer.
- (c) Equipment and Materials shall be supplied by companies who provide a full after sales service. The supply, in this country, of adequate general spares and components for a period of at least ten years from the date of Practical Completion shall be ensured so far as is reasonably practical.

E063100 DATE STABILITY

- (a) Written confirmation shall be provided by the Services Installer at tender that all software and date dependent programming is date stable for both past and future known date issues e.g. 2000, 2010 and 2038.

- (b) Each system shall be demonstrated to the satisfaction of the Engineer to show that performance and functionality shall be unaffected by dates, months, years and centuries and in particular.
- (c) No value for current date, month, year and century shall cause any interruption in operation.
- (d) Date based functionality must behave consistently for dates. No equipment or product shall use particular date values for special meanings e.g. 99 to signify no end value.
- (e) In all interfaces and data storage, the century in any date must be specified either explicitly or by unambiguous algorithms of interfacing rules.
- (f) 'Leap year' as defined in BS ISO 8601 must be recognised as leap year.

E063400 RADIO INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY

- (a) The systems have been designed in accordance with the requirements of the EMC Directive 2014/30/EU and the associated UK EMC Regulations as they apply to fixed installations.
- (b) The Electrical Services Installer shall ensure that the equipment installed and the installation methods adopted do not compromise the design intent.
- (c) The Electrical Services Installer shall employ the services of an EMC specialist to verify compliance with the EMC Directive.
- (d) The plant and equipment supplied and installed as part of the works shall meet the relevant harmonised standards for emissions and immunity.
- (e) The Electrical Services Installer shall ensure the equipment supplied is CE marked demonstrating conformity with the applicable European Directives and shall submit proof of compliance.
- (f) As part of the requirements, an ongoing review of the installation by the Client's 'Responsible Person' shall be undertaken and the Electrical Services Installer shall liaise as necessary with the Responsible Person and provide all documentary evidence of compliance with the EMC Directive, as required.

E063700 SYSTEM SOFTWARE/FIRMWARE

- (a) The Services Installer shall maintain a log of any component dependent on either software or firmware for its operation.
- (b) The log shall be maintained throughout the contract until the end of the defect's liability period.
- (c) The log for any component shall commence at the initial commissioning of that component either at factory or at site. The log shall detail the version and revision number of the soft/firmware commissioned at that date.
- (d) A detailed description of the revision, the reasons for the revision and details of testing to be carried out on the proposed revision shall be submitted to the Engineer for review.

- (e) Any modifications shall be entered on the log together with the version and revision number, the date the revision was installed and a synopsis of the reason for the revision.
- (f) Where soft/firmware is dependent on site entered parameters for its correct operation, the date of the initial entered information shall be recorded in the log and a hard copy of the parameters shall be appended to the log. Any subsequent modifications to these parameters shall be entered on the log and the revised parameters appended.
- (g) The log shall be maintained and shall form part of the operation and maintenance manuals. The initial copy shall be incorporated at practical completion and a final copy incorporated at the end of the defects liability period.
- (h) Where the Engineer considers that the modifications are significant, the systems shall be fully retested with the new software/firmware to ensure that the modifications do not affect the operation of that or other systems.
- (i) Software licenses shall be provided for the Employer to use the software utilised within the Services Installations on any terminal in his possession whether on or off site.
- (j) The Services Installer shall confirm in writing that the Employer has the non-exclusive right to use the software in the system for the purposes of his business.
- (k) The Services Installer shall confirm in writing that the Employer is entitled to make such copies of the software as he may reasonably require for his own internal use without payment of any royalty. Such software shall include, but not be limited to that installed on the following Systems:
 - i) Building Management System
 - ii) Energy Metering Systems
 - iii) Fire alarm
 - iv) Lighting control systems
- (l) The software licensor shall be prepared to provide an Escrow agent for the storing and handling of the software source code for release to the licensee on violation of the software license agreement.

E064300 GALVANISING

- (a) The hot dipped process in accordance with BS EN ISO 1461 shall be used to apply galvanising. The preparation for galvanising and the process shall not adversely affect the mechanical properties of the material being coated. The average thickness of the coating shall be equivalent to not less than 0.6 kg/m² of zinc.
- (b) Pre-site drilling, punching, cutting, bending and removal of burrs shall be completed before treatment where the material is to be galvanised after manufacture.
- (c) Surfaces in contact with oil shall neither be galvanised, nor cadmium plated, unless finished with an oil resisting varnish.
- (d) Where it is necessary to cut and work galvanised materials on site, which result in damage to the original galvanised finish, the Services Installer shall treat the damaged

area with two coats of zinc rich paint. The remedial works shall be carried out to the satisfaction of the Engineer prior to the formation of any corrosion and following any necessary de-burring of the cut edges.

E064600 FIXINGS

- (a) Fixings shall be provided to the satisfaction of the Engineer. Supports, brackets, clamps, spacers and any other steelwork, whether or not shown in detail on the drawings, required for the proper and effective fixing of any equipment, shall be provided.
- (b) Fixings including secondary support steelwork, gantries, channel systems, etc. shall be designed and installed by the Services Installer. The details of such systems shall be submitted to the Structural Engineer for comment.
- (c) Where support systems, brackets, clamps and spacers are assembled from proprietary channel support systems they shall be installed in accordance with the manufacturer's recommendations. Channel support assemblies shall be factory manufactured wherever possible, where they have to be fabricated at site they shall be cut to suit, de-burred, the galvanised finish repaired by two coats of zinc rich paint and all exposed ends fitted with proprietary end caps.
- (d) Fixings to brickwork and blockwork shall be made in the bricks and blocks and not in the bond. Wood screws shall be zinc coated and machine thread screws shall be solid brass, greased before installation. Accessories mounted in fixed equipment shall incorporate adjustable slotted fixing holes.
- (e) Heavy equipment shall be fixed with purpose made clamp brackets, ragbolts or patent fixing bolts. Shot plugs, bolts or welding fixings to structural steelwork shall not be used without the written agreement of the Structural Engineer.
- (f) No structural steelwork shall be drilled for any purpose without the written agreement of the Structural Engineer. In general fixings to steelwork shall be by studs secured to the steelwork by clamp-brackets or hook bolts. Exterior steelwork fixings shall be galvanised.
- (g) Nuts shall be locked in position with lock nuts or lock washers, Castell-nut and split pin or other devices. Lock washers shall not be used above M24 size except when a spring type is specially agreed by the Engineer. Each bolt or stud, except for terminal and relay stems, shall show at least one full thread through its nut after assembly and shall not project through its nut by more than 10mm or four threads whichever is the less. Bolts, nuts and washers on outdoor equipment shall be of non-corroding material. Suitable special spanners shall be provided for bolts and nuts which are not properly accessible by means of an ordinary spanner.

E064900 CLEANING AND PAINTING

- (a) Before painting components shall be thoroughly clean, free from rust, scale, burrs, grit and moisture with external rough surfaces on castings filled.
- (b) Ferrous sheet metal work not galvanised shall be cleaned to remove all grease and rust before painting with an agreed protective coating applied before despatch from works. Any deterioration or damage to protective coatings or finishes during delivery, storage and following installation shall be made good to the satisfaction of the Engineer. Damaged areas shall be made good as if they were bare metal.

- (c) Ferrous metal including brackets, hangers and steelwork not protected by galvanising, works applied primer, protective paint or insulation shall be cleaned to remove grease and rust, given one coat of primer and finished with two coats of non-metallic paint of a colour agreed with the Engineer. Where the surfaces will be subjected to temperatures above 100 °C finishing coats shall be heat resisting paint and the primer omitted.
- (d) The minimum painting requirements described below shall apply to all ferrous parts unless the Engineer agrees, in writing, to any alternatives proposed. Successive coats of paint shall be easily distinguishable by shade or colour and shall be applied to a clean, dry and properly prepared surface. Each coat shall be compatible with the previous coat.
- (e) The Services Installer shall ensure that all paints, varnishes and other surface treatments applied to the engineering services whether applied in situ or in the factory are tested and compliant with the requirements of BS EN 13300. Where the proposed paints, varnishes or other treatments have not been tested and accredited in accordance with BS EN 13300, the Services Installer shall provide proof of compliance with a standard equal to, or more onerous than the requirements of BS EN 13300. The Services Installer shall also provide a full technical validation of the standard applied against BS EN 13300 to demonstrate it is a comparable and applicable standard.

E065200 FIRE PRECAUTIONS

- (a) Apparatus, connections and cabling shall be designed and arranged to minimise the risk of fire and any damage which might be caused in the event of fire.

E065500 TIMBER

- (a) All timber used either to facilitate construction or for permanent use shall be FSC Certified. The Services Installer shall be responsible for documenting timber use and providing FSC Certification for all timber to the appropriate person for approval.

E065800 TOOLS

- (a) The Services Installer shall supply in steel boxes complete with keys, any special tools that may be required for making adjustments to equipment during normal operation or maintenance periods. Tools shall be of alloy steel and stamped with an identification marking.

E066100 ALIGNMENT AND FIXING OF ACCESSORIES

- (a) Particular attention shall be paid to the method of fixing of outlet boxes so that they shall, when completed be level and in an exact position relative to the finished surrounding surface permitting the cover plate to be fixed accurately, where electrical accessories are adjacent to either a horizontal or vertical plane, they shall be proportioned so as to achieve perfect alignment.
- (b) Where electrical accessories are fitted into tiled surfaces the last 150 mm shall be run in flexible conduit to permit accurate adjustment of the accessory.
- (c) Where conduit work is to be concealed, particular care shall be taken with the alignment of outlet boxes. A definite datum line from which all measurements can be

taken shall be ascertained, together with the thickness of walls, depths of plaster and final finishes of all relevant surfaces. Accessories shall be co-ordinated with final finishes, particularly wall tiling, to the satisfaction of the Engineer.

- (d) The Services Installer shall loosen off or remove all accessories from their back boxes to allow for decoration of finishes without damage to the accessories. The Services Installer shall finally re-fix all accessories when decorations are complete and dry.

E066400 BUILDING CONSTRUCTION

- (a) The Services Installer shall acquaint himself with the finishes to the building fabric as detailed on the Architect's and Structural Engineer's drawings. The installation of conduits, trunking and cables shall suit the structural beams and reinforced concrete structure.
- (b) The installation shall take account of the structure and finishes to the building as described on the Architect's drawings. They shall co-ordinate with the Architect's reflected ceiling plan for location of luminaires and ceiling mounted electrical and mechanical components.
- (c) The installation shall take account of the appearance and finish of wall mounted control devices and accessories which must be agreed with the Architect prior to ordering and fitting.
- (d) A contrast must be achieved to meet with Part M of the Building Regulations.

E066700 EXPOSED SERVICES INSTALLATIONS

- (a) Where services installations are indicated either on the drawings or in the specification as being exposed, careful attention shall be paid to the final appearance and quality of the installation.
- (b) Exposed installations are likely to include terminal units, grilles and diffusers, ductwork, pipework, cable tray (containing cables and/or refrigerant pipework) or cable trunking. In particular the methods of support adopted for each service shall enhance the appearance of the overall installation.
- (c) Finishes shall be selected to maintain their appearance for the life of the installation and shall be sufficiently robust to withstand the risk of mechanical damage appropriate to their location.
- (d) Methods of fixing to the structure or building finishes shall be agreed with the Structural Engineer or Architect as appropriate.
- (e) All services shall follow and shall respond to influences from the building form and structure to achieve an aesthetically pleasing appearance.
- (f) Any exposed or cut edges shall be covered to improve their appearance. Exposed cut ends of drop rods and the like will not be accepted.
- (g) Where multiple services can be supported on common support systems this shall be considered and will generally be encouraged to minimise the overall appearance of the support systems.

- (h) Full installation details shall be submitted to the Engineer and Architect for final acceptance before the installation works are commenced. Typical details shall include as a minimum:
 - i) Methods of support (with details, drawings and samples) for each service
 - ii) Methods of support from the structure
 - iii) Finishes
 - iv) Methods of insulation (where appropriate)
 - v) Colour of finishes available for selection (where not specified herein)
- (i) Where exposed services are proposed, following the submission of the details described above, a sample area shall be installed with all services, for inspection and acceptance by the Engineer and Architect, before other areas are commenced. The sample area shall either be a temporary mockup, or a section of the final works, but shall be kept available for the duration of the overall installation works to allow it to be used to benchmark the quality which shall be achieved in the permanent installations. Any subsequent permanent installations that do not achieve the agreed standard shall be replaced at the services installers cost.
- (j) Where the high-level services are wired utilising armoured cabling, pre-fabricated wiring systems or other 'flexible' cabling solution for either power or data the Services Installer shall pay particular attention to the appropriate method of containment which is to be agreed with the Engineer.
- (k) Where the architect requires all high-level services to be over sprayed in a particular finish, it is the responsibility of the Services Installer to ensure that the finish does not affect the long term performance of the high level services or the manufacturer's warranty for the equipment. Where the high-level services equipment is fitted with safety or operating instruction labels these shall be masked or replaced by the services installer.

E08 WIRING SYSTEMS – CABLES

E080100 GENERAL

- (a) This section of the specification describes the general requirements for wiring systems. Particular requirements shall be as described in the services description or Schedules section of this specification.
- (b) The cables supplied by the Electrical Services Installer shall be strictly in accordance with those specified in the schedule of manufacturers.
- (c) All cables shall be sourced directly from manufacturers and not through wholesalers or Cable Specialist without prior written consent of the Engineer.
- (d) Under no circumstances shall the Electrical Services Installer substitute alternative manufacturers without the written consent of the Engineer.
- (e) The Electrical Services Installer shall submit a technical submittal covering all cable types to be installed.
- (f) The Electrical Services Installer shall ensure that all cables manufacturers comply with the mandatory requirements of the Construction Products Regulations by applying CE marking to any of their cables covered by the harmonized standard BS EN 50575.
- (g) The Electrical Services Installer shall ensure that compliant Declaration of Performance documents are issued as part of the technical submittal and these shall achieve the minimum performance standards:

i)	BS 6724 1.5 - 4mm ²	Performance	Dca S1 d2 a1
ii)	BS 6724 6 - 400mm ²	Performance	B2 S1 d1 a1
iii)	BS 7211 (6242/3B)	Performance	Dca S2 d2 a1
iv)	6491B 1.5 - 25mm ²	Performance	Dca S2 d2 a1
v)	6491B 35 - 630mm ²	Performance	Dca S1 d2 a1
vi)	BS 8346	Performance	Dca S2 d2 a1
- (h) The Electrical Services Installer shall be responsible for the design, supply and installation of all containment systems and fixings.
- (i) Wiring systems shall comply with the requirements of BS 7671.
- (j) Wiring systems shall be re-wireable in the future without disturbance to the fabric of the building unless the inherent nature or the system prevents this.
- (k) The cables shall have copper conductors, except where indicated otherwise or agreed, in writing, by the Engineer.
- (l) Cables shall be delivered as complete coils with wrapping and seals intact. Each coil shall be complete with the manufacturer's test certificate and date of manufacture. The test certificates shall be submitted to the Engineer prior to commencement of the installation.

- (m) Neutral conductors shall be sized throughout to carry the full design load current and shall not be less than the full size of the phase conductors. Neutral conductors shall not be shared between circuits.
- (n) Cables shall, where practicable, not be installed within escape routes.
- (o) Where the installation of cables within escape routes is unavoidable, the cables runs and the associated containment shall be kept as short as possible.
- (p) Any Power and Communications cabling and the associated containment systems shall fully comply with the requirements of BS 7671 and the requirements of the Building Control Officer.
- (q) Power Cabling shall satisfy the requirements of the Construction Product Regulations and BS7671 in respect to their reaction to fire.
- (r) Communications Cabling shall satisfy the requirements of the Construction Product Regulations and BS7671 and BS 6701 in respect to their reaction to fire.

E080400 CABLE SIZING

- (a) Cables are sized to take account of volt drop, circuit impedance, grouping, protection and environmental conditions. Sizes are based on the relevant tables and correction factors in BS 7671. Major cable routes are indicated on the drawings and these shall be adhered to. Cable sizes for final circuits are based on direct routes from the distribution equipment to the respective loads, with due allowance for routeing around the structure and other services.
- (b) Cables shall not be installed in or through thermal insulation except where they are required to pass through fire barriers. Any instance where the thickness of the fire barrier exceeds 300 mm shall be brought to the attention of the Engineer prior to installation of the cables. In exceptional circumstances where it is considered that the installation will be improved by installing cables in or through thermal insulation full details of the proposal, including calculations showing the derating effect on cable sizes and relative costs, shall be submitted to the Engineer for comment.
- (c) Cable lengths where indicated are shown only as a basis for design. It is the responsibility of the Electrical Services Installer to ascertain actual cable lengths, include for the actual lengths in the Tender and provide materials accordingly.
- (d) If any cable length varies significantly from that indicated or implied in the Tender Documents, the Electrical Services Installer shall provide the appropriate calculations to show that the cable is suitable for the intended load. Similarly, if any loads vary from those envisaged in the Contract Documents, the Installer shall show that appropriate cables will be provided to suit the revised conditions.
- (e) Thermistors circuits for motors shall be wired in cable not less than 1.5 mm², or greater if particularly specified. Heating and Ventilation Controls shall be wired in cable not less than 1.5 mm², or greater if otherwise specified. The type of cable shall be to the control manufacturer's requirements.

E081000 LV ARMoured CABLES FOR GENERAL POWER DISTRIBUTION

- (a) The armoured power cables shall be cross linked polyethylene (XLPE) insulated, low smoke zero halogen (LSOH) bedding, steel wire armoured (SWA), LSOH; cables shall be manufactured to comply with BS 6724. They shall be 600/1000 volt rated unless otherwise specified, with standard sector shaped copper conductors. The conductors shall be stranded, and each insulated with XLPE sheath. The sheathed conductors shall be covered with an overall LSOH extrusion to form bedding for the single galvanised steel wire armouring, which shall be covered with a flame retardant extruded black LSOH sheath.
- (b) The cable insulation and other components shall be suitable to permit operation of the cable at a maximum sustained conductor temperature of 90 °C and for a maximum short circuit temperature of 250 °C.
- (c) The CU/LSOH/SWA/LSOH cables shall be terminated by compression type, gunmetal or brass glands constructed to grip both the inner and outer sheath and so designed that any strain on the cable is taken by the steel wire armouring, which shall be effectively bonded to the gland. The cable glands shall incorporate an effective seal between the gland itself and the outer cable sheath, which shall be weather and moisture proof and complete with an LSOH shroud. The type of gland shall be agreed with the Engineer before any terminations are carried out.
- (d) Where cable lugs are to be utilised to terminate the cable, the Electrical Services Installer shall advise the Engineer of the type and manufacturer of the lugs to be used, prior to the works commencing and alternatives shall not be used without the written consent of the Engineer. The manufacturer of the cable lug shall dictate the type and make of crimping tool that may be used to secure the lug to the cable.
- (e) The bolted connections of the cable lug should be torqued in accordance with the equipment manufacturer's recommendations, in the absence of specific recommendations, the recommendations contained within BS 7609 shall be followed.
- (f) Where multiple single core armoured cables are specified, they shall have circular stranded copper conductors. The armouring shall comprise non-magnetic aluminium wire or strip, bonded at the cable terminations.
- (g) The Electrical Services Installer shall ensure that the gland plates at both ends of the cable are non-ferrous, aluminium.
- (h) The CU/XLPE/LSOH/SWA/LSOH cable shall be installed externally direct buried in the ground, within cable ducts or cable trench, only where the soil conditions are free draining. Where any other conditions exist or where laid directly into the soil, the armoured power cables shall be CU/XLPE/MDPE/SWA/MDPE (medium density polyethylene), manufactured generally to BS 6724.
- (i) The cores shall then be additionally identified by the appropriate coloured sleeves as required by BS 7671.

E081600 LOW VOLTAGE ARMoured CABLES FOR LIFE SAFETY SUPPLIES

- (a) Power cables feeding life safety and firefighting equipment, such as sprinkler pumps, wet riser pumps firefighting lifts, smoke extract and pressurisation fans; shall be classified as Category 3 in accordance with the Code of Practice BS 8519, with a fire survival time of 120 minutes, when tested in accordance with the test protocol set out in BS 8491, under defined fire conditions.
- (b) Fire rated cables with conductors less than 6 mm² cross sectional area shall be MICC.
- (c) The cables shall be manufactured to comply with BS 7846. They shall be 600/1000 Volt rated, unless otherwise specified, with standard sector shaped copper conductors, the conductors shall be stranded, with XLPE insulation. The conductors shall incorporate a mica/glass fire resistant tape, in order to achieve the required fire performance. The insulated conductors shall be covered with an overall LSOH extrusion to form the bedding for the single galvanised steel wire armour, the cable shall then be covered with an extruded black flame retardant LSOH sheath.
- (d) The Electrical Services Installer shall include for all necessary tests required in order to gain Local Authority/District Surveyor approval for the cable to supply the life safety and firefighting equipment.
- (e) The cable shall have LPCB approval for the fire performance characteristics and appear on their web site www.redbooklive.com.
- (f) The cable shall be terminated by compression type, gunmetal or brass glands constructed to grip both the inner and outer sheath and so designed that any strain on the cable is taken by the steel wire armouring, which shall be effectively bonded to the gland. Glands shall incorporate an effective water seal between the gland itself and the outer cable sheath. Glands shall be weather and moisture proof and complete with LSOH shrouds. The type of gland shall be agreed with the Engineer before any terminations are carried out.
- (g) The cable support systems and fixings for the fire performance cable shall be of suitably up-rated construction to cater for the reduced tensile strength of steel when exposed to fire. The support systems shall maintain their integrity in a fire situation for a minimum of two hours, being designed in accordance with the recommendations given in the Code of Practice BS 8519.
- (h) Where cable cleats are required to support fire rated cables, they shall be of the cast iron type and not the aluminium or PVC equivalent.
- (i) The cables feeding life safety firefighting equipment shall not be routed through areas defined in BS 8519 as areas of special fire risk; these areas include loading bays, underground car parks etc. Where this is unavoidable Category 3 cables shall be installed with the addition of supplementary passive fire protection.

E082200 LOW VOLTAGE UNARMoured CABLES**E082201 Single Core LSOH Cables**

- (a) Single core cables within conduit or trunking and flexibles shall be LSOH insulated. Cables shall comply with BS 7211. No cable with a conductor smaller than 1.5 mm² shall be used for general-purpose circuits or smaller than 2.5 mm² for socket outlet circuits.

- (b) Cables in trunking or conduit shall be 600/1000 volt grade.
- (c) Where conditions require the use of PVC insulated cables and flexibles instead of LSOH the Engineer must agree such alteration in writing.

E082204 LSOH Twin and Earth Cabling

- (a) Twin and Earth type, stranded copper conductor, XLPE insulated, LSOH sheathed cables shall be used only where particularly specified. The cable shall be of the flat type with outer sheath coloured white for surface installations and white or grey for concealed installations and be manufactured to BS 7211.
- (b) The colour code of the cable cores shall be altered, where required, with the agreement of the Engineer in writing by means of indelibly coloured cable sleeves which are not less than 20 mm long and fit tightly on the cable core. Where earth continuity conductors are exposed by removal of the outer sheath, they shall be protected by LSOH green/yellow coloured sleeving so that the minimum of bare copper conductor is visible.
- (c) The number and size of cables in conduit or trunking shall not exceed that stated in BS 7671.
- (d) Circuit protective conductors within insulated and sheathed cables shall be sized to suit the circuit requirements and in any case shall be 1.5 mm² minimum for 2.5 mm² live conductors.
- (e) Connector boxes shall not be used and cables shall be looped from point to point.
- (f) Cables shall be run in floor and roof spaces with steel conduit protection within walls. Conduits used as down drops shall be fixed at the top, at the box and at least one intermediate position. The ends of the conduits shall be smooth, free from rough edges and equipped with rubber grommets or brass bushes.
- (g) Cables in wood joist floors or roofs shall be run over joists where furring pieces are provided, through holes in the joists drilled not less than 100 mm down or suspended from the sides of the joist by free-running cable loops spaced not more than 250 mm apart. Cables in accessible roof or floor voids shall be fixed at similar spacings with plastic cable clips to the sides of the joints. Notching tops of joists will not be permitted and drilling holes shall be agreed with the Architect prior to commencement. Where cables run within 50 mm of the finished surface a galvanised metal plate of not less than 1.6 mm thick shall be provided to protect the cables along the entire length.
- (h) Where cables are run within ceiling voids they shall be supported at 600 mm centres via stainless steel cable ties or butterfly clips fixed to the soffit.
- (i) Where XLPE insulated, LSOH sheathed cables are connected to fully enclosed tungsten light units, LED luminaires with integral drivers and where cables pass the choke on a fluorescent fittings, the cables shall be additionally insulated with heat resisting sleeving; however, where practicable, the cables should be routed clear of heat sources and the UV emissions from the lamps.
- (j) Metal work such as switch boxes, conduit and metal luminaires shall be effectively bonded to earth. The cable entry and exit holes shall be protected with the appropriate brass bushes.

E082207 Flexible Cables and Cords

- (a) Flexible cables and cords shall comply with BS EN 50525 series of standards.
- (b) Flexible cables shall be rated for voltages up to 450/750 Volts.
- (c) Flexible cables and cords shall have XLPE insulation and generally a low smoke zero halogen sheath.
- (d) Where specified for a particular purpose heat resistant (silicone) or oil resistant sheathing shall be utilised.
- (e) Minimum conductor size shall be 1.00mm².

E082213 Single Core Flexible Cables Used For Power Distribution

- (a) Where detailed within the services description or the cable schedules, EPR insulated single core flexible cables with a low smoke and fire, heat and oil resistant, flame retardant outer sheath (BS EN 60332) shall be utilised.
- (b) Such cabling shall only be utilised to supply plant from a switchboard where the switchboard and plant are located within the same or adjacent rooms and where the risk of mechanical damage to the cable installation is minimal.
- (c) Under No circumstances shall such cables be utilised to supply life safety or Fire Fighting plant or equipment.
- (d) Cables shall be installed on perforated cable trays (with perforated lids if required for protection).
- (e) DC supplies or Single phase and neutral supplies shall be installed 'flat touching' together with the associated earth cable. Cables shall be individually tie wrapped to the cable tray at the manufacturers recommended spacings and additional ties shall be provided at suitable intervals to identify the cabling associated with the individual circuits.
- (f) Three phase circuits shall be installed in trefoil formation utilising proprietary LSOH trefoil cleats. Where a neutral conductor is run, quadrafoil cleats shall be utilised.
- (g) Where cables change direction from the horizontal to vertical installation whether in a dedicated riser or at drops to the switchboard or the item of plant being supplied, the cables shall be fully supported by a prefabricated tray work through the transition.
- (h) Flexible cables shall not be run over the tray lip.
- (i) Vertical tray supports shall terminate 600 mm – 800 mm above the glanding plate of the switchboard or plant being supplied.
- (j) Cables shall enter the cable chambers of the switchboard or plant supported by compression glands at the nonferrous gland plate.
- (k) The outer sheath of the cable shall not be removed from the cable until the point of termination.

E082500 FLEXIBLE METALCLAD CABLES

- (a) Proprietary flexible metal-clad cable systems shall consist of XLPE insulated copper cables complying generally with BS 6004 or BS 7211 permanently sheathed in a

galvanised steel flexible sheath. Conductors shall be identified in accordance with BS 7671 for colours of core of non-flexible cables for fixed wiring.

- (b) The system shall be assessed and certified by BASEC.
- (c) Earth continuity shall be provided by an integral earth conductor. The sheath shall be bonded to earth and tested as a conduit system. The sheath shall not be used as a circuit protective conductor.
- (d) Glands and other accessories shall be supplied and approved by the system manufacturer. Insulating bushings shall be fitted inside the cut ends of the sheath to prevent damage to the conductor insulation.
- (e) Sheath cutters and other special tools shall be supplied and approved by the system manufacturer and shall be used in accordance with their recommendations and installation instructions, to reduce the risk of cable damage.

E083400 FIRE ALARM AND EMERGENCY LIGHTING CABLES

E083401 General

- (a) Fire alarm and emergency lighting cables shall be selected in accordance with the requirement of BS 5839-1. The cable shall be Category 3 (enhanced) with a fire survival time of 120 minutes. Only if specifically noted within the services description or cable schedules shall Category 1 (standard) cables with a fire survival time of 30 minutes be used.
- (b) Unless specifically called for elsewhere in this specification only Category 3 enhanced cable shall be installed for fire alarm systems.
- (c) The fire performance characteristics of the Category 3 enhanced cable shall comply with the test protocol in BS EN 50200 incorporating fire, mechanical impact and water, on a single sample of cable; with the elevated test temperature specified in BS 8434-2.
- (d) The cable shall have an outer sheath of LSOH material compliant with the requirements of LTS3 in accordance with BS 7629. The sheath colour shall be red for fire alarm, voice alarm and fire telephone systems.
- (e) The cables shall have been independently tested for data transmission whilst being exposed to tests described in BS 8434-2.
- (f) The cables for central battery powered emergency lighting systems shall be selected in accordance with the requirements in BS 5266-1, having a fire survival time of 60 minutes, classified as Category 2 according to BS 8519, with a white LSOH sheath.
- (g) The manufacturer shall hold LPCB (Loss Prevention Certification Board) approval for the products they manufacture and supply.
- (h) The manufacturer shall hold BASEC approval (British Approval Services for Cables) for the products they manufacture and supply and in addition, be approved by Quality Assurance Standard BS EN ISO 9001.

E083404 Glands and Fixings

- (a) Cable termination shall be via the installation of the cable manufacturer's recommended cable glands complete with LSOH red shroud. These components shall be approved by the cable manufacturer for use with their cables.
- (b) Where the pliable cables are fixed direct to the building fabric, purpose designed coloured LSOH coated stainless steel or copper "P" clips shall be used. The fixings shall be approved by the cable manufacturer for use with these cables and shall be installed in accordance with the manufacturer's recommendations.
- (c) Where pliable cables are fixed to cable tray, purpose designed coloured LSOH coated stainless steel or copper fixings shall be used in accordance with the manufacturer's recommendations.
- (d) Alternative means of cable fixing will not be considered without the written endorsement from the cable manufacturer. Any such approved alternative fixings shall be installed strictly in accordance with the cable manufacturer's installation instructions.
- (e) Where more than two cables follow common routes, cable trays shall be provided, suspended from the structure via suitable galvanised steel brackets.
- (f) The maximum distance between fixings shall be dependent of the size of the cable and shall not be greater than that specified in the table below.

Surface Fixed

Overall Diameter of Cable (mm)	Maximum Spacing of Fixings	
	Horizontal (mm)	Vertical (mm)
Exceeding 9 mm and not exceeding 15 mm	300	400
Exceeding 15 mm and not exceeding 20 mm	400	450
Exceeding 20 mm and not exceeding 40 mm	400	500

Tray Fixed

Maximum Spacing Dependent on Installation	Maximum Spacing of Fixings	
	Horizontal (mm)	Vertical (mm)
Subject to compliance with local regulations	700	900

E083407 Installation

- (a) All bends shall be neat and uniform and their radius shall not be less than six times the diameter of the cable.

- (b) The fire alarm cables shall be segregated from other circuits in separate conduits or separate trunking compartment to avoid mechanical damage.
- (c) Cables should be installed without joints wherever practicable. All terminations and other accessories shall be such as to minimise the probability of early failure in the event of fire. Terminals used to join the cables shall be constructed of materials that will withstand a similar temperature and duration to that of the cable.
- (d) Pliable cables shall be installed in accordance with BS 7671 and in conjunction with the manufacturer's recommendations.

E083800 POWER CABLES FEEDING MECHICAL PLANT PROVIDED BY OTHERS

- (a) Where the electrical power supplies to mechanical plant are to be designed, supplied and installed by others, i.e. Mechanical Services Installer or Controls/BMS Installer, the Electrical Services Installer shall be responsible for requesting a copy of their cable calculations carried out in accordance with recommendations of BS 7671.
- (b) The Electrical Services Installer shall ensure that the supplies to the plant control panels are not energised, without the appropriate cable design calculations being provided to the Engineer for comment and approval.
- (c) The Controls/BMS Installer should also prepare and submit to the Engineer, prior to practical completion, a copy of their BS 7671 Electrical Completion Certificate for this section of the electrical installation, confirming compliance with the regulations, which shall include the associated test and commissioning sheets for the electrical installation.

E083801 Variable Frequency Drive (VFD) Cables

- (a) Where non-standard VFD cables are to be installed from a variable frequency drive to the plant motor, the associated manual cable calculations shall be provided to the Engineer for comment and approval.
- (b) The electrical installation shall comply with BS 7671.
- (c) XLPE/SWA/LSOH cable can be used from the VFD to the motor, provided the cable is 3-core and is appropriately terminated and earthed, via the recommended cable glands at both ends.
- (d) The installation and the use of non-standard cables, such as CY, SY and YY cables will not be permitted, as they are not manufactured to British or harmonised standards.
- (e) The installer should ensure that all cables purchased have manufacturer's identification and a specification reference/standard number printed on the sheath to enable testing, if necessary and to provide traceability.
- (f) Where VFD cable is to be installed, it should provide an enhanced EMC performance, comprising of 3No symmetrical phase conductors and 3No reduce cross sectional area protective conductors distributed symmetrically within the cable construction.
- (g) The combined protective conductor cross-sectional area shall be approximately 50% of the live conductors.
- (h) The cable to be installed shall be verified by cable calculation and the protective conductor cross-sectional area sized correctly.

- (i) The cable terminations shall be carefully selected to ensure they meet good EMC practice.
- (j) The installation recommendations of the VFD manufacturer shall be followed.
- (k) The cable and terminations shall be suitable for the environment into which they are to be installed.
- (l) Additional mechanical protection shall be provided where necessary, as the screen and sheath do not offer the equivalent degree of mechanical protection to the SWA.
- (m) The proposed VFD cables shall have approval from an independent testing organisation.
- (n) The VFD cable should have manufacturer's identification and a specification reference / standard number printed on the sheath to enable testing and traceability.

E084600 CABLE INSTALLATION PRACTICE**E084601 General**

- (a) Cables shall not be installed or removed from the drum unless the ambient temperature and the temperature of the cable is above 0 °C and has been for the previous twenty-four hours. Where cables have been subjected to temperature below 0 °C care shall be taken to ensure that they are above that temperature before they are removed from the drum.
- (b) Cables once installed shall have their ends sealed to prevent the ingress of moisture, prior to cable termination. Cables installed and left unprotected may be replaced at the expense of the Electrical Services Installer. Similar protection should be applied to cables stored on cable drums prior to installation.
- (c) Cables shall not be left exposed to sunlight for periods of time in excess of installation requirements. All cables shall be covered whether they are being stored or have been installed in open trenches.
- (d) Cables shall run directly from point to point without joints unless the length required is in excess of the length obtainable in one piece from the cable manufacturer.
- (e) Where cables change direction, whether horizontal or vertical then the bending radius shall be kept as large as possible, and no cable shall be bent to a radius less than the minimum specified by the cable manufacturer.
- (f) The inside radius of bends in a cable shall not be less than eight times the overall diameter of the cable or that set out in the manufacturer's recommendations whichever is the greater.
- (g) Cables shall be pulled into position in such a manner as to avoid damage to the cable or its sheath. Cables shall, wherever possible, be pulled directly from the drum, which shall be adequately supported to allow free rotation throughout the installation of the cable.
- (h) An adequate number of cable rollers, each of which shall be in perfect working condition, shall be used to support the cable during installation in such a manner that no part of the cable can touch the ground or any internal part of the trench or cable duct.

- (i) Cables shall wherever possible be pulled into position by hand using a number of operatives positioned along the length of the cable.
- (j) Winches, whether powered or hand operated, shall only be used with prior acceptance. Whenever a winch or similar appliance is used, an approved tension gauge shall be fitted into the haulage line between the winch and the cable. The pulling tension must at all times be within the limit advised by the cable manufacturer.
- (k) When a cable stocking is used to 'pull-in' cables it shall be of an approved pattern with swivel eye in perfect condition and be fitted with care to avoid damage to the cable sheath.
- (l) The cable shall be checked after the stocking has been removed and if the cable end has been damaged it shall be cut off and the cable immediately sealed.
- (m) During the 'pulling in' operations, the cable shall not be allowed, under any circumstances, to twist or rotate about its longitudinal axis as a result of excessive pulling tension or for any other reason.
- (n) Damage to the armouring or sheath of any cable shall be avoided. If the armouring or sheath becomes damaged at any point, it shall be rectified to the satisfaction of the Engineer. Where the damage is sufficiently severe, the cable shall be pulled out and replaced.
- (o) Unless otherwise specified, sheath colour for low voltage cables shall be black and MV shall be red and cables shall have stranded copper cores. Cores of multi core cables shall be coloured in conformity with the British Standard in order to provide easy identification.
- (p) Terminations shall be in accordance with manufacturer's instructions taking care to avoid stressing the cores during installation. Where junction boxes are required to terminate cables, the size, type and specification of the junction box shall be agreed with the Engineer prior to the works proceeding.
- (q) At terminations of wires and cables the insulation shall be neatly stripped without nicking the conductor. In no case shall bare conductors be allowed to project beyond any insulated shrouding or mounting of a terminal.
- (r) All cables passing through the floor structure or fire rated walls, shall be sleeved utilising proprietary cable sleeving systems. The Electrical Services Installer shall submit samples of the proposed sleeving to be utilised. Cables shall be sealed within the sleeves by suitable intumescent materials recommended by the cable/sleeve manufacturer. The fire rating of the complete assembly shall equal the fire rating of the structure through which it passes.
- (s) All cables passing through walls or foundations to external areas shall be sleeved utilising proprietary cable sleeving systems and puddle flanges so as to maintain the weathering of the finishes and to negate any seepage from the atmosphere or ground to either the internal areas or the building structure. The Electrical Services Installer shall submit samples of the proposed sleeving and or flanges to be utilised. Cables shall be sealed within the sleeves by suitable materials recommended by the cable/sleeve manufacturer.
- (t) Where cables enter IP rated enclosures, they shall do so via bottom entry cable gland plates in order to maintain the IP rating of the enclosure. The Electrical Services Installer shall obtain acceptance from the Engineer if top entry is the only option

available, a detailed method statement shall be submitted to the Engineer as to how the IP rating will be maintained.

- (u) Cables installed in formed ducts and elsewhere specified shall be fixed with cable cleats, bolted to vertical or horizontal mild steel channel supports embedded in the duct walls to support the cable in accordance with the manufacturer's recommendations.
- (v) Single core armoured cables shall not be installed within areas, where visual display terminals or data processing equipment may be adversely affected by the radiated electromagnetic fields. Single core armoured cables shall only be utilised with the written consent of the Engineer and shall, where installed, be screened by mu-metal to reduce radiated magnetic fields to below recommended levels.

E084604 Cables on Ladders and Trays

- (a) Cables installed on trays or ladder shall be laid in a single layer, leaving 25% of the tray or ladder width as spare capacity for further use.
- (b) Where cables leave ladder or tray they shall be adequately supported and protected so as not to place pressure on the cables.

E084607 Cable Cleats and Fixings

- (a) Single core cables forming part of a three phase circuit shall be installed in trefoil formation, (L1, L2, L3 or Brown, Black, Grey) whether installed horizontally or vertically and supported using proprietary trefoil cleats certified for the peak fault current that cable could be subjected. The cleats shall be spaced in accordance with the manufactures recommendations for the given fault level. Where necessary the neutral conductor shall be run adjacent to its set of phase conductors using quadrafoil cleats.
- (b) Single core cables forming part of a DC circuit or single phase and neutral non life safety circuit when run horizontally on trays or ladders shall be installed 'flat touching' together with the associated earth cable. Each conductor shall be individually fixed using proprietary stainless steel cable ties to the cable tray or ladder at the spacings indicated in Table T1.1. Marker ties shall be provided at 3000 mm intervals which shall encompass all conductors of the circuit. Where the cables run vertically they shall be cleated using non-metallic cable cleats at fixing centres noted in table T1.1.
- (c) Non life safety multi core cables laid horizontally on cable tray or ladder shall be secured by the use of proprietary stainless steel cable ties or 'P' clips, securing the cables of only one circuit. The ties shall be spaced in accordance with table reference T1.2. Additional ties shall also be provided within 100 mm of each bend. Where non life safety cables run vertically they shall be cleated using non-metallic cable cleats with spacings in accordance with table reference T1.2.
- (d) Life safety multi core cables laid horizontally on cable tray or ladder shall be secured by the use of proprietary stainless steel cable ties or 'P' clips, securing the cables of only one circuit. The ties shall be spaced in accordance with the table reference T1.2. Additional ties shall also be provided within 100 mm of each bend. Where life safety cables run vertically they shall be cleated in accordance with the table reference T1.2. Cleats utilised for life safety cabling shall be as recommended by the manufacture for that type of cable and shall be manufactured from either cast iron or stainless steel.

- (e) Where cables are on inverted tray they shall be fixed with cable cleats spaced in accordance table T1.2 or the manufactures recommendations should they be more onerous. Cleats for non life safety cables shall be insulated type, and cleats for life safety circuits shall be as recommended by the manufacture for that type of cable and shall be manufactured from either cast iron or stainless steel.
- (f) Where cables are to be installed direct to the structure they are to be supported by cleats bolted to vertical and/or horizontal mild steel galvanised channel supports which in turn shall be bolted to the structural walls or soffit at the required fixing centres for the cable fixings noted in tables T1.1 or T1.2 or the manufactures recommendations should they be more onerous. Cleats for non life safety cables shall be insulated type, and cleats for life safety circuits shall be as recommended by the manufacture for that type of cable and shall be manufactured from either cast iron or stainless steel.
- (g) Coatings for stainless steel cable ties shall manufactured from materials with low smoke zero halogen properties.
- (h) Non-metallic cleats shall be manufactured from materials with low smoke zero halogen properties.

Spacing's of supports for cables in accessible positions Table T1

Maximum Spacing's of Cable Fixings						
Overall diameter of cable*	Non-armoured thermosetting, thermoplastic or lead sheathed cables and non-armoured fire resisting cables		Single wired armoured cables including fire resisting armoured cable		Mineral insulated copper sheathed or aluminium sheathed cables	
	Ti.1 General		Ti.2 General		Ti.3	
	Horizontal 2	Vertical 3	Horizontal 6	Vertical 7	Horizontal 8	Vertical 9
Mm	Mm	Mm	Mm	Mm	Mm	Mm
Not exceeding 9	300	300	-	-	600	600
Exceeding 9 and not exceeding 15	300	300	300	300	900	1200
Exceeding 15 and not exceeding 20	300	300	300	300	1500	1800
Exceeding 20 and not exceeding 40	300	300	300	600		
Exceeding 40 and not exceeding 50	600	600	900	900		
Exceeding 50 and not exceeding 60	600	900	900	900		

Exceeding 60 and not exceeding 70	900	1200	900	1200		
Exceeding 70 and above	900	1200	1200	1200		

(i) Note:

- i) Fire resistant fixings should be used for fire resistant cables
- ii) For flat cables taken as the dimension of the major axis
- iii) The spacing's shown above apply to multi-core cables
- iv) The spacing of fixings on single core cables in ac. installations must take account of the magnitude of forces generated under fault conditions
- v) The spacing's stated for horizontal runs may be applied to runs at an angle of more than 30° from the vertical. For runs at an angle of 30° or less from the vertical, the vertical spacing's are applicable

E084610 Cables in Trunking and Conduit

- (a) Cables shall only be drawn into conduits or laid in trunking after conduits and trunking have been finally fixed, cleaned out and inspected by the Engineer.
- (b) Where cables emanate from separate distribution boards, or are serving different parts of an installation, such as lighting and power, or landlord and tenant, they shall be installed in separate conduits or trunking unless otherwise specified.
- (c) Where trunking or adaptable boxes are provided with suitable barriers, cables for differing services may be installed through the same trunking or box provided that the different services are each run in a separate compartment.
- (d) Each circuit of cables contained in trunking shall be taped and bound at 10 metre intervals throughout the run and suitably labelled at each junction and terminal point for identification purposes.
- (e) No joints will be permitted and cables shall be looped from point to point.
- (f) Connector blocks will be permitted only where cables cannot be terminated direct into an appliance and if agreed by the Engineer. Connector blocks shall be rated to suit the circuit and shall be manufactured from porcelain. They shall be fixed base type and installed in a conduit or adaptable box. Unfixed connectors will not be permitted. Connector blocks shall not be located within trunking.
- (g) Flexible cords shall incorporate the appropriate level of strain relief as part of each termination to ensure that mechanical stress is not applied to the cables inner cores or the cable terminations.

E084613 Cable Lugs

- (a) Cable lugs rated in excess of 30 Amp shall be brass castings machined on the lug faces to a smooth finish and drilled to meet the conductor size, excessive clearances being avoided. After soldering, all burnt or damaged insulation shall be cut away and the bared conductor wrapped with LSF tape to the thickness of the original insulation.

- (b) Cable lugs for low voltage cables shall be of the crimping type.
- (c) The bolted connections of the cable lug should be torqued in accordance with the equipment manufacturer's recommendations, in the absence of specific recommendations, the recommendations contained within BS 7609 shall be followed.

E084900 CABLE JOINTING

- (a) Where joints are required on armoured mains cables, they shall only be undertaken with the Engineer's written permission and as described in the succeeding paragraphs of this clause.
- (b) Conductors shall be jointed colour to colour, or number to number. They shall be tested for condition and insulation resistance before jointing is completed. Joints shall be completed on the same day as commenced. Straight through joints will not normally be permitted.
- (c) Joints in copper conductors shall be by means of tinned copper connectors with the conductor firmly butted together and sweated solid with tinman's solder. Joints in rubber insulated or polyvinyl chloride cables shall be insulated with pure rubber tape served to a thickness equal to the cable insulation.
- (d) Joint boxes shall be completely filled with insulating compound of a suitable grade. Each box shall be topped up as necessary to ensure that it is properly filled. Joint box compound shall have a high dielectric strength and insulation resistance suitable for the working voltage of the cables. It shall be non-hygroscopic and be suitable in all respects for the type of joint being made. Where there is any possibility of ingress of oil into the sealing box, the compound shall be oil resistant type. Jointing compounds shall be poured at the correct temperature specified by the makers. No plug or air vent shall be fitted until all air has been released from the joint box. Plugs and air vents shall be sealed with compound after filling.
- (e) Where aluminium sheathed cables are used the jointing method shall be strictly in accordance with the manufacturers recommendations.

E085200 CABLE IDENTIFICATION

- (a) Conductor identification shall be carried out in accordance with BS 7671.
- (b) The cores of multi-phase circuits shall be identified by the colours Brown, Black and Grey and the numbers L1, L2 and L3 signifying live conductors with Blue and "N" for the neutral conductor.
- (c) Where 3c armoured cables are utilised to feed single phase loads the brown core shall be utilised as the "live", the grey core shall be over-sleeved with blue to indicate neutral and the black over-sleeved with green/yellow to indicate earth.
- (d) Bare conductors, other than earth continuity conductors and earthing leads shall be identified by means of sleeves or discs of the appropriate colours and alphanumeric labels prescribed in BS 7671.
- (e) The cores of flexible cords shall be coloured throughout with brown for the phase or live conductor, blue for the neutral or return conductor and green/yellow for the earthed conductor.

- (f) Identification of switchboard busbars and connections to individual phases of poles shall be by colouring and alphanumeric labels in accordance with BS 7671.
- (g) On AC systems the phase sequence shall be maintained throughout the installation and all phase connections shall be in the order brown, black, grey from the top to bottom or left to right. Neutral connections, links, and busbars shall always be located above or to the side of the phase connections, links or busbars.
- (h) The particular phase connected to fuse banks and busbars shall be clearly indicated by marking with the appropriate colour and alphanumeric labels in accordance with BS 7671. In addition, the cores of cables connecting control gear, etc. with marked terminals shall be identified by ferrules or marker beads bearing the same marking as the terminals to which they are connected and alphanumeric labels in accordance with BS 7671 to signify the phase.
- (i) Cables forming special circuits such as extra low and low voltage circuits for bells, alarms etc. shall be distinctively coloured or marked, but the colours shall be different from any of those specified for other purposes as detailed in BS 7671.
- (j) Sub main and final circuit armoured cables shall include a reference tag at each point of termination securely fixed to the cable sheath identifying the cable by cross reference to the main distribution schematic.

E085500 CABLE AND WIRING TESTS

- (a) Wiring systems shall be subjected to the tests required by BS 7671 and as described hereunder. As soon as possible after completion of the installation and jointing of cables and before they are concealed or put into service all cables shall be tested. Testing shall be carried out in accordance with the requirements of the Inspection, Testing and Commissioning section of this specification.
- (b) An insulation test shall be carried out with an agreed type of test instrument to measure the insulation resistance between each conductor and the remaining conductors also between each conductor and the metallic sheath or armouring. The test voltages shall be 500 Volts for LV cables and not less than 1000 Volts for MV cables.
- (c) The tests shall be carried out both before and after any pressure tests. The insulation resistance shall not be less than required by BS 6724, for cables up to 3.3 kV. For higher voltages resistances shall be agreed with the Engineer.
- (d) When specifically directed by the Engineer a pressure test complying with Appendix B of BS 6724 shall be applied to low voltage cables for a minimum duration of 15 minutes.
- (e) An earth continuity test shall be carried out to verify that cable armouring and metal sheath, if any, have been properly bonded to earth. The test shall be carried out with an agreed type of testing instrument.
- (f) Phase rotation and phase correspondence tests shall be carried out to demonstrate that the cable have been correctly connected.

E100100 GENERAL

- 27618-SP-ES-001

- (m) The Electrical Services Installer shall maintain the following clearance between power and communications cable route where the rated voltage of the supply exceeds 1000 V rms AC:

Type of Installation	Distance		
	Without divider or non-metallic divider	Aluminium divider	Steel divider
Unscreened power cable and unscreened IT cable	200 mm	100 mm	50 mm
Unscreened power cable and screened IT cable	50 mm	20 mm	5 mm
Screened power cable and unscreened IT cable	30 mm	20 mm	2 mm
Screened power cable and screened IT cable	0 mm	0 mm	0 mm

- (n) Where the power and communications cable routes are required to cross-over, they shall do so perpendicular to each other. Where the Electrical Services Installer is unable to maintain the above separation distances written notification shall be given to the Engineer in sufficient time to allow the areas of concern to be resolved, and prior to the installation of any cables or containment routes.
- (o) Unless otherwise described elsewhere in this specification, trunking and conduit systems shall be carried out in mild steel. Where multiple parallel conduit runs would occur, use may be made of cable trunking with removable lids, subject to the provisions of this specification and with the agreement of the Engineer. Due regard shall be given to derating of cables due to grouping.
- (p) Any cable systems or non-metallic containment systems, fixings and fittings installed within false ceilings or floor voids etc. forming part of an air plenum shall be of low smoke zero halogen material.
- (q) Cable ties shall be stainless steel or copper, where coated the coating shall be low smoke zero halogen (LSOH) material.
- (r) The Electrical Services Installer shall be responsible for confirming to equipment suppliers the sizes and types of cables to be connected to the equipment. Equipment shall be arranged to accommodate the specified cable. The Installer shall advise all other parties of the size and type of cable to be connected to items supplied by them.
- (s) Conduit and trunking systems shall be erected completely with all accessories connected. They shall then be offered to the Engineer for inspection and comment before any cables are installed.
- (t) No lubricants shall be used to assist when pulling cables into conduit.
- (u) Draw wires shall be provided where conduits are not to be wired on completion or are to be wired by others.
- (v) The Electrical Services Installer shall allow for all necessary standard and specialist plant in order to safely install all containment and cabling including dressing and fixing of cabling to the specified containment.

- (w) Utilising containment or its associated support systems as a 'mansafe' system shall not be permitted unless the systems have been designed, tested and certified for this use.
- (x) The Electrical Services Installer shall provide the appropriate level of detail on their coordinated services working drawings, to demonstrate that sufficient access is provided to allow safe working access for operatives. Including when working from either standard or specialist plant, designed for working at height. The plant shall enable them to safely install, dress and fix the cables, as required, both in open corridors, plant areas and risers. The space allowed shall be consistent with the installation method described in the relevant installation method statement.
- (y) The Electrical Services Installer shall ensure that all plant used for 'pulling' cables onto containment is properly fixed and restrained independently of the containment systems and its supports unless these systems have been specifically designed, tested and certified for that use.

E101300 CABLE TRAY

- (a) Cable tray shall be medium or heavy duty with double edge return. It shall be manufactured from perforated mild steel hot-dip galvanised sheet complying with BS EN 10346 Cable tray and accessories shall comply with the following requirements:

Width of Tray/Accessory (mm)	Minimum Thickness (mm)
Up to and including 150	Medium Duty 0.8
over 152 up to and including 300	Heavy Duty 1.2
over 300 up to and including 600	Heavy Duty 1.5
over 600 up to and including 914	Heavy Duty 2.0

- (b) Cable tray shall be installed with the greater dimensions in the horizontal position unless otherwise agreed with the Engineer. Where tray is installed in the vertical position, cables shall be supported by cable cleats or in the case of Fire alarm and emergency lighting cables, saddles or clips.
- (c) Tees, intersection units and sets shall be purpose made by the manufacturer. Where this is not possible the units may be made on site only with the agreement of the Engineer.
- (d) Cable tray shall only be cut along a line of plain metal, not through perforations. Cut edges shall be prepared and treated according to the original finish of the metal. Where tray has been welded and on galvanised tray, a zinc rich paint shall be applied. Holes cut in cable tray for the passage of LSOH covered cables shall be provided with grommets or, alternatively, bushed or lined to prevent damage to the cable covering.
- (e) Cable trays shall be securely fixed in accordance with the manufacturer's recommended fixing centres. Support shall ensure that there is no perceptible sagging of the trays when all the cables are in position. Trays shall be fixed at both sides of a change of direction at a maximum distance of 150 mm from the direction change.

- (f) Mushroom headed steel roofing bolts and nuts shall be used for the installation and coupling of trays. Cable tray brackets shall be of sufficient depth to provide access to the rear of the tray for easy installation of PVC saddle type fixings.
- (g) Where cable containment systems are to be installed in IT facilities (i.e. data centres, MERs, SERs, comms rooms etc.) the containment systems shall be fabricated using the Hot Dip Pre-Galvanised process in accordance with BS EN 10346.

E102200 STEEL CABLE TRUNKING**E102201 General**

- (a) Trunking shall comply with the requirements of BS EN 50085. Sizes shall be determined to comply with the requirements of BS 7671, including due allowance for all likely future supplies, unless otherwise described. The requirements for conduits described elsewhere in this specification shall, wherever appropriate, be applied to trunking installations.
- (b) Trunking shall be a minimum of IP4X in accordance with BS EN 60529.
- (c) Steel cable trunking shall be manufactured from galvanised steel sheet with a minimum sheet thickness of 1.22 mm.
- (d) PVC trunking shall only be used with permission, in writing, from the Engineer. PVC cable trunking shall be manufactured from high impact PVC
- (e) Trunking shall have a removable cover throughout its length with centre turnbuckle type latch fixings.
- (f) All lid fitments shall be overlapping type maintaining the IP4X classification of the trunking installation in accordance with BS EN 60529.
- (g) All elements of the lid shall be of factory manufactured.
- (h) Trunking shall have a removable cover throughout its length with centre turnbuckle type latch fixings. All lid fitments shall be overlapping type maintaining the IP4X classification of the trunking installation in accordance with BS EN 60529. All elements of the lid shall be of factory manufacture and fitted with turnbuckle type latch fixings.
- (i) Trunking bends, in line joints, angles and other fitments shall be gusseted and of factory manufacture maintaining a classification of IP4X in accordance with BS EN 60529.
- (j) Butt jointing of either trunking or lid is not acceptable.
- (k) Trunking fittings and accessories shall be factory manufactured and finished by the trunking manufacturer. They shall be of a similar construction and finish to the main trunking.
- (l) Lengths of trunking shall be connected by internally fixed rectangular coupling units of sufficient width to provide a minimum bearing face of 25 mm to which the lengths shall be welded or bolted. The length of lids shall be so arranged that the joint always coincides with the centre of the coupling unit.
- (m) Trunking for installation with the lid to the bottom shall be provided with cable retainers near to lid fixings and spacers to ensure that cables cannot be damaged when the lid is secured. They shall be spaced at maximum intervals of 1000 mm.

- (n) Vertical cable trunking shall be provided with cable pin racks arranged to avoid any strain on the cables. They shall be spaced at maximum intervals of 3000 mm.

E102204 Installation

- (a) Trunking shall be rigidly fixed throughout its length. Fixings directly to the building fabric shall be by at least two roundhead screws spaced at not more than 1000 mm fixing centres and at each side or bends and junctions. Elsewhere trunking shall be supported by substantial brackets at intervals not exceeding those specified in BS 7671. No suspensions or fixings shall intrude into the internal space unless otherwise specified.
- (b) PVC trunking shall be installed strictly in accordance with the manufacturer's recommendations.
- (c) Couplers on PVC trunking shall be fixed in place by a permanent solvent on one end and non-hardening mastic on the other to allow for expansion of the trunking. In addition, fixing holes in the body of the trunking shall be elongated to allow axial movement. Fixing screws shall be provided between ends of trunking or 6 per 3000 mm length.
- (d) Trunking shall be firmly attached to its associated equipment, either by bolted flanges or by hexagonal male bushes, couplings and compression washers, according to the direction of run in relation to the equipment.
- (e) Earth continuity shall be maintained between each section of steel trunking by copper links fixed to the outside of the trunking. For PVC trunking a protective conductor not less than 2.5 mm² with green and yellow insulation shall be installed throughout. The conductor shall be of sufficient length to allow looping in and out of metallic equipment and accessories.
- (f) Where trunking crosses building settlement or expansion joints a connector shall be provided, with slotted fixing holes to permit a movement of 10 mm in both the horizontal and vertical planes. The earth continuity link shall be of braided copper tape not less than 15 mm wide by 2 mm thick having a resistance from fixing to fixing equal to or less than the links used for standard trunking joints. The braid shall be long enough to allow for the maximum movement of the trunking. Braid ends shall be folded and swaged solid.
- (g) A fixed section of lid shall be provided where trunking passes through the building structure, terminating 80 mm from each side of the structure.
- (h) Where trunking passes through building fire barriers, suitable fire resistant barriers shall be provided within the trunking. A sample of the proposed fire barrier shall be submitted to the Engineer for comment. The submission shall include certification as to the fire performance offered by the materials and instructions as to how the material is to be installed. The location of all fire barriers shall be recorded on the 'As Fitted' drawings. Care shall be taken to see that no aperture is left between the trunking and the structure through which fire might spread.
- (i) Where access points in ceilings or floors or the like are provided to trunking, the trunking shall be provided with a short removable section of lid.
- (j) Where conduits connect to multi-compartment trunking and their appropriate compartment is not accessible from the side, they shall be provided with skeleton

type stop-end boxes securely fixed on to a short section of fixed lid positioned so that direct wiring is possible.

- (k) Care must be taken to ensure that all steel and brass particles and the like are removed from the trunking prior to the installation of the cables. All trunking shall be installed so that cables are not liable to mechanical damage due to abrasion.

E102500 STEEL CONDUIT

E102501 General

- (a) Steel conduit shall comprise heavy grade, welded seam conduit complying with BS EN 61386-1 and provided with screwed ends. Dimensions shall comply with BS EN 60423. Black conduit shall be finished in category class 2, stove enamel. Galvanised conduit shall be finished in category class 4, hot dip zinc coating.
- (b) Inspection bends, solid bends, elbows or tees shall not be installed.
- (c) Where a number of conduits converge they shall terminate in a metal box to prevent bunching. Draw boxes and junction boxes shall be of ample size to permit cables being drawn in and out. Boxes shall be at least 75 mm x 75 mm x 50 mm for cables up to 6 mm² or conduits up to 25 mm diameter. They shall be at least 150 mm x 150 mm x 50 mm for larger cables or conduits.
- (d) Boxes shall be manufactured from cast iron or substantial heavy gauge sheet with welded corners. Lids shall be made of the same material as the box. For flush work, lids shall overlap the box adequately on all sides. For surface work the lids shall make good contact with the box.
- (e) Small circular boxes and extension rings shall be constructed of malleable cast iron. Boxes shall be complete with an earth terminal and be of the same class of finish as the conduit. Where loop-in pattern boxes are required, they shall be of the same circular pattern with back outlets of the appropriate number. Standard conduit boxes complying with BS EN 61386-1, small or large pattern, shall generally be used at lighting points.
- (f) Circular boxes shall be provided with long spouts, internally threaded, with a shoulder for the proper butting of the conduit. Conduit boxes mounted outside the building or in damp areas shall have external fixing lugs. Each such box shall include a neoprene gasket between the lid and the box. Box lids shall be made of sheet steel for surface work. They shall make good contact with the box. The box lids shall be secured by brass screws. The lids on external boxes shall have machined joint faces mating to machined faces on the box.
- (g) Adaptable boxes shall be grey iron pattern. Where adaptable boxes are fitted flush, the cover plates shall be heavy gauge metal with 12 mm overlap on all sides. The internal depth of the box shall not be less than 40 mm. Covers shall be secured by a screw at each corner and by additional screws as necessary to provide a maximum spacing of 300 mm between adjacent screws. Fixing screws shall be brass with round or cheese heads. Weatherproof boxes and covers shall have machined mating faces complete with a neoprene gasket and shall be fixed to the structure via external fixing lugs. Knockout boxes shall not be used where there is a risk of moisture ingress.
- (h) Flush outlet boxes to which a pull switch or similar is to be fitted shall, unless otherwise specified, be provided with a break joint ring.

- (i) Accessories, switch boxes and associated apparatus used with galvanised conduit shall also be galvanised.

E102504 Conduit Layout

- (a) Steel conduit shall be heavy duty galvanised, unless otherwise specified.
- (b) Where a conduit run passes from a concealed area to an area requiring galvanised conduit, then the whole of the conduit run shall be galvanised. Conduit external to a building shall be weatherproof.
- (c) Conduit runs shall be concealed in ceilings, voids, walls or chases. Where exposure of conduits in rooms is unavoidable they shall be routed through rooms of secondary importance, using back outlets to boxes.
- (d) Particular care shall be taken when setting out conduit runs to outlet points which are to be fitted to furniture, kitchen fittings, etc. Exact details of the construction of furniture and fittings shall be ascertained so that all conduit work shall, wherever possible, be concealed.

E102507 Installation Requirements

- (a) Every conduit and fitting shall be free from internal burrs and other defects. Adequate precautions shall be taken to prevent the ingress of silt or moisture into the conduit system by the use of screwed metal caps and plugs to protect open ends. If fouling should occur, the affected conduit shall immediately be swabbed clean.
- (b) Where the finish of the conduit is damaged during erection or suffers from the effects of corrosion, surfaces shall be wire brushed and painted with rust inhibiting paint to the same standard as the normal surface. Exposed threads shall also be protected by rust inhibiting paint immediately after erection. Galvanised conduit shall be treated with zinc rich paint. The conduits shall be maintained in good condition throughout the duration of the Works.
- (c) Conduit runs shall be so arranged that any condensed moisture can drain to the lowest point, where a screwed plug shall be provided for the purpose of draining off. The conduit routes shall be arranged to avoid traps or low level pockets.
- (d) Bends shall be made on site to suit conditions. Not more than two right angled bends will be permitted without the interposition of a draw box. Generally, long straight conduit runs shall have 'draw in' boxes installed at maximum intervals of 8 metres. Bends shall be made using a standard type of bending machine. The radius of any bend shall not be less than four times the outside diameter of the conduit. Care shall be taken to prevent conduit deformation. Conduit sets through walls will not be permitted.
- (e) Where running couplers are essential and at any other position where hexagonal lock nuts are not practicable, circular lock nuts with knurled edges shall be utilised. Great care shall be taken to ensure that they seat firmly and evenly on to mating faces of couplings or other accessories.
- (f) Conduit joints shall butt solidly to boxes, couplings, etc. with no exposed threads except at running couplings. Full use shall be made of the total length of threads in accordance with the dimensions of BS EN 61386.

- (g) Where a conduit is exposed to different temperatures, either by surrounding air conditions or by virtue of the surrounding medium with which it is in contact, such as a conduit running from a warmed building to exterior points, the section of the conduit at the higher temperature shall be isolated from the section at the lower temperature. The isolation shall be provided by a conduit box filled with a permanently plastic compound, after completion and testing of all wiring.
- (h) Where a conduit terminates at a main switch, distribution board, sub-switch or other metal clad accessory, a screwed socket shall be provided, arranged to be in good mechanical and electrical contact with the metal case. A brass bush shall be screwed into the socket from inside the case and the two locked together with a compression washer between.
- (i) Where a conduit terminates into an IP rated enclosure, luminaire or panel; a flange coupler complete with lead washer and brass male bush shall be utilised. The entry location shall be in such a position as to prevent the ingress of moisture into the enclosure.
- (j) For boxes with trapped entries and where internal space permits, a ring bush shall be used as a lock nut. Where the space is insufficient a knurled lock nut shall be used on the outside of the box.
- (k) Where conduits cross expansion joints in the building structure, special expansion couplings shall be used or such other methods as are agreed in writing by the Engineer shall be adopted. Continuity through all such joints shall be maintained.

E102510 Conduit Fixings

- (a) Conduit boxes shall be fixed to the structure of the building independently of the conduit except where this fixing would break down any provision for weatherproofing. Conduits shall be fixed to the structure of the building within 150 mm of each box or bend and at centres not exceeding 1000 mm on straight runs.
- (b) Conduit boxes shall be fixed by countersunk screws of the appropriate size, using special plugs or plugging materials. Wooden plugs will not be permitted. Holes in boxes shall be adequately countersunk to ensure complete recession of the fixing screws.
- (c) Purpose made clips shall be fabricated from strip iron or mild steel flat bar. They shall receive one coat of protective paint after fabrication with a further coat after erection. Details of proposed clips and brackets shall be submitted to the Engineer for comment prior to manufacture being commenced.

E102513 Surface Conduit

- (a) Surface conduit layouts shall be shown on the working drawings. Surface mounted conduits shall be installed vertically, horizontally or parallel with features of the building.
- (b) Where the appearance of the conduit runs would be improved by the introduction of dummy lengths of conduit, or where a more secure fixing for the suspension of fittings would be obtained, such dummy conduits and continuations shall be provided.

- (c) Where conduits pass directly through floors and washing down is likely, conduits shall be sleeved. Sleeves shall be flush with the underside of the floor, extend 75 mm above the top surface and be secured to the wall by means of a heavy gauge saddle.
- (d) Unless otherwise specified, surface conduits shall be fixed by means of distance saddles or purpose made clips, manufactured from the same material and with the same finish as the conduits. The saddles or clips shall allow the conduits to be taken directly into the accessories without sets or bends. They shall be fixed using non-ferrous screws. Conduit shall not be mounted directly on building surfaces. A minimum spacing of 6 mm to the back of the conduit shall be maintained.
- (e) Where conduits are to enter an IP rated enclosure the conduit connection shall be made utilising a flange coupler, lead washer and long reach brass male bush, the conduit connection to the enclosure shall maintain as a minimum the same IP rating as the enclosure in question.

E102516 Concealed Conduit

- (a) Concealed conduits shall be securely fixed to prevent movement during building operations. Fixing shall be by means of purpose made clips or other agreed means, so as to ensure that there is no conduit deformation.
- (b) Where conduits are installed in multi-storey buildings, a substantial right angle shall be interposed at every third storey to ensure adequate support of the installed cabling and to prevent undue stress on the terminal connections.
- (c) Where conduits are installed in ducts or voids, fixing shall be in the manner specified for surface conduits. Supports for conduits in ceiling cavities shall be independent of the suspended ceilings.
- (d) Conduit boxes buried in plaster shall permit a full 6 mm depth of cover over its entire length. Conduits shall be mechanically and electrically continuous throughout so that cables are fully protected. Deep boxes, or extension rings on standard circular conduit boxes shall be used where necessary to bring boxes flush with the surface.
- (e) Conduits in chases shall be firmly secured by wrought iron pipe hooks or crampets. The fixings shall themselves be sufficient to hold the conduits in place. Conduits mechanically damaged by crampets will be rejected and shall be replaced. Conduits installed in chases shall be painted with one coat of rust inhibiting paint before erection. A further coat shall be applied to all accessible surfaces, including the hooks and crampets, after erection.
- (f) Conduit boxes and draw boxes cast into concrete shall be held in place so that they are absolutely rigid until and while the concrete is poured and vibrated. The depth of such boxes shall be such that the open side is flush with the finished surface of the concrete.
- (g) Where conduits are laid direct on the shuttering of reinforced slab construction, conduit extension rings or deep boxes shall be used to space the conduit to run between the top and bottom reinforcing. PVC tape shall be wrapped round butt joints on extension rings to prevent the ingress of wet concrete.
- (h) Where conduits are laid in concrete slabs or screeds and the like, a competent person shall be in attendance while the concrete pouring or screeding operation is being carried out. The competent person shall ensure that damage to the conduit is avoided

and that the conduit work is in sound condition, properly and efficiently maintained, during this period.

- (i) Conduit buried in the ground shall be wrapped with PVC self-adhesive tape, half lapped. The taping shall extend for a distance of 150 mm beyond the point where the conduit emerges from the ground. Joints in the conduit system shall be made watertight using aluminium paint and hemp, or alternatively, neoprene gaskets. The joints shall be partially screwed up before the paint and hemp are applied to maintain electrical continuity.
- (j) Where the system of wiring is concealed, the "Looping-in" system of conduit shall be used.

E103400 FLEXIBLE CONDUIT

- (a) Final conduit connections to motors or other apparatus likely to transmit vibration shall be by means of a through type box with a galvanised watertight pattern flexible metallic conduit complete with LSOH over sheath. Mechanical brass adaptor glands, providing a male thread for connection to the through box, shall incorporate a positive means of preventing the conduit becoming loose.
- (b) An earth wire, minimum size 2.5 mm² shall be drawn through the length of the flexible conduit. It shall be connected to the conduit system at one end and to the apparatus at the other end.
- (c) Connections to small motors, such as in small ventilating fans, shall be made by means of multicore LSOH cable with brass packing gland type adaptors at each end.
- (d) Flexible conduit will not be permitted in lieu of sets and bends in a rigid conduit system.

E103700 UNDERFLOOR CABLE TRUNKING

- (a) Underfloor trunking shall comply with the appropriate requirements for cable trunking. The trunking system shall be embedded in the floor or mounted under the floor surface.
- (b) Underfloor trunking shall be manufactured from galvanised steel sheet with a minimum thickness of 1.6 mm. The trunking and installation shall comply with the manufacturer's recommendations and shall be provided as required by this specification.
- (c) Trunking that is intended for the accommodation of cables from various services shall be divided into compartments to provide complete segregation of the different service cables. Cable crossovers shall be designed to maintain segregation of services. Where space permits, crossovers shall be of the double height type to maintain the trunking system capacity.
- (d) Inspection units shall be provided where required. They shall comprise 1.6 mm subdivided steel units with cast iron or steel covers. Where necessary, they shall be suitable for accepting the floor finish.
- (e) Suitable floor outlet boxes for the connections to equipment shall be provided at the positions indicated on the drawings. Connections between the floor outlet boxes and the trunking shall be made using LSOH served flexible metallic conduits, 3 metres long

unless otherwise specified. An equipotential bonding conductor shall be provided between each floor outlet box and the floor trunking.

- (f) Floor outlet boxes shall be clearly labelled with their circuit reference on the inside adjacent to the power outlet. Labels shall not be fixed to the underside of the lids.

E104000 FLUSH FLOOR TRUNKING

- (a) Flush floor trunking lids shall be manufactured from 3 mm thick galvanised steel plate. The lid shall be of tray construction to accept the floor finish. It shall be sectionalised to allow for replacement of one section of lid with a floor service box without modification to the rest of the system. Each lid shall be provided with neoprene gasket seals along its entire length to prevent the ingress of water and the like.
- (b) Where flush floor trunking is routed under office partitions, it shall be tightly packed at these points with non-flammable sound absorbing material to reduce the possibility of cross talk.
- (c) Where flush floor trunking passes through fire rated walls, suitable fire resistant barriers shall be provided within the trunking. A sample of the fire barrier shall be submitted to the Engineer for acceptance. The submission shall include certification as to the fire performance offered by the material and instructions as to how the material is to be installed. The location of all fire barriers shall be recorded on the 'As Fitted' drawings. Care shall be taken to ensure that no aperture is left between the trunking and the structure through which fire might spread.
- (d) Where trunking systems are installed within access floor voids, the system shall be installed on 21 mm channel supports securely fixed to the slab or as otherwise agreed in writing with the Engineer.

E104300 DADO AND SKIRTING TRUNKING

- (a) Dado and Skirting trunking systems shall be either PVCu or Aluminium extrusion as specified in the accompanying schedules to this specification.
- (b) Trunking and accessories shall be of the finish specified within the schedules
- (c) The trunking shall comprise three or more separate compartments each with its own cover plate.
- (d) Internal dividers shall be provided with 'knockouts' to minimise site drilling.
- (e) The trunking system including accessories and fixtures shall be suitable for both the distribution of power cabling and Cat 6 /Cat 7 telecommunications cabling.
- (f) Systems shall comply with the following standards:
 - i) BS EN 50585-1
 - ii) BS EN 50585-2-1
 - iii) BS 7671
- (g) All internal and external angles, straight joints tee's etc. shall be manufactured assemblies. Site cut mitres or but joints are not acceptable.

- (h) The trunking shall allow the installation of 45 mm deep accessory boxes suitable for both single and twin gang outlet plates for power and telecommunications.
- (i) The system shall be flexible to allow the easy addition of outlets for both power and telecommunications and any associated rewiring.
- (j) Where aluminium trunking systems are utilised the base housings shall be equipped with bonding kits and bonding straps in order to maintain earth between sections. Proprietary bonding straps shall also be provided between the base and lids.
- (k) Mounting heights for dado trunking shall be as detailed on the Architects elevation drawings or as noted on the layout drawings.

E31 PANEL BOARDS, DISTRIBUTION BOARDS AND CONSUMER CONTROL UNITS

E310100 GENERAL

- (a) This section of the specification describes the general requirement for moulded case circuit breaker panel boards, miniature circuit breaker distribution boards, fuse distribution boards including 'Ryefield' units and consumer units.
- (b) Particular requirements shall be as described within the services description in this specification.

E310400 MOULDED CASE CIRCUIT BREAKER DISTRIBUTION PANEL BOARDS

- (a) Distribution panel boards shall be constructed from steel comprising a pan assembly base, outer cover and hinged lockable outer door. Any cable or accessory extension boxes shall be of the same manufacture and type as the panel board.
- (b) With the outer door in the open position it shall not be possible to touch or gain access to live parts without the use of a tool.
- (c) Distribution panel boards shall be metal clad and constructed in accordance with BS EN 61439-2 with a degree of segregation to Form 3b type 2.
- (d) They shall be provided with ingress protection to IP 3X in accordance with BS EN 60529.
- (e) Panel boards shall be of the size and type described on the distribution diagrams and schedules with a minimum busbar rating of 250 Amp and maximum of 800 Amp.
- (f) The board shall be equipped with a minimum of four three phase outgoing ways and a maximum of twelve.
- (g) The panel board enclosures shall be suitably sized to provide sufficient space for the routing of cabling including all possible spare ways, cable extension boxes shall be fitted where required.
- (h) All panel boards shall be provided with incoming switch disconnectors complying with BS EN 60947-3.
 - i) Single phase panel boards shall be provided with double pole devices
 - ii) Three phase panel boards shall be provided with four pole devices

Note incoming switch disconnectors includes any device from an alternate source (e.g. generator supply).

- (i) Incoming and outgoing supplies shall have the capability of being metered as required.
- (j) Busbar supports shall be independently certified to 25 kA for 1 second.
- (k) 100% rated neutral bars shall be provided within the panel board enclosure with equivalent outgoing ways as devices.

- (l) Two earth bars shall be provided within the panel board enclosure each with equivalent out going ways as devices.
- (m) The cable capacity of the neutral and earth busbar outgoing ways shall be equivalent to the largest outgoing device terminal capacity.
- (n) Each individual way of the neutral and earth busbars shall be clearly numbered.
- (o) Where a panel board is utilised as the main incoming switchboard or where they supply external equipment they shall be equipped with suitable **surge protection devices**.
- (p) Panel boards shall be supplied complete with all out going moulded case circuit breakers as described on the distribution diagram and schedules.
- (q) Spare ways not equipped with circuit breakers shall be supplied with metal blanking plates.
- (r) Panel boards shall be provided with identification labels with their specific reference, the incoming cable reference. Outgoing ways shall be labelled with the destination of the circuit protected and the cable reference.
- (s) A framed circuit chart shall be mounted adjacent to the panel board.
- (t) Unless otherwise indicated on the schedules or schematics the panel board shall be provided with 25% spacings.

E310700 MINIATURE CIRCUIT BREAKER DISTRIBUTION BOARDS

- (a) Distribution boards shall be metalclad pattern manufactured from pre-treatment galvanised sheet steel and of rigid welded construction. They shall be supplied complete with panel door, phase barriers, masking plates, earth terminal bar, miniature circuit-breakers or cartridge fuses as specified and circuit charts.
- (b) Distribution boards shall comply with BS EN 61439-3.
- (c) Internal access to the distribution board shall be by means of a hinged door which shall be fitted with a suitable locking device. With the door in the open position it shall not be possible to touch or gain access to live parts without the use of a tool.
- (d) The distribution board enclosures shall be suitably sized to provide sufficient space for the routing of the sub-circuit cabling including all possible spare ways.
- (e) Distribution boards shall be supplied with an integral CT chamber fitted with copper links to allow the installation of current transformers, to facilitate metering.
- (f) Where split pan assemblies are specified each separate pan assembly shall be capable of being separately metered.
- (g) Distribution boards shall be fitted with an integral incoming on-load switch to isolate all live conductors. Switches shall comply with BS EN 60947-3 and have a minimum utilisation category at 400 Volt of AC 23A.
- (h) Phases or poles shall be indelibly identified by colouring or other agreed means. The board enclosure shall be sufficient in size to accommodate all devices and spare ways specified.

- (i) Unless otherwise indicated within the schedules, distribution boards shall be provided with a minimum of 25% spacings.
- (j) Each distribution board shall be clearly labelled indicating its service. Three phase distribution boards shall be fitted with white labels, red engraved: DANGER - and the appropriate 3-phase voltage.
- (k) The distribution boards shall be delivered to site as a factory built and tested assembly, assembly shall not be carried out on site.
- (l) Distribution boards shall be provided with top and bottom removable metal gland plates, which shall be site drilled to suit cable glands or conduit entry, together with a complement of knock-outs provided both top and bottom and in the sides.
- (m) Neutral busbars shall be supplied with pinch type clamp connections, they shall be of the same current carrying capacity as the phase bars, and have one terminal for each single phase circuit way. Where indicated on the schedules, double rated neutral bars shall be provided.
- (n) Earth busbars shall be supplied with pinch type clamp connections, they shall be of the same current carrying capacity as the phase bars, and have one terminal for each single phase circuit way.
- (o) Where indicated on the schedules, an independent clean earth bar shall be provided within the distribution board. The bar shall have one terminal for each single phase circuit way.
- (p) The cable capacity of the neutral and earth busbar outgoing ways shall be a minimum of 16 mm². Each individual way of the neutral and earth busbars shall be clearly numbered. The insulated neutral busbar shall be shrouded to prevent accidental contact.
- (q) Each distribution board shall be fitted with an earth stud located in an accessible position on the outside of the board. All metal parts of the board except current carrying parts shall be bonded together electrically and to the earth busbar. An earth terminal shall be provided for each earth cable terminated.
- (r) Each distribution board shall be fitted with phase barriers. Barriers shall be fitted around the circuit breakers such that only the front surface and toggle of the circuit breakers are showing.
- (s) Each distribution board shall be fitted with a distribution board chart set out in accordance with the requirements of BS 7671, contained in a heavy duty transparent plastic pocket securely bonded to the inside of the door panel. Circuit charts shall indicate phasing, connected load, circuit breaker or fuse rating and final circuit cable size. Single phase boards shall include phase colour identification discs. The connected load shall be determined based on the completed installation.
- (t) Distribution boards for use on DC systems shall be provided with a set of incoming links such that isolation of both poles can be effected. Each outgoing circuit on these boards shall be provided with a two-pole miniature circuit breaker.
- (u) Each distribution board shall be provided with an engraved label on the outside of the front cover, bearing the designation of the board and its reference number. Each such label shall bear the required inscription in black on white using characters not less than 5 mm high.

- (v) Each protective outgoing device in the distribution board shall be clearly numbered to correspond with the numbering on the circuit chart. They shall be identified in an appropriate manner to indicate the supply phase to which it is connected.
- (w) The method of numbering the outgoing ways shall be consistent for all distribution boards on site and the method shall be submitted to the engineer for acceptance.
- (x) The numbering of the protective device ways, neutral busbar and earth busbar ways shall correspond with the numbered ferrules installed on the terminated cables, as specified elsewhere.
- (y) Distribution board enclosures shall provide a degree of protection against contact with live parts, ingress of dust, solid objects or moisture not less than IP3X.
- (z) Distribution boards shall be the product of one manufacturer and shall have a guaranteed production life of at least 10 years.
- (aa) The Electrical Services Installer shall ensure that the cables are neatly dressed into the distribution boards, leaving the access required to wire the spare ways in the future. Cables shall enter the distribution board on the side on which they are to be terminated. The cables shall not be tie wrapped into large bunches, where this would cause a derating of the cables due to grouping.
- (bb) The Electrical Services Installer shall provide a detailed method statement to cover all torque settings, the checking and sign off process for the cable terminating within the equipment.
- (cc) Distribution boards supplying final circuits in the following areas shall be sized to accept additional protection devices for arc fault detection whether such devices are fitted or not.
 - i) Premises with sleeping accommodation
 - ii) Locations with a fire risk due to the nature of either stored or processed materials.
 - iii) Premises constructed of combustible materials
 - iv) Fire propagating structures
 - v) Locations where irreplaceable goods are stored or displayed

E34 DEVICES**E340100 GENERAL**

- (a) This section of the specification deals with the general requirements for protection, switching and isolation devices including:
 - i) Moulded case circuit breakers ($I_n = < 800$ Amp)
 - ii) Electronic low voltage protection relays
 - iii) Fused switches
 - iv) Isolators
 - v) Auto transfer switches
 - vi) Auto transfer schemes
 - vii) Contactors
- (b) Specific requirements will be detailed in the services description of this specification and the associated schematics and schedules.
- (c) All incoming isolation devices on switchboards, panel boards and distribution boards shall switch all live conductors.
- (d) All devices forming part of an auto change over scheme either between two utility supplies or a utility supply and standby generator supply shall switch all live conductors.
- (e) Devices shall be of the type described within the specification schedules and as shown on the distribution schematic.
- (f) All devices shall have the facility to transmit their status to either a Power Management or Building Management System.

E340700 MOULDED CASE CIRCUIT BREAKERS

- (a) Moulded case circuit breakers shall be manufactured in accordance with BS EN 60947-2.
- (b) Moulded case circuit breakers shall be installed in:
 - i) Low voltage switchboard
 - ii) Low voltage panel board
 - iii) Busbar tap off unit
- (c) Moulded case circuit breakers shall be of the current limiting type enabling full use of current limitation and cascading techniques. Alternatively, the breaking capacity of a circuit breaker shall be at least equal to the prospective short circuit at the point of the distribution system where the breaker is installed.
- (d) Moulded case circuit breakers shall be of a circuit breaker disconnect type and shall be designed for horizontal or vertical mounting without any adverse effect on electrical performance. It shall be possible to reverse feed the breaker without reduction in performance up to 500 V AC and in 3 or 4 pole versions.

- (e) Unless otherwise specified moulded case circuit breakers shall be either 'plug-in' or 'withdrawable' and spare ways shall be equipped with the relevant size plug-in base or frame.
- (f) Where utilised for protection purposes the circuit breaker shall be equipped with an electronic protection relay with the following functionality:
 - i) Adjustable long time delay
 - ii) Adjustable short time delay
 - iii) Adjustable instantaneous trip
 - iv) Protection relays shall be capable of transmitting diagnostic information to a Power Management System via a high level interface
 - v) Circuit breakers in the range of 630 Amp to 800 Amp or where utilised as the first protective device on the network shall also have an earth fault function. (Note that the Earth Fault protection shall be able to be inhibited or where this is not possible then separate relays shall be utilised)
- (g) Where specified circuit breakers shall have facilities for remote opening and closing to enable priority switching and load shedding to be achieved. Each device shall be fitted with a local/remote key switch to disable/enable the remote operation at the device. The Status of the local/remote switch shall be wired to the common control section of the switchboard.
- (h) Motor operator supplies shall be separate from any other secondary supplies to devices.
- (i) The status of each functional device shall be wired to the common control section:
 - i) Open, closed and tripped for automatic circuit breakers
 - ii) Open and closed for non-automatic circuit breakers
- (j) Note that the status of the devices shall be monitored at all times no matter what the status of the power supply to the switchboard. If necessary to maintain signals the switchboard manufacture shall supply and install a separate uninterruptable power supply system with two hour autonomy to maintain the signal output of the devices.

E341000 MINIATURE CIRCUIT BREAKERS

- (a) Miniature circuit breakers shall be moulded case all-insulated pattern with silver tungsten contacts and quick make quick break trip-free mechanism.
- (b) They shall conform to BS EN 60898 and BS EN 60947-2.
- (c) Tripping curves unless noted within the distribution board schedules shall be as follows:
 - i) Lighting circuits – Type B
 - ii) Small power circuits – Type C
 - iii) Motors circuits or small power circuits with large inrush – Type D
- (d) All circuit breakers shall have a minimum short circuit rating of 15 kA in accordance with BS EN 60947-2.

- (e) Each miniature circuit breaker shall carry its full rated current continuously, without tripping out, in the enclosure specified.
- (f) The calibration of the thermal magnetic trip mechanism shall not be affected by ambient temperature variations.
- (g) Circuit breakers shall have dolly operated control switches with clear indication of the ON, OFF and TRIP positions.

E341300 RESIDUAL CURRENT DEVICES

- (a) Residual current devices (RCD) shall be double or four pole devices and comply with BS IEC 62873 and shall unless otherwise specified be provided with Type A 30 mA trip devices.
- (b) RCD's shall have a minimum fault rating of 15 kA.
- (c) RCD's shall be fitted with protection to protect against nuisance tripping caused by downstream transient surges and switching.
- (d) It shall not be possible manually hold an RCD in circuit under fault conditions.
- (e) RCD's shall incorporate protection to ensure that pulsating dc currents do not affect their operation.
- (f) RCD's shall have dolly operated control switches with clear indication of the ON, OFF and TRIP positions.

E341600 RESIDUAL CURRENT CIRCUIT BREAKERS

- (a) Residual current circuit breakers (RCBO) shall be single or triple pole devices and shall comply with BS EN 61009 Type A 30mA devices.
- (b) All RCBO's shall have a minimum short circuit rating of 15 kA.
- (c) RCBO's shall be fitted with protection to protect against nuisance tripping caused by downstream transient surges and switching.
- (d) RCBO's shall give a positive indication of the opening of the contacts by a suitable flag.
- (e) It shall not be possible manually hold an RCBO in circuit under fault conditions.
- (f) RCBO's shall incorporate protection to ensure that pulsating dc currents do not affect their operation.
- (g) RCBO's shall have dolly operated control switches with clear indication of the ON, OFF and TRIP positions.

E341900 FUSED SWITCHES

- (a) Fuse switches shall be constructed in accordance with BS EN 60947-3.
- (b) Fuse Switches shall have a utilisation category at 400 Volt of AC 23 A in accordance with BS EN 60947-3 and be suitable for switching motor loads.
- (c) Fuse switches shall be installed in:
 - i) Low voltage switchboards

- ii) Low voltage panel boards
- iii) Busbar tap off units
- iv) Individual dedicated steel enclosures
- (d) Fused switches shall be either, switched three pole and solid neutral link or switched three pole and switched neutral link as noted on the schematic drawings and schedules. The neutral shall be linked by a removable hard drawn high conductivity copper bar. Where switched neutrals are specified, the neutral shall be arranged to make first and break last.
- (e) Fused switches shall, where specified, be provided with motor operators fitted to facilitate remote opening and closing.
- (f) Fuse links shall generally be BS 88 HRC type. Where a higher fault level breaking capacity is required fuse switches shall be DIN type 100 kA. The particular type of fuse, fuse rating and characteristics shall be selected to meet the fusing and discrimination requirements of the system.
- (g) The status of each fuse switch shall be wired to the common control section:
 - i) Open and closed
 - ii) Where specified elsewhere individual fuse failure shall be monitored
- (h) Note that the Status of the devices shall be monitored at all times no matter what the status of the power supply to the switchboard. If necessary to maintain signals the switchboard manufacture shall supply and install a separate uninterruptable power supply system with two hour autonomy to maintain the signal output of the devices.

E342200 LOAD BREAK SWITCHES AND ISOLATORS

- (a) Load break switches and Isolators shall be constructed in accordance with BS EN 60947-3.
- (b) All devices utilised for switching or isolating motors shall be Load Break type.
- (c) Load break switches shall have a utilisation category (at 400 Volts) of AC 23 A in accordance with BS EN 60947-3 and be suitable for switching motor loads.
- (d) Isolators and off-load switches utilised for the local isolation of fixed stationary equipment or resistive loads and incoming isolators on distribution boards and panel boards shall have a minimum utilisation category at 400 Volt of AC 22 A in accordance with BS EN 60947-3.
- (e) Load break switches and isolators shall generally switch all poles. Where switched neutrals are specified, the neutral shall be arranged to make first and break last.
- (f) Visual on/off indicators shall be provided on all load break switches and isolators.
- (g) Load break switches and isolators shall be lockable in the off position.
- (h) The status of each load break switch or isolator where specified elsewhere shall be capable of being monitored.

E342500 CONTACTORS

- (a) Contactors shall comply with BS EN 60497-1 and BS EN 60947-4-1.
- (b) Contactors shall be metal clad of the continuously rated pattern, as required by the particular duty and the number of operations per hour.
- (c) Each contactor shall be provided with the appropriate main contacts, one normally open and one normally closed auxiliary contact. The main contacts shall be rated at a minimum of 15 A inductive unless the load exceeds this when they shall be rated to suit the application.
- (d) Each contactor shall be provided with a label clearly defining its function and in addition to this a label engraved in red on a white background "Danger live terminals. Isolate elsewhere before opening".
- (e) Where small contactors are incorporated in composite panels the wiring shall be brought to adjacent terminal blocks so that each complete unit can be easily removed and replaced. Such contactors, together with any associated relays, shall be housed in a separate compartment with a dedicated hinged lid.

E342800 METERS**E342801 General**

- (a) Meters shall be provided as detailed on the medium voltage, low voltage, metering schematics and schedules.
- (b) Meters shall be utilised as noted within the services description to measure electrical energy and or power quality of the installation or particular parts of the installation.
- (c) All energy meters utilised for revenue purposes shall be MID approved and certified.
- (d) Each electrical meter shall communicate with the various monitoring systems on the project such as electrical and Energy Metering Systems, Power Management System and Building Management Systems via a dedicated data communications network using industry standard protocol such as BACnet, Modbus, MBus or equivalent relaying all measured parameters and functions.
- (e) Whilst certain medium and low voltage circuit breaker protection relays provide limited metering functionality these shall not be utilised for energy metering or power quality purposes.
- (f) Where meters are utilised purely to measure and report energy usage to an Energy Metering System meters may be DIN rail mounted with no local display. Full functional displays will be required on the Energy Metering Systems head end for each meter.
- (g) Metering displays shall be fascia mounted in suitable locations on the switchboards, distribution boards or panels in locations that are easily accessible to an operator.
- (h) CT's utilised on revenue collection or billing meters shall be class 0.5 or better. Other measurement devices shall be in accordance with the meter manufacturer's recommendations.

E342804 Multi-Function Energy Meters and Displays

- (a) Meters may be panel mounted with full local functional displays or din rail mounted with facia mounted displays.
- (b) Displays shall be back lit liquid crystal or light emitting diode.
- (c) Meters shall be BS EN 62053-22 Class 0.5 and MID approved and certified.
- (d) The meters shall have the following minimum functionality:
 - i) Instantaneous line and phase voltage
 - ii) Instantaneous current for all phases including neutral
 - iii) Power factor
 - iv) Frequency
 - v) Instantaneous active, reactive and apparent power
 - vi) Maximum demand in active, reactive and apparent power
 - vii) Energy usage in kW/hr
 - viii) Peak current
- (e) Additional functionality where required will be as noted within the services description or schedules.

E342807 Multi-Function Power Quality Meters and Displays

- (a) Meters may be panel mounted with full local functional displays or din rail mounted with facia mounted displays.
- (b) Meters shall be BS EN 62053-22 Class 0.2S, if the meter is to be utilised for revenue collection the meters shall be MID approved and certified.
- (c) The meters shall have the following minimum energy metering functionality:
 - i) Instantaneous line and phase voltage
 - ii) Instantaneous current for all phases including neutral
 - iii) Power factor
 - iv) Frequency
 - v) Instantaneous active, reactive and apparent power
 - vi) Maximum demand in active, reactive and apparent power
 - vii) Energy usage in kW/hr
 - viii) Peak current
 - ix) The meters shall have the following power quality functionality:
 - x) Waveform capture
 - xi) Disturbance direction detection

- xii) Dip and swell, transient
- xiii) Harmonic distortion up to 63rd harmonic
- xiv) Setpoint learning
- xv) Voltage sag and swell detection
- (d) The meters shall retain event logs with date and time stamping and logs shall be accessed either locally at the display or remotely by the monitoring system.
- (e) Additional functionality where required will be as noted within the services description or schedules.

E35 AUTOMATIC CHANGE OVER SYSTEMS**E350100 GENERAL**

- (a) A change-over system shall generally be formed by one of the following systems:
 - i) Two circuit breakers or load break switches fed via different electrical sources supplying a common bar in a one from two configuration
 - ii) Two circuit breakers or load break switches fed via different electrical sources supplying a common bar with an intermediary bus coupler in a two out of three configuration
 - iii) Automatic transfer switches
 - iv) Digital static transfer switches
- (b) All change-over systems shall comply with the interlocking requirements of G99 to ensure that paralleling of supplies cannot occur.
- (c) The Electrical Services Installer shall provide details of all auto and manual change-over systems to the Distribution Network Operator for their perusal/approval and if necessary shall arrange for demonstrations of such systems to the Distribution Network Operator. The information shall include details of manual bypass of such systems including rotary bypass switches and wrap around maintenance bypass systems for UPS installations etc.
- (d) All interlocking systems shall be failsafe.
- (e) All changeover systems shall be break before make.

E351000 AUTOMATIC TRANSFER SWITCHES

- (a) Automatic transfer switches shall comply with BS EN 60947-6-1.
- (b) Where specified elsewhere the critical supplies to the life safety and firefighting systems shall be derived via an automatic transfer switch (ATS). The devices shall comprise of incoming isolators, automatic open transfer switch complete with control system as detailed.
- (c) The Electrical Services Installer shall include for the provision of an ATS bypass, unless written confirmation is obtained from the Engineer that the bypass may not be required. In this case the Electrical Services Installer shall be responsible for the production of the appropriate risk assessment to establish the impact on the critical equipment of the ATS being out of service due to periodic maintenance or component failure.
- (d) The changeover switches shall be either within the low voltage switch panels or shall be stand-alone units mounted adjacent to the item of plant, which they supply and enclosed within a sheet steel enclosure manufactured to BS EN 60947 and this specification.
- (e) Where the ATS units are to be integrated to a switch panel, they shall be of cubicle construction to give a degree of separation to BS EN 61439 to Form 4 – Type 6, where the ATS device is considered to be a single functional device and protection against ingress of solids and liquids to IP3X.

- (f) Individual ATS cabinets within dedicated electrical switchrooms shall be protected against the ingress of solids and liquids to IP31. Where mounted elsewhere the degree of protection shall be IP54.
- (g) Incoming isolators, busbars and automatic open transfer switches and their associated bypass systems shall be rated as described on the drawings and associated schedules of this specification.
- (h) In certain instances where detailed within the schedule the auto-changeover panels shall be further enclosed in weatherproof housing giving a minimum level of protection of IP65. The enclosures shall be fitted with suitably sized frost protection heaters controlled by thermostats and all compartments of the system shall be suitable for outdoor operation. The Electrical Services Installer shall ensure that the termination of the cables to the weatherproof enclosures shall not lessen the ingress protection rating afforded by the enclosures.
- (i) All auto-changeover panels shall be monitored by the Fire Alarm System and the Building Management System. Monitoring shall be achieved by auxiliary contacts on the automatic transfer switches and bypass arrangements and shall give the following outputs:
 - i) Normal supply healthy/failed
 - ii) Emergency supply healthy/failed
 - iii) Switch closed to normal supply
 - iv) Switch closed to emergency supply
 - v) Switch open and bypass in operation
- (j) All auxiliary contacts and volt free contacts shall be wired to a dedicated termination enclosure with all outputs clearly labelled. Final connection to the Fire Alarm System and Building Management System will be carried out by others.
- (k) The Electrical Services Installer shall carry out all final connections from the auto-changeover panels to the items of plant in accordance with the recommendations of BS 8519.
- (l) Where neutral conductors are to be switched, the ATS device shall be provided with fully rated fully separated neutral transfer contacts.
- (m) The automatic transfer switch and bypass shall be electrically operated by one solenoid operator, momentarily energised and mechanically held, ensuring only one of two positions "Normal/Primary or Emergency/Secondary".
- (n) Where specified in the schedules separate bypass and isolation handles shall be used to ensure clear distinction between these functions. The bypass handle will have three positions: "Bypass to Normal", "Automatic" and "Bypass to Emergency". Bypass to the critical load shall be achieved without interruption of power to the load. The operating speed of the bypass contacts shall be the same as that of the associated automatic transfer switch, regardless of the speed at which the manual bypass handle is operated.
- (o) The isolation handle shall provide three operating modes "Closed", "Test" and "Open". The "Test" mode shall permit testing of the entire emergency power system, including the ATS; without interruption of power to the load. The "Open" mode shall

- completely isolate the ATS from all source and load conductors. When in the “Open” mode, it shall be possible to completely withdraw the ATS for inspection or maintenance without removal of power conductors or the use of tools.
- (p) When the isolation switch is in the “Test” or “Open” mode, the bypass switch shall function as a manual transfer switch allowing transfer and retransfer of the load between the two available sources without the feedback of load-regeneration voltage to the transfer switch.
 - (q) The control module sensing and logic shall be controlled by a built in microprocessor for reliability and digital communications capability.
 - (r) The control module shall be enclosed and be mounted separately from the transfer switch unit for safety and ease of maintenance.
 - (s) The voltage of all phases of the normal/Primary source shall be monitored, with pick up adjustable from 85-100% and drop-out adjustable from 75-98% of pick up setting, in increments of 1% and shall be fully adjustable. Repeat accuracy shall be $\pm 2\%$ or better over a temperature range of -20°C to 70°C . Factory set to pick up at 90% and drop out at 85%.
 - (t) Provide single-phase voltage sensing of the emergency/Secondary source, with pick up adjustable from 85-100% (drop-out fixed at 84-86% of pick up) and frequency sensing with pick up adjustable from 90-100% (drop-out fixed at 87-89% at pick up) . Both pick up settings shall be fully field adjustable in 1% increments. Repeat accuracy offsetting shall be $\pm 2\%$ or better over a temperature range of -20°C to 70°C . Factory set to pick up at 90% voltage and 95% frequency.
 - (u) The control module shall include four timers that are fully field adjustable in increments as follows:
 - i) Timer to override momentary normal source failures to delay transfer switch and engine starting signals. Adjustable from 0 to 6 seconds. Factory set at 1 second
 - ii) Transfer to emergency timer. Adjustable from 0 to 5 minutes. Factory set at 0 minutes
 - iii) Re-transfer to normal timer. Time delay is automatically bypassed of emergency source fails and normal source is acceptable. Adjustable from 0 to 30 minutes
 - (v) Where ATS units feed emergency lighting circuits comprising of self-contained emergency luminaires, the luminaire ballasts shall be carefully selected to ensure there is not a malfunction of the ballast when the ATS switches back to the primary supply. Where the malfunction is identified the Electrical Services Installer shall be deemed to have included for a timer contactor module to each lighting distribution board.
 - (w) Where an ATS device supplies a firefighting lift, a remote indication unit shall be provided at the fireman’s entry level, within the firefighting/protected lobby, providing indication as to which supply the lift is operating on primary or secondary), this indication shall also be reported to the fire command centre. The ATS shall be provided with all necessary contacts as required.

E39 METERING AND METERING STRATEGY**E390100 GENERAL**

- (a) This section of the specification describes the general requirements for the provision of meters and energy metering systems (EMS) to enable systems to be monitored in accordance with the requirements of Building Regulations Part L and where required utilisation of that system to be able to prepare billing for the resale of energy to tenants.
- (b) Energy metering systems shall have the capability to carry out the following functions:
- i) Monitor energy usage in accordance with Part L requirements
 - ii) Record energy usage via MID (UK) certified and approved meters such that energy may be 'resold' to the buildings respective tenants, including the following systems:
 - Electricity
 - Cooling
 - Heating

The specified systems to be metered shall be noted elsewhere within the specification
 - iii) Capable of being interfaced with a building management system and power management system, where specified

E390400 ENERGY METERING FOR PART L COMPLIANCE

- (a) Meters for checking purposes shall be of an approved electronic type complying with current British Standards applicable at the time of installation.
- (b) The check meters shall be provided with a pulsed output for kWhr and the option for a plug-in communications module to allow each instrument to be interfaced with an energy metering system building management system or power management system. The protocol selected for the communications module shall be co-ordinated with the relevant system or systems to which it is to be connected.
- (c) Meters shall be approved and certified in accordance with the Metering Instrumentation Directive (MID) for use within the United Kingdom.
- (d) Electrical check metering to monitor lighting, mechanical services and small power loads separately shall be provided to all tenant distribution boards in each electrical riser at each floor level.
- (e) Electrical check metering shall be provided to supplies serving boilers, chillers and mechanical ventilation and air conditioning plant where not supplied via a control panel, incorporating check metering, provided by others.
- i) On control panels providing electrical power to fans and pumps totalling 10 kW rated input power and above

- ii) On final electrical distribution boards serving equipment totalling 50 kW rated input power and above
- iii) Meters shall be provided on all electrical generation systems such as photo voltaic arrays, wind turbines, fuel cells and CHP plant, where connected to the landlord's distribution network.

E391000 ENERGY METERING SYSTEMS

E391001 General

- (a) Unless otherwise indicated within the services description the Electrical Services Installer shall provide an Energy Metering System. This system shall download data from all meters installed throughout the project and be capable of providing billing information to tenants for the reselling of electricity, providing historical record data on Energy usage including reports for particular services etc.
- (b) The Electrical Services Installer shall provide a complete electrical metering system for the building for monitoring and billing purposes and to comply with the requirements of the Building Regulations approved document L2 and CIBSE guide TM39.
- (c) The system shall have the facility to record water, gas and heat energy as required.
- (d) The energy metering systems shall utilise a separate communications network and head end so as not to interfere with the control and monitoring elements of the building management system.
- (e) The system shall be capable of metering > 90% of the overall electrical energy for the development.
- (f) The Electrical Services Installer shall provide a functional design specification for the system detailing compliance with the specification.
- (g) The System shall monitor and meter the following elements:
 - i) Incoming utility supplies including electrical energy, water and gas
 - ii) Landlord's medium and low voltage energy usage
 - iii) Landlord's lighting of communal areas
 - iv) Landlord's lighting of external areas
 - v) Electrical Energy of Cooling systems
 - Chillers
 - Pumps
 - Cooling towers
 - vi) Electrical energy of heating systems
 - Boilers
 - Pumps
 - vii) Electrical energy of water distribution pumping systems
 - viii) On floor cooling and water heating systems
 - ix) Tenant's lighting
 - x) Tenant's small power
 - xi) On floor power to mechanical services if separate

- xii) Ventilation systems
 - Main office AHU's
 - Main office extract units
 - Plant room AHU and extract unit
- xiii) Tenant's direct supplies
- xiv) Lifts
- xv) Energy generated at site via low carbon generation system such as photovoltaics, fuel cells or combined heat and power systems
- (h) Quiescent life safety supplies such as stair pressurisation and sprinkler systems shall not be metered.

E391004 Energy Metering System

- (a) A fully-licensed PC Windows-based, IP-addressable, client-server energy metering systems shall be provided, allowing multi-user access via workstations on proprietary IT networks, in addition to access to Web HTML pages for web-browsing facilities.
- (b) The energy metering systems shall be able to be interrogated via the web and shall allow all reports and billing information to be downloaded remotely.
- (c) The energy metering systems be provided with all peripheral devices, such as alarm and report Printers, which shall be configured accordingly.
- (d) The energy metering systems shall provide a graphical user interface to the energy metering systems serving the building. The menu structure of the energy metering systems shall be sub-divided logically in accordance with the infrastructure of the energy metering systems.
- (e) The energy metering systems shall be provided with full web-browsing capabilities. The IP-addressable energy metering systems shall be configured to allow a minimum of 2-No multi-user web-browser access from designated workstations via the proprietary client IT networks.
- (f) The energy metering systems shall support a minimum of 2 No concurrent terminal services sessions. The terminal services for the energy metering systems shall be configurable such that access from designated areas, such as control rooms, can be prioritised accordingly, via respective password levels, as required by the end user. This is to allow higher priority users onto the energy metering systems in the event of an emergency should a conflict occur from too many concurrent user access demands via the terminal services.
- (g) The energy metering systems, where necessary, shall communicate via a high-level read/write data communications interface with the building management system.

E391007 EMS Front-End Supervisor Colour Graphic Pages

- (a) The Energy Metering System shall include the following colour graphic pages as a minimum:
 - i) System login page
 - ii) Home page to include Image of the building, navigation links to:
 - iii) Electrical metering of MV incoming supplies

- iv) Electrical metering of LV supplies
- v) Photo Voltaic System
- vi) Where specified in the services description:
 - Heat energy metering of landlord's heating systems
 - Heat energy metering of tenants heating systems
 - Heat energy metering of landlord's cooling systems
 - Heat energy metering of tenants cooling systems
 - Landlord's and tenants water metering systems
 - Landlord's and tenants gas metering systems
 - Network schematic, etc.
- (b) The Network schematics shall lead to the following graphical representations for electrical energy usage:
 - i) MV incoming supply metering schematics and monitoring pages
 - ii) LV incoming supply metering schematics and monitoring pages
 - iii) Landlords communal lighting metering schematics and monitoring pages
 - iv) Landlord's external lighting metering schematics and monitoring pages
 - v) Landlords small power metering schematics and monitoring pages
 - vi) Tenant's lighting metering schematics and monitoring pages
 - vii) Tenant's small power metering schematics and monitoring pages
 - viii) Landlord's heating plant metering schematics and monitoring pages
 - ix) Landlord's cooling plant metering schematics and monitoring pages
 - x) Landlord's ventilation plant metering schematics and monitoring pages
 - xi) On-Floor plant metering schematics and monitoring pages
 - xii) Lift plant metering schematics and monitoring pages
 - xiii) Miscellaneous system and plant monitoring pages
- (c) Where specified in the services description the network schematics shall lead to the following graphical representations for heat energy usage:
 - i) Landlord's heating plant metering schematics and monitoring pages
 - ii) Tenant's heating plant metering schematics and monitoring pages
 - iii) Landlord's cooling plant metering schematics and monitoring pages
 - iv) Tenant's cooling plant metering schematics and monitoring pages
 - v) Miscellaneous system and plant monitoring pages

- (d) Where specified elsewhere the network schematics shall lead to the following graphical representations for gas usage:
 - i) Landlord's gas metering schematics and monitoring pages
 - ii) Tenant's gas metering schematics and monitoring pages
- (e) Where specified elsewhere the network schematics shall lead to the following graphical representations for water usage:
 - i) Landlord's water metering schematics and monitoring pages
 - ii) Tenant's water metering schematics and monitoring pages
- (f) The network schematics shall lead to the following graphical representations for the photo voltaic system:
 - i) Photo voltaic monitoring system package
- (g) Electrical, water, gas and heat energy reporting and billing.
- (h) The energy metering systems shall have the facility to generate, either automatically or via operator command, reports of all metered functions on a daily, weekly, monthly, quarterly or annual basis.
- (i) The energy metering systems shall have the facility to generate electrical, water, gas and heat energy metering reports at operator-selectable times of the day, for any individual meter, tenant, floor or zone basis.
- (j) The energy metering systems shall have the facility for the electrical, water, gas and heat energy metering reports to be printed, archived or exported to third-party proprietary applications, as required. The metering reports shall be fully compatible with Microsoft office applications, including word and excel.
- (k) The energy metering systems shall have the facility to generate the electrical, water, gas and heat energy metering reports to third party tenants in a suitable format for billing purposes.
- (l) The energy meters shall be monitored by the energy metering supervisor system, with the following data, as a minimum, being displayed at both the energy metering systems and where specified elsewhere the building management systems:
 - i) Actual values:
 - Energy, active, reactive and apparent power
 - Maximum demand
 - Reactive power
 - Instantaneous line and phase voltage
 - Instantaneous current for all phases including neutral
 - Power factor
 - Frequency
 - Harmonics where fitted

- (m) In addition, the following data, as a minimum, shall be displayed at the energy metering systems for each electrical meter being provided:
- i) Previous weekly data:
 - Energy, active, reactive and apparent power
 - Maximum demand
 - Previous monthly data:
 - Energy, active, reactive and apparent power
 - Maximum demand
 - ii) Previous yearly data:
 - Energy KWhr, kVArh, kVAh
 - Maximum demand
- (n) Where specified in the services description to be provided the heat energy meters shall be monitored by the energy metering systems, with the following data, as a minimum, being displayed at the energy metering systems:
- i) Actual values:
 - Energy
 - Maximum demand
 - Volume
 - Flow rate
 - Flow temperature
 - Return temperature
- (o) In addition, the following data, as a minimum, shall be displayed at the energy metering systems for each heat meter being provided:
- i) Previous weekly data:
 - Energy
 - Maximum demand
 - Volume
 - ii) Previous monthly data:
 - Energy
 - Maximum demand
 - Volume
 - Missing days
 - iii) Previous yearly data:

- Energy
 - Maximum demand
 - Volume
- (p) Where specified in the services description to be provided the gas meters shall be monitored by the energy metering systems, with the following data, as a minimum, being displayed at both the energy metering systems and building management system:
- i) Actual values:
- Energy
 - Maximum demand
 - Volume
 - Flow rate
- (q) In addition, the following data, as a minimum, shall be displayed at the energy metering systems for each gas meter being provided:
- i) Previous weekly data:
- Energy
 - Maximum demand
 - Volume
 - Flow rate
- ii) Previous monthly data:
- Energy
 - Maximum demand
 - Volume
 - Flow rate
- iii) Previous yearly data:
- Energy
 - Maximum demand
 - Volume
 - Flow rate
- (r) Where specified in the services description to be provided the water meters shall be monitored by the energy metering systems, with the following data, as a minimum, being displayed at both the energy metering systems and building management system:
- i) Actual values:
- Maximum demand

- Volume
 - Flow rate
- (s) In addition, the following data, as a minimum, shall be displayed at the energy metering systems for each water meter being provided:
- i) Previous weekly data:
 - Energy
 - Maximum demand
 - Volume
 - Flow rate
 - ii) Previous monthly data:
 - Energy
 - Maximum demand
 - Volume
 - Flow rate
 - iii) Previous yearly data:
 - Energy
 - Maximum demand
 - Volume
 - Flow rate

E391010 Password Access

- (a) Energy metering system operator interfaces shall be configured with the following levels of password access as a minimum:
- i) Basic operator:
 - View metering schematics
 - Acknowledge alarms
 - View trend logs
 - View reports and billing
 - ii) Intermediate operator:
 - Alter control set-points/parameters
 - Setting up trend logs
 - Setting up alarm routines
 - Generation of energy usage reports

- Generation of energy billing reports
- Basic level access
- iii) Advanced operator:
 - Add or edit graphics
 - Re-load system software/configuration details
 - Add points to the system
 - Setting up of energy usage reports
 - Setting up of energy billing reports
 - Password assignment
 - Basic and intermediate level access

E391013 System Topology

- (a) The Energy Metering System shall be wired on a separate network from the Building Management System to avoid metering information slowing the operation of the control system.
- (b) The main communication network between the central and remote controls shall be via fibre optic cables, wired diversely routed ring circuits.
- (c) Note that all Energy Metering System components shall be supported via either a central or decentralised UPS systems.
- (d) Field wiring between MV and LV switchboards to the Energy Metering System RIO remote input/output panels will be carried out by the Electrical Services Installer.

E391016 Power Management System and Building Management System Data Communications Interface with Energy Metering System

- (a) The energy metering systems shall have a high-level read/write data communications Interface with both the power management system and building management system, utilising an industry-standard protocol such as BACnet, OPC or equivalent to enable selected energy metering systems data and parameters to be displayed at the energy metering system and building management system operator interfaces.
- (b) The energy metering systems installer shall provide all necessary hardware and software for the high-level read/write data communications interface between the power management system, building management system and energy metering systems utilising an industry-standard protocol such as BACnet, OPC or equivalent, which is to be agreed with the Engineer. All available data shall be graphically displayed at the power management system and building management system operator interfaces.
- (c) The high-level data communications Interface shall be suitable for the application such that all read/write data transfers are carried out in the most optimum, timely and efficient manner, without any compromise or undue delay to the control, monitoring and operation of the respective plant or system.

- (d) The energy metering systems installer shall include all costs for provision, production and liaison with the power management system and building management system installers for providing a fully functioning read/write interface. The interface shall provide the most commonly used and usable information with regards to the operation, functioning and alarm information for the energy metering systems.
- (e) Production of the data communications interface shall be the responsibility of the energy metering systems installer who shall liaise directly with the power management system and building management system installers to obtain all necessary protocol information and data required to produce the interface. The energy metering systems installer shall provide full hardware and software support for the interface.
- (f) The energy metering systems manufacturer/supplier shall provide a dedicated communication port for the interface to the power management system and the building management system. Completion of the interface including all cabling connections, gateways etc. shall be the responsibility of the power management system and the building management system installers.
- (g) The data communications interface shall be developed and fully tested prior to installation on site and shall be witness-tested to the satisfaction of the Engineer off-site at the power management system manufacturer/supplier's works or at an alternative venue to be agreed with the Engineer.
- (h) A data communications "watchdog" function shall be provided that shall identify a loss of communication between the systems and generate an alarm on all connected systems.
- (i) Sufficient capacity within the data communications Interface must be provided for the future mapping of all data points available from the energy metering systems.
- (j) Following power failure, the data communications interface shall automatically restart without a requirement for operator intervention at the power management system, building management system or energy metering systems.

E391019 Electrical Energy Meters

- (a) Refer to the services description, section E342800 of this specification and the engineering schedules for full details of individual meters.
- (b) Meters shall be provided as detailed on the medium voltage, low voltage, metering schematics and schedules.
- (c) Meters shall be utilised as noted within the services description to measure electrical energy and or power quality of the installation or particular parts of the installation.
- (d) All energy meters utilised for revenue purposes shall be MID approved and certified.
- (e) Where meters are utilised purely to measure and report energy usage to the energy metering systems meters may be DIN rail mounted with no local display. Full functional displays will be required on the energy metering systems head end for each meter.
- (f) CT's utilised on revenue collection or billing meters shall be class 0.5 or better.

- (g) Each electrical meter shall communicate with the energy metering systems via a dedicated data communications network using industry standard protocol such as BACnet, Modbus, MBus or equivalent.

E391031 Testing and Commissioning

- (a) The Electrical Services Installer shall allow for a factory test to demonstrate all screens, operations and functions of the power management system prior to installation at site.
- (b) The data communications interface between the power management system and the energy metering systems shall be developed by the Electrical Services Installer and fully tested by both parties prior to being presented to the Engineer for witness testing at the factory. All such testing shall be completed to the satisfaction of the engineer prior to delivery and installation of the system at site.
- (c) The data communications interface between the energy metering systems and the building management system shall be developed by the Electrical Services Installer and the building management system installer/Mechanical Services Installer and fully tested by both parties prior to being presented to the Engineer for witness testing at the factory. All such testing shall be completed to the satisfaction of the engineer prior to delivery and installation of the system at site.
- (d) Final site commissioning and testing shall include point to point testing and functional testing of all systems.

E41 STANDBY GENERATION PLANT**E410100 GENERAL**

- (a) The Electrical Services Installer shall appoint a specialist Standby Generator Manufacture and Installer to carry out the design, manufacture, installation and commissioning of the standby generator system including factory and site acceptance tests.
- (b) The generator system shall comprise a single generator set onto a common bar. Each set shall generally comprise:
 - i) Diesel engine complete with engine management systems and governor of rating applicable to the duty
 - ii) Alternator with associated CT's and VT's in order to provide all necessary protection functions.
 - iii) Local protection circuit breaker at the generator
 - iv) Liaison with the Electrical Services Installer's appointed Protection Specialist to ensure all criteria from the generator scheme is incorporated into the protection scheme.
 - v) Fully automatic starting system either air/electric or dual electric
 - vi) Starting and control cubicle, including all control systems and where noted in the services description interfacing of controls with Power Management Systems, Building Management Systems and Energy Metering Systems.
 - vii) Day fuel tanks.
 - viii) Fuel oil
 - ix) Cooling systems including all necessary direct coupled radiators and or remote radiators, heat exchangers and primary and secondary pumping systems
 - x) Air inlet and exhaust air supply duct work, louvres, dampers and attenuation
 - xi) Exhaust flues, silencers and exhaust after treatment systems
 - xii) Acoustic enclosures including lighting and general power systems
 - xiii) Acoustic attenuation to inlet and exhaust air systems and the generator room or enclosure
 - xiv) Anti-vibration mountings including floating inertia slabs where required.
 - xv) Fire protection systems
 - xvi) Parasitic load requirements
 - xvii) Load bank testing facilities
 - xviii) Factory acceptance testing
 - xix) Site acceptance testing

- xx) Integrated systems tests
- (c) Generators shall be suitable for the duty for which they are to be utilised and the voltage of the system at which they operate.
- (d) Particular requirements shall be as described within the services description.
- (e) Equipment and components shall comply with all relevant legislation, British European and International Standards and recommendations as noted within Section 1 of the specification and in particular the following:
 - i) Energy Networks Associations Recommendations G84 – Recommendations for the Connection of Mobile Generating Sets to the Public Distribution Network.
 - ii) Energy Networks Associations Recommendations G99 – Recommendations for the Connection of Generating Plant to the Distribution Systems of Licensed Distribution Network Operator.
 - iii) The Electricity Safety, Quality and Continuity Regulations.
 - iv) The Chartered Institution of Building Services Engineers Guide K Electricity in Buildings
 - v) BS ISO 8528 – Reciprocating Internal Combustion Engine Driven Alternating Current Generating Sets.
 - vi) The European Union Non-Road Mobile Machinery Regulations 2016/1628.
 - vii) The Medium Combustion Plant Directive 2015/2193/EU and associated UK legislation
 - viii) Local Planning Authority Requirements in respect of Environmental Health including any restrictions on acoustic performance, engine emissions and generator testing regimes.
 - ix) Environment Agency air quality requirements where building systems exceed 50MW_(th).
 - x) BS 9999 – Fire Safety in the Design, Management and Use of Buildings. Code of Practice.
 - xi) BSRIA BG 70 – Life Safety and Firefighting Power Supplies
- (f) This section of the specification shall be read in conjunction with the Acoustic Consultants Report with particular respect to the acoustic requirements and limits noted there in for both the Generator Set and ancillary systems such as remote heat rejection plant etc.
- (g) Diesel sets and their associated switchboards and control panels shall be suitable for operating conditions as follows:
 - i) Minimum ambient air temperature - Minus 10 °C
 - ii) Maximum ambient air temperature - 35 °C
 - iii) Relative humidity - 100%
 - iv) Sets shall be capable of operating continuously in high dust concentration conditions as defined in BS ISO 5011

- (h) The generator shall be enclosed within its own acoustic enclosure or within its own generator room either of which shall have a minimum fire rating of 2 hours.
- (i) Ratings and duties of generator sets shall be as defined in BS ISO 8528 and shall be suitable for their intended operation.
- (j) Generators installed externally shall be installed within their own fire rated, weatherproof and acoustic enclosures.
- (k) The Electrical Services Installer shall with the aid of the Generator Manufacture make all necessary applications to the Distribution Network Operator for connection agreements whether the generators are connected in parallel or run in island mode.
- (l) The Electrical Service installer shall manage all interfacing requirements of the Generator System and its controls with other systems including but not limited to:
 - i) Power Management System
 - ii) Building Management Systems
 - iii) Energy Metering Systems
 - iv) Fire alarm and fire protection systems

E410104 Plant Replacement

- (a) Generators and their associated plant shall be installed to allow future periodic plant replacement.
- (b) The Electrical Services Installer shall provide a fully detailed plant replacement strategy for the generator installation and its associated plant.

E410400 GENERATOR SETS FOR LIFE SAFETY PURPOSES

- (a) The following clauses of the specification shall apply only where a generator set is utilised solely for the purpose of providing an alternative supply to the building's primary utility supply for life safety purposes.
- (b) The Generator set shall be selected in accordance with BSRIA BG70, ISO 8528 -1 & ISO 8528-12.
- (c) Generator Engines shall comply with the Tier V emission levels of the European Union Non-Road Mobile Machinery regulations 2016/1628.
- (d) Generators utilised for life safety purposes shall be rated to provide 'Emergency Standby Power (ESP)' in accordance with BS ISO 8528.
- (e) The generator rating shall be the maximum permissible load with no overload capacity with the power output subject to a load factor of 70% of the published power rating over a 24-hour period.
- (f) A maximum runtime limitation of minimum 200 hours per year.
- (g) Voltage regulation shall be a minimum of class G2 in accordance with BS ISO 8528.
- (h) The generator shall be sized to support all life safety loads including transient conditions. For example, where the life safety generator set provides standby power to sprinkler and/or wet riser pumps the worst-case transient condition should be

identified with one pump with locked rotor condition and one pump starting, as described in BSRIA BG70, to ensure the generator set is adequately sized to maintain the maximum transient load without stalling.

- (i) Generator sets shall be classified as fully automatic and shall be able to start and accept 100% full load within 15 seconds of detection of failure of the normal mains supply.
- (j) Generators for life safety systems shall receive start signals from various sources including phase failure relays on incoming utility supplies as well as individual start signals from the various auto transfer switches installed to provide the transfer from primary mains supply to generator supplies locally.
- (k) Life Safety generator sets shall be provided with a minimum of 8-hour fuel oil storage.
- (l) Visual indication shall be provided at the fire command centre or main fire panel as for the following conditions:
 - i) Life safety systems supported by mains
 - ii) Life safety systems supported by generator
 - iii) Generator fault
 - iv) Voltmeter and ammeter indication

E411300 ENGINES

- (a) The engine type shall have been in commercial operation for at least 3 years prior to tender and have a substantiated record of reliability whilst operating at the specified duty.
- (b) The load may be accepted in not more than two steps, the first of which shall be not less than 65% for engines rated up to 1000kW_e(PRP) and 50% for engines rated greater than 1000kW_e(PRP).
- (c) Engines shall be water cooled, 4-stroke, direct injection, compression-ignition type, totally enclosed and with an in-line or vee cylinder configuration.
- (d) Engines may be naturally aspirated or turbo-charged dependent on rating and duty.
- (e) Engines shall be provided with engine management systems in order to minimise emissions in accordance with EU regulations 2016/1628 Tier V.
- (f) Unless specifically noted within the services description the engine speed shall be 1500rpm.
- (g) Engines shall have a forced lubrication system using an integral gear driven pump with coarse strainer on the suction side and a full flow filter, of nominal micron rating not greater than 10, on the delivery side.
- (h) Manual lubrication of any part of the engine will not be accepted.
- (i) The capacity of the lubricating oil system shall be sufficient to enable the engine to run continuously for 24 hours at any load without replenishment, and for 200 hours without replacement

- (j) The engine lubricating oil dipstick shall be easily accessible and be clearly marked to indicate maximum and minimum levels. The engine sump shall have an easily accessible drain point, or suitable drainpipe.
- (k) Sumps shall be provided with thermostatically controlled electric heaters as part of the cold start system for the engine.
- (l) A system shall be provided to lubricate bearings, preferably by automatic pre-start priming using a 12 or 24 volt DC motorised pump energised by the engine starting battery.
- (m) Engines shall be provided with cold starting aids and protection including thermostatically controlled water jacket and under sump heaters.
- (n) Where the engine is to remain in storage or stand on site for a period before commissioning advice from the engine manufacturer shall be sought and adhered to in respect of safe storage so as not to effect warranties.
- (o) Instrumentation shall be situated in an easily visible location, isolated from harmful vibration and shall provide the following facilities:
 - i) Lubricating oil pressure gauge.
 - ii) Running hours meter, which may be engine or cubicle mounted.
 - iii) Coolant outlet thermometer.
 - iv) Lubricating oil outlet thermometer.
 - v) Turbo-charger air pressure gauge where applicable.
 - vi) Provision only for a test thermometer in each exhaust gas outlet manifold, each turbo-charger inlet and turbo-charger outlet. A brass plug shall be fitted at each test point.
- (p) Engines shall be capable of starting from any crankshaft position, using a 12 or 24 volt DC supply, by axial type starter motors engaging with the flywheel. Starter motors shall disengage automatically when the engine starts or when de-energised and shall be easily accessible. Terminals shall be fitted with non-conducting protective shrouds.

E411600 ALTERNATOR

- (a) Alternators shall be capable of delivering the specified output continuously at any voltage within $\pm 1\%$ of the rated voltage, at a power factor of 0.8 lagging and at rated frequency.
- (b) Alternators shall be sized to handle harmonic currents likely to be present in the system. Where a harmonic spectrum has not been provided in Section 1 the alternator shall be sized on an expected total harmonic distortion I_{thd} 15% and V_{thd} 8%. The spectrum shall comprise typically UPS loads comprising 12 pulse rectifiers and where reflected in the design 6 or 12 pulse inverter loads.
- (c) Alternators may be flange or foot mounted with single or twin end-shield bearings. Single bearing rotors shall be directly coupled to the engine crankshaft. Twin bearing rotors shall be coupled through an intermediate flexible coupling.

- (d) Bearings shall be suitable for operation over long periods without the need for replacement or replenishment of lubricant. Oil lubricated bearings shall be fitted with a clearly visible and protected oil level gauge.
- (e) Alternators shall be brushless type with directly coupled AC exciters. Solid state rectifiers shall incorporate over-excitation protection.
- (f) Three phase machines shall be star connected with ABC phase rotation and with the neutral brought out to the alternator terminal box. A diagram showing the terminal markings and phase rotation shall be provided in the terminal box.
- (g) Current transformers shall be fitted to the alternators for all necessary protection functions.
- (h) Cables connecting the machine windings and machine terminals shall have the same temperature rating as the machine windings.
- (i) Insulation shall comply with BS EN 60085 excluding classes Y and A. The insulation shall have an oil and moisture proof finish with a surface, which will not retain dust or condensation.
- (j) Deviation of line-to-line voltage waveform from a pure sine wave with the generator running at rated speed and rated voltage on open circuit, shall not exceed the 10% limit specified in BS ISO 8528 and BS EN 60034-1, with the third harmonic factor not exceeding 5%.
- (k) Radiated interference from all sources shall be suppressed to the limits specified in BS EN 55014-1.
- (l) Terminal boxes shall be easily accessible, suitable for connecting cables without distortion or cramping. Terminals shall be suitable for pressure crimped or soldered lugs of a size appropriate to the rating of the set and giving full face contact with the cable lugs. Glands and gland mounting plates shall be detachable. Where terminal or cable boxes are arranged for single core cables they shall be non-ferrous or designed to eliminate eddy currents.
- (m) The final connection to the generator set shall be made utilising flexible cable, to allow for the movement of the engine/alternator assembly on the anti-vibration mounts, to minimise the transmission of vibration and prevent damage to the alternator or circuit breaker terminations.
- (n) The multi-core generator cables shall be terminated in a securely mounted cable termination box, isolated from the generator vibration. The final connection to the alternator or the set mounted circuit breaker enclosure shall be carried out utilizing single core flexible cable.
- (o) The cable connection should be mechanically protected where necessary and where cable tray is installed, it should not be rigidly connected to the generator set, allowing for the necessary movement and vibration.
- (p) The installation should also comply with the cable manufacturer's minimum bending radius for the specific cable being installed.
- (q) The cable shall be suitable for the output voltage and the rated current of the generator set, when sizing the flexible cables the designer shall take account of the ambient temperature of the generator room or acoustic enclosure, the selected method of installation, grouping factor with other cables, etc.

- (r) The installation of single core cables shall require the gland plates to be non-ferrous material such as aluminium or a non-metallic material such as tufnol.
- (s) All connections should be carefully checked for the integrity. Phase rotation should also be checked for compatibility with the installation.

E411900 STARTING SYSTEMS

- (a) The generators shall be provided with dual starting systems.
 - i) Dual electric
 - ii) Electric and separate air compressor
- (b) Where dual electric systems are provided the systems shall be fully independent of each other including separate batteries, chargers, controls and starter motors.
- (c) Each set of batteries shall be arranged on a non-corrodible spill proof tray or rack, isolated from harmful vibration. They shall be of the nickel-cadmium alkaline type and of sufficient capacity to crank the diesel engine above the minimum firing speed for 3 consecutive 10 second periods, which may be repeated at two-hourly intervals. In addition the batteries shall also supply the maximum demand from the control cubicle.
- (d) Batteries shall have not less than a 10-year life, under continuous maintenance charge conditions.
- (e) A constant current type battery charger shall be provided for each set of batteries, located in the control cubicle or on the set isolated from harmful vibration. They shall have sufficient capacity to maintain the charge of the batteries under all specified duties and during long periods of in-operation. Chargers shall be fitted with an ammeter to measure the charge and discharge current, except for the starter motor demand. Low battery indicators shall be provided in the main generator control panel.
- (f) Engines shall be capable of starting from any crankshaft position, using a 12 or 24 volt DC supply, by axial type starter motors engaging with the flywheel.
- (g) Starter motors shall disengage automatically when the engine starts or when de-energised and shall be easily accessible. Terminals shall be fitted with non-conducting protective shrouds.
- (h) Where air start equipment is utilised the assembly shall consist of the following components, a compressor, two receivers and the associated pipework.
- (i) The receivers shall each have a capacity of 200 litres, with a service pressure of 30 bar.
- (j) The compressor shall be a flat twin, two-stage type, with intermediary air cooling, designed for 40 bar maximum operating pressure. The start and stop functions, shall be controlled by a pressure switch, including a compressor pressure release valve. Compressor outlet separator and receiver shall be automatically drained by a cycle operated solenoid valve.
- (k) A connection manifold shall be provided to feed other air receivers.
- (l) The compressor shall be driven by a suitably rated 400-volt 3-phase motor. The supply for the motor shall be derived from the ancillary services panel.

- (m) The receivers shall be constructed of welded carbon steel internally epoxy painted. The design pressure shall be 33 bar, they shall be hydraulically tested to 50 bar and supplied with the test documentation.
- (n) Each receiver starting head shall include a relief valve, a dial pressure indicator and an output hand valve.
- (o) An engine driven, mobile compressor shall be provided for black start purposes. The compressor start shall be manual, using a rope starter on the engine; stop shall be automatic via a pressure switch and a pressure relief valve.

E412200 LOCAL CIRCUIT BREAKERS

- (a) Each generator set shall be provided with a local automatic circuit breaker of the correct current and voltage rating.
- (b) The circuit breaker shall be fully automatic and be provided with the required protection functions as noted on the schematics.
- (c) The circuit breaker shall disconnect the generator supply in the event of a lock out fault on the generator, alternator, cabling or the operation of the set or suite emergency power off system.
- (d) Cabling from the set circuit breaker shall be fitted with Type 1 surge arrestors.

E412500 PROTECTION

- (a) The Electrical Services Installer shall provide electrical protection relays for all necessary protection functions as detailed within the services description and schedules.
- (b) The protection functions may either be provided by specific relays on the local circuit breakers, paralleling circuit breakers for multi set systems or the electronic engine management and voltage regulation controller.
- (c) The Electrical Services Installer shall provide all necessary CT's, VT's at the circuit breaker, alternator and or paralleling panels in order to provide a complete protection scheme for the systems.

E412800 EMERGENCY POWER OFF

- (a) An emergency stop button shall be provided for each individual generator set or where in multi room in each generator room.
- (b) Operation of the button shall isolate the control circuits from the battery supply, fuel supply to the generator and stop and lock out the set.
- (c) Where the set provides power to a paralleling bar in a separate switchroom the emergency power off button in that switchroom if operated shall isolate the control circuits from the battery supply and stop and lock out all sets supplying the paralleling bar.

E413100 FUSIBLE LINK OR IN ROOM HEAT DETECTION

- (a) Fusible links and or fixed temperature heat detectors shall be provided above each generator.

- (b) They shall control fire valves to isolate the fuel supply and initiate the dump facility on the day tank.
- (c) They shall stop and lock out the generator.
- (d) The operation of fusible link or heat detector shall be monitored by the following systems:
 - i) Fire alarm system via an interface unit.
 - ii) Local fire protection system where fitted
 - iii) Generator control system
 - iv) Building Management System
 - v) Power Management System

E413400 DIESEL GENERATOR SET CONTROL**E413401 General**

- (a) The particular description of operation shall be as detailed in the services description.
- (b) The generator control system shall comprise:
 - i) Individual engine PLC control
 - ii) Generator system control for multi set systems
 - iii) High level interface to the following systems as noted within the services description
 - Power Management System
 - Energy Metering System
 - Building Management System
- (c) Load control operations shall be carried out in accordance with section E37 of the specification by the Power Management System.
- (d) The Electrical Services Installer shall ensure all control interfaces between the generator control system and Power Management System are fully coordinated including dual control of circuit breakers where required for paralleling purposes.

E413404 Individual Set Control

- (a) Each engine shall be provided with a dedicated PLC to monitor and control the generator.
- (b) Each engine shall be provided with a dedicated industrial class HMI screen providing interrogation of the generator parameters, real time alarms and event logs etc.
- (c) Where part of a multi set system the plc shall be of the same manufacture as the system PLC and shall be able to communicate directly to the system plc without a protocol interface.

- (d) Control equipment shall be designed to operate on an 'energise to run, de-energise to stop' basis and shall provide facilities to control the starting and stopping of the engine.
- (e) The equipment shall also provide automatic regulation of alternator voltage with fault identification and automatic engine shut down.
- (f) Control equipment shall be housed in a purpose built cubicle. Controls shall be mounted on a baseplate with anti-vibration mountings. The cubicle shall be totally enclosed, vermin-proof, drip-proof and dust-protected with adequate access for installation, maintenance and repair.
- (g) The cubicle shall contain all necessary equipment and instrumentation to start, operate, control, and stop the generating set.
- (h) A selector switch shall be fitted having three positions and providing the following facilities:
 - i) AUTO - The set shall start and stop automatically on mains failure
 - ii) MANUAL - The set shall start and stop by the operation of push-button(s) mounted on the control cubicle
 - iii) OFF - The set shall not be able to start
- (i) When the set is stopped, other than under lockout conditions it shall be self-resetting and ready for the next starting sequence.
- (j) Switches and push buttons shall be clearly marked to indicate their function and shall be located on the front face of the control cubicle.
- (k) Push buttons shall be of the impulse type with holding circuits to ensure completion of the selected function.
- (l) The STOP push-button shall be of the mushroom head type, coloured red, and prominently located.
- (m) An electronic multimeter shall be provided for each set on the individual control panel. The meter shall have the provision to monitor:
 - i) Phase and line voltage
 - ii) Line current
 - iii) Frequency
 - iv) Power KW
 - v) Reactive power KVAR
 - vi) Volt Amps KVA
 - vii) Power factor
 - viii) Frequency
- (n) The meter shall be capable of being repeated generator control system where this control panel is remote.

- (o) Each diesel generating shall be provided with the following indicators mounted on the control panel:
 - i) Emergency stop push button operated
 - ii) Failure to start
 - iii) High engine temperature
 - iv) Low oil pressure
 - v) Over-speed
 - vi) Over-current
 - vii) Alternator voltage low/high
 - viii) Alternator over temperature
 - ix) Earth fault/differential earth fault
 - x) Excitation failed
 - xi) Frequency/voltage error
 - xii) Reverse power
 - xiii) Low fuel alarm
 - xiv) Engine heaters on
 - xv) Battery chargers off/low battery voltage
 - xvi) Breaker available to close
 - xvii) Generator protection operated
 - xviii) Interfacing with exhaust after treatment controls
 - xix) Fuel oil delivery
- (p) Each shutdown fault indicator shall have additional remote indicating terminals to relay the indication to the Building Management System. A NORMAL/MUTE/RESET control switch shall be provided to permit fault alarms to be reset.
- (q) The set shall immediately stop and lockout to prevent further starting when:
 - i) The lubricating oil pressure falls to an unsafe condition
 - ii) Cooling water temperature exceeds a safe maximum
 - iii) The over speed trip has operated
 - iv) The circuit breaker has tripped on fault
 - v) The generator has failed to start
 - vi) Alternator voltage is low
 - vii) Alternator voltage is high
 - viii) High alternator stator temperature
 - ix) Alternator excitation has failed

- x) Reverse power has operated
- xi) Generator differential
- xii) Fail to synchronise
- xiii) Inadvertent closure circuit breaker with set at standstill
- xiv) Emergency stop push button has been pressed
- xv) Fire fusible link has operated
- xvi) Over current on the stator
- xvii) Earth fault on the stator winding (Note 100% of stator winding to be monitored)
- xviii) Failure of neutral earthing resistor where fitted
- (r) Alarms and lockout systems shall not operate during normal starting and shut down procedures.
- (s) Individual indicator lamps shall be illuminated by the operation of any lockout and the lamp shall remain illuminated until the fault condition has been rectified. A lamp test switch or push-button shall be provided and biased to the NORMAL position. Operation of the switch or push-button shall illuminate the indicator lamp.

E413700 SUPPLIES TO PARASITIC LOADS AND ANCILLARY SERVICES

- (a) The Electrical Services Installer shall supply and install all electrical supplies to the generator ancillary equipment including but not limited to the following:
 - i) Local ambient heating
 - ii) Battery chargers
 - iii) Heating jackets
 - iv) Control panels
 - v) Local lighting and power
- (b) Supplies shall be derived from a distribution board or panel supported via an automatic transfer switch which will derive supplies from the normal main supply and generator supply.
- (c) The ATS shall be monitored by the generator control system.
- (d) The generator room shall be provided with lighting, emergency lighting and small power supplies to allow safe maintenance of the generator sets and associated control panels and switchgear.

E414000 EARTHING

- (a) The generator installations shall be effectively earthed in accordance with BS 7430 and BS 7671.
- (b) Generator star points shall be taken to earth either directly or via neutral earthing switchgear, resistors or transformers.

- (c) Metalwork housing electrical equipment shall be bonded to a brass-earthing terminal of not less than BS 3692 ISO bolt M10 size in an easily accessible position on the base plate. The generating set shall be installed with an independent earth path in accordance with British Standard BS 7430. The neutral earth link shall be located at the generator switchboard and the generator circuit breaking shall be TP & N to provide a solid neutral path to the neutral earth point.
- (d) Where restricted earth fault protection is specified, the generator manufacturer shall provide clear details as to the location and operation of the equipment to be provided.

E414600 ACOUSTICS**E414601 General**

- (a) Attenuators, anti-vibration mounts and flexible couplings shall be installed to ensure that the noise levels within and external to the building meet with the specified levels required by the Acoustic Consultant
- (b) The Electrical Services Installer shall ensure that:
 - i) Attenuators are installed in air systems with due allowance made for the static pressure loss, ease of maintenance and replacement
 - ii) Acoustic screens, panels and enclosures are provided where noise generated by the generator installation and its associated equipment causes external noise levels to exceed those specified
 - iii) Acoustic louvres are provided where specified or where necessary to meet the external noise level specified
 - iv) Anti-vibration mounts/hangers are installed to eliminate all vibration from the structure
 - v) Any other measures necessary to meet the requirements of the specification are carried out
- (c) The noise produced by the generator and its associated equipment shall be acoustically treated such that noise levels in the occupied spaces do not exceed those specified.
- (d) The noise produced by the generator and its associated equipment shall be acoustically treated such that external noise levels do not exceed those specified for the external receptors.
- (e) Noise level information for all items of plant, based on octave band analysis data, shall be supplied to the Engineer. This data shall be in the same format/parameter type as used in the specification. The reference level and the testing technique shall be stated.

E414604 Attenuators

- (a) Casings shall be manufactured from 0.8 mm thick galvanised sheet steel to BS EN 10346 continuously lock-formed and mastic sealed.
- (b) Splitters shall be constructed from not less than 0.8 mm perforated galvanised sheet metal complying with BS EN 10346 incorporating aerodynamic leading and trailing edges (not square edges).

- (c) Locating and stiffening members shall be not less than 0.8 mm thick galvanised sheet metal.
- (d) Attenuators shall have a regular splitter/airway dimension across the width, with a half width splitter fixed to each side wall of the casing. The composite splitter(s) shall be secured to the casing by electrolytically compatible rivets located in such a manner as to prevent their ingress into the air stream in the event of a mechanical fastener failure. The splitter(s) shall be secure regardless of vertical or horizontal location. Preferably the splitters shall be arranged vertically, however where arranged horizontally, splitters should be stiffened to prevent flexing.
- (e) Splitter infill materials shall be of inorganic mineral or glass fibre of a density sufficient to obtain the specified acoustic performance and packed under not less than 5% compression to eliminate voids due to vibration and settling. Materials shall be inert, vermin and moisture proof. All internal surfaces shall be sealed against fibre release.
- (f) Combustion rating for the silencer acoustic fill shall not be less than the following when tested in accordance with ASTM E84, HFWA standard 255 or UL No 723.
 - i) Flame spread classification - 20
 - ii) Smoke development rating - 20
- (g) Attenuator ratings shall be determined in accordance with BS EN ISO 7235. Acoustic ratings shall include Dynamic Insertion Loss and Self-Noise Power Levels at the required face velocity.
- (h) Static pressure loss of silencers shall not exceed those specified at the required airflow. Airflow measurements shall be made in accordance with applicable portions of ABMI, AMCA, BS and ADC airflow test codes.
- (i) Attenuators shall be sealed at both ends when delivered to site so as to prevent the ingress of site materials and damage to splitters.

E414607 Acoustic Enclosures

- (a) Acoustic enclosures and screens shall provide, in-situ, minimum sound reduction indices (SRIs) sufficient to meet the specification requirements and Acoustic Consultants report.
- (b) The in-situ sound reduction index shall include any loss of performance due to doors, windows, joints and ventilation openings etc.
- (c) Acoustic screens shall be constructed from double skinned acoustic panels suitable for external applications. The outer skin of the panels shall be manufactured from not less than 1.25 mm zinc coated mild steel and the inner surface not less than 0.8 mm galvanised perforated mild steel having a free area of at least 23%.
- (d) Infill materials shall be of inorganic mineral or glass fibre of a density sufficient to obtain the specified acoustic performance and packed under not less than 5% compression to eliminate voids due to vibration and settling. The infill materials shall be faced with a protective membrane to prevent fibre migration.
- (e) The panels shall be structurally self-supporting to withstand site conditions, without additional stiffening. All steelwork shall be provided by the specialist manufacturer and be galvanised after manufacture.

E414610 Internal Acoustic Lining

- (a) Where it is not possible to achieve sufficient insertion loss due to restrictions on silencer lengths or the like, the intake and exhaust ductwork and generator room shall be acoustically lined internally.
- (b) The lining shall be mineral wool quilt faced with a woven glass cloth to prevent fibre release. It shall be secured to the inner surfaces of ductwork and builders work shafts or plant room using lagging pins and suitable adhesives at no more than 300 mm centres.
- (c) Where used as a plant room lining, the mineral wool quilt shall also be faced with perforated metal sheet with a minimum free area of 23%.
- (d) Edges and joints shall be protected to prevent the lining lifting due to the action of the airflow.

E414613 Acoustic Doors

- (a) All acoustic doors shall provide minimum, Sound Reduction Indices (SRIs) equivalent to or greater than that stated in the specification. The SRIs of the acoustic door shall be determined in accordance with BS EN ISO 10140-2.
- (b) The supplier or manufacturer shall guarantee that the method of installation does not reduce the stated SRI the acoustic door.
- (c) The doors shall be constructed of either hardwood or steel, complete with all seals, frames and furniture.
- (d) Wipe/drag seals will not be permitted at thresholds.

E414616 Acoustic Louvres

- (a) All louvres shall provide, in-situ, minimum sound reduction indices (SRIs) to meet the specification requirements, when tested in accordance with BS EN ISO 10140-2. In addition the static pressure loss of the louvre shall not exceed those specified at the required airflow.
- (b) Acoustic louvres shall be of the weather resistant type. Where indicated they shall be located behind an architectural louvre.
- (c) The louvre frame shall be constructed from galvanised sheet steel not less than 1.2 mm thick, supporting louvre blades constructed from galvanised mild steel not less than 0.7 mm thick. The blades shall be of an aerofoil or similar configuration, and shall have a perforated lower and solid upper face.
- (d) The acoustic infill within the blades shall consist of inert, rot and vermin proof, non-hygroscopic mineral wool or glass fibre of a density sufficient to achieve the stated acoustic performance, packed to a minimum of 5% compression so as to eliminate voids due to settling.
- (e) Acoustic louvres shall be supplied with an integral bird screen of galvanised mild steel or aluminium mesh, fixed to its internal face. The mesh pitch shall be no more than 15 mm x 15 mm square grid.

- (f) The louvres shall be supplied complete with all necessary fixings, flanged, etc. for fitting into the builders work or other suitable opening or support frame.
- (g) All gaps between the outside of the louvre frame and the wall or duct shall be made good and sealed with heavy grout and/or dense non-hardening mastic.

E414619 Anti-Vibration Mountings General

- (a) All plant and associated ductwork/pipework shall be isolated from the building structure by means of anti-vibration mountings/hangers where indicated and where required to meet the requirements of the specification and acoustic consultant's report.
- (b) All anti-vibration mountings shall be supplied and fixed by the Electrical Services Installer.
- (c) The Electrical Services Installer is responsible for ensuring that all anti-vibration mountings/hangers supplied are suitable for on-site loads and conditions (operating and environmental). Mountings/hangers exposed to atmospheric conditions shall be non-corrosive.
- (d) All anti-vibration mountings/hangers shall be selected to achieve the specified minimum static deflection, where applicable, under equipment weight. It is the responsibility of the Electrical Services Installer to ensure that mounting/hanger selection allows for uneven load distribution and any torque reaction, hence the minimum specified static deflection must be achieved by all mounts/hangers under normal plant operation.
- (e) All mountings shall be colour coded in accordance with BS EN 15800/BS 1726-1 to enable easy identification during installation.
- (f) Where required a restraining device must be incorporated into anti-vibration mountings/hangers. This shall be designed to prevent movement of equipment if its load changes. The restraining device shall be designed so as not to cause any reduction in isolation efficiency of the mountings/hangers during normal operating conditions.
- (g) Where equipment is mounted on anti-vibration mounts pipework and ductwork connections shall not be rigid. Flexible couplings or connections shall be installed.

E414622 Steel Equipment Bases

- (a) Steel frame equipment bases shall be made sufficiently rigid to enable permanent equipment alignment and support, and adequately stiff to prevent resonance's at operating frequencies of supported equipment.
- (b) Anti-vibration rails shall be constructed of steel beams of sufficient strength to avoid deflection, which would strain the equipment supported. Height saving support brackets shall be incorporated at each end of the rail.
- (c) Support bases shall be a steel framework of all welded construction of sufficient strength to support the plant without deflection. The frame shall have a depth of 0.1 times the longest dimension of the supported plant and not less than 150 mm.

E414625 Concrete Inertia Bases (when used in conjunction with steel springs)

- (a) Concrete inertia bases shall be formed from steel beam shuttering with perimeter beams having a depth of not less than $\frac{1}{12}$ the largest dimension of the base of 150 mm (whichever is the greater). The bottom of the frame shall be blanked off, and concrete (min. 2300 kg/m³) poured in over steel reinforcing. This reinforcing should consist of 13 mm diameter bars welded on 150 mm centres running cross-batch in a layer 35 mm above the bottom of the base and no greater than 300 mm, or as specified by the Structural Engineer.
- (b) The inertia base shall be sufficiently large to provide support for all parts of the equipment base, such as suction and discharge elbows on centrifugal pumps. Unless otherwise specified in the schedules, the weight of the base shall be twice that of the supported equipment, and the included angle between the mounting positions and overall centre of gravity should be no less than 60 °.
- (c) Alternative constructions should be issued to the Structural Engineer and Engineer for approval.

E414628 Concrete Inertia Bases (when used in conjunction with neoprene mounts/pads)

- (a) Concrete inertia bases shall be formed from steel beam shuttering with perimeter beams having a depth of not less than $\frac{1}{12}$ the largest dimension of the base or 150 mm (whichever is greater). The bottom of the frame shall be blanked off, and concrete (minimum density 2300 kg/m³) poured in over steel reinforcing. This reinforcing should consist of 13 mm diameter bars welded on 150 mm centres running cross-batch in a layer 35 mm above the bottom of the base and no greater than 300 mm, or as specified by the Structural Engineer.
- (b) The inertia base shall be sufficiently large to provide support for all parts of the equipment base, such as suction and discharge elbows on centrifugal pumps. Unless otherwise specified in the schedules, the weight of the base shall be twice that of the supported equipment, and the included angle between the mounting positions and overall centre of gravity should be no less than 60 °.
- (c) The inertia base should be supported on the specified neoprene mounts or pads, the whole resting on a plinth as required. The construction of bases on cork, expanded polystyrene or mineral wool slabs is not permitted. Where neoprene pads are used, small areas of pads must be equally spaced to provide the correct static deflection. The numbers, locations and sizes of pads should be advised by the supplier.
- (d) Alternative constructions should be issued to the Structural Engineer and Engineer for approval.

E414631 Pipework Flexible Connections

- (a) Water serviced plant isolated by vibration control equipment must be equipped with flexible pipe connections which are able to flex and thereby maintain de-coupling from the structure and minimise stress to pipework.
- (b) Flexible hose pipe couplings must be installed to flex transversely and therefore flexible pipe couplings shall be installed horizontally and parallel to the rotating shafts of the plant.

- (c) Flexible pipework connections shall be of rubber and butyl construction, with integral full faced rubber and butyl flanges. They shall be internally steel wire reinforced and be complete with steel retaining rings.
- (d) Rods and control cables shall be fitted to prevent excessive elongation and must be out of rigid contact or slack during normal operation.
- (e) The Electrical Services Installer shall ensure that the pipe connections proposed are capable of withstanding the system operating temperatures and pressures.

E414634 Ductwork Flexible Connections

- (a) All ductwork connections to fans and air handling units shall be flexible.
- (b) Flexible connections shall be manufactured from high grade woven fire-resisting cloth with an impermeable coating applied by vacuum diffusion, and a minimum superficial density of 5 kg/m².
- (c) A minimum distance of 50 mm shall be allowed between faces to be bridged by the flexible connection.
- (d) The connection shall be made by clamping the entire perimeter of both ends of the flexible element, the connection shall be straight but not rigid so as to ensure excess material allows for relative motion to arise without being arrested by tension in the connection.
- (e) The flexible connection shall be installed in such a way as to avoid impeding air flow or causing turbulence.
- (f) An earthing strap shall be provided across each flexible connection to provide electrical bonding. This shall be arranged to avoid fracture or vibration leading to fracture. It shall be labelled 'Safety Earth - Do Not Remove'.

E414900 EXHAUST SYSTEMS**E414901 General**

- (a) An exhaust system shall be provided on each set, including an exhaust silencer(s) and stainless steel expansion bellows with BS flanged or BSP screwed ends. Gaskets, joints and fixings to provide a gas tight system shall be provided.
- (b) The engine manufacturer's recommendations for exhaust system design to conform to the noise limitation requirements set out in the Acoustic Engineers Report shall be provided.
- (c) Details of sound power levels in dB for each octave from 63Hz to 8kHz shall be submitted to the Engineer. Typical readings given at the design stage shall be confirmed at the works test. Sound power levels shall be with the generator running at full load for the following conditions:
 - i) Generator assembly, excluding exhaust
 - ii) Exhaust noise without silencer
 - iii) Exhaust noise with silencer and no attenuation

E414904 Flues

- (a) Each generator shall be provided with an exhaust flue system from the generator exhaust outlet to atmosphere.
- (b) Final connection to generator exhausts shall be purpose made as necessary to suit the application. Where single skin construction is used for the final connection it shall be manufactured by welding from mild steel plate with a minimum thickness of 6 mm. The connections shall be insulated to reduce the surface temperature to 70 °C at full engine load. Tappings shall be provided on each connection for exhaust gas temperature indication and flue gas analysis.
- (c) Flue systems operating at positive pressure shall be constructed of stainless steel in a twin wall formation suitable for a working pressure of 15kPa. The liner wall shall be constructed from grade 316 stainless steel sheet with a minimum thickness of 1 mm. The outer shall be constructed of grade 304 stainless steel sheet with a minimum thickness of 0.8 mm. The annulus shall be insulated with mineral fibre insulation.
- (d) Flues shall be constructed in sections with butt joints held by bolted clamping rings over the inner skin with the manufacturer's sealant applied. The outer band shall be sealed with the manufacturer's sealant and the band bolted tight. The inner lining shall be the structural bearing component. The expansion of the flue shall be accommodated by the provision of bellows.
- (e) Exhaust flues shall be installed and supported in accordance with the manufacturer's recommendations. Adequate provision shall be made for movement due to thermal expansion. Externally mounted sections shall be braced or secured to provide adequate wind resistance.
- (f) A mild steel sleeve with a minimum thickness of 5 mm shall be provided wherever the flue passes through the structure. The sleeve shall be 25 mm greater in diameter than the flue to allow for sealing and fire stop provision and shall project 50 mm on each side of the structure. An insulated stainless steel apron shall be provided at roof level, dressed around the flues, arranged to overhang a builder's work curb and prevent the ingress of moisture.
- (g) Flues shall be tested for air-tightness on completion.
- (h) Access doors or hatches shall be provided at the base of each flue and at bellows for inspection and cleaning.
- (i) A copper condensate drain shall be connected to a condensate collection boss, provided at the base of each flue. It shall be run to drain with a suitable sized trap.

E416400 HEAT REJECTION**E416401 General**

- (a) Generator cooling systems shall be defined within the services description and will comprise one of the following systems:
 - i) Direct close coupled set mounted radiators with mechanical or electrically driven cooling fans

E416404 Close Coupled Radiators

- (a) Each engine shall be provided with a water cooling system comprising water pump, radiator and piping.
- (b) The cooling system shall also provide a thermostatically controlled electrically heated, water jacket as part of the engine cold start system.
- (c) Cooling system pumps may be engine driven.
- (d) The radiator shall be arranged for engine mounting on the main base frame forming a complete package.
- (e) The radiator shall be force cooled via a fan, which may be either mechanically driven or electrically driven. The fan shall be capable of operating against the resistance of the radiator, plenum, attenuation and louvres.
- (f) Where specified in the services description the fan may also be required to produce flue dilution of the exhaust gasses.
- (g) The cooling system shall be adequate for the engine when running on continuous full load and where Prime Rated sets are provided it shall be capable of handling a 10% overload for at least one hour.
- (h) Water systems shall be provided with suitable anti-freeze as recommended by the manufacturer in order to protect all components of the system should the thermostatically controlled heating of the jacket water system fail.

E417000 FACILITIES FOR POST COMPLETION LOAD TESTING**E417001 General**

- (a) Where specified in the services description the Electrical Services Installer shall provide facilities for the ongoing maintenance and testing of generators via either:
 - i) Temporary load bank connection point
 - ii) Permanent load bank installation
- (b) The Electrical Services Installer shall include all necessary power and control cabling as required.

E417004 Temporary Load Bank Connection Point

- (a) Where specified in the services description the Electrical Services Installer shall provide a connection point for an external temporary load bank.
- (b) The connection point shall be suitable for the voltage and duty of the generator system.
- (c) The connection point shall be located as indicated on the contract drawings. Where the connection point is not in its own dedicated room the Electrical Services Installer shall provide any necessary protection around the panel.
- (d) The connection panel shall be constructed for installation externally with a minimum design life of 20 years.
- (e) The connection point shall comprise the following sections:

- i) Incoming automatic circuit breaker
 - ii) Incoming cable chamber - Suitable for either cable or bus bar as noted on the schedules.
 - iii) Protection relay with CT's to protect the temporary cables to the load bank.
 - iv) Digital meter
 - v) Panel mounted emergency power off button which should isolate the local circuit breaker and the connection point feeder breaker.
 - vi) Outgoing cable connection chamber with lockable door and vermin proof cable entry point
- (f) The generator control system shall be configured such that if a 'generator start' signal is received from any of the monitored inputs the incoming circuit breaker shall be isolated allowing the generators to take up the building load.

E417300 GENERATOR SET TESTING**E417301 General**

- (a) Generator sets shall be tested as required by the appropriate British Standards. Tests shall comply with the Inspection, testing and commissioning section of this specification and to the requirements described in the succeeding paragraphs.
- (b) During all tests the required measurements shall be recorded and compared with the requirements of this specification or the agreed performance agreed with the set manufacturer. Any deviation from these conditions shall be referred to the set manufacturer for rectification and the set retested.

E417304 Works Tests

- (a) Copies of type test certification shall be provided for the equipment to be supplied. The documentation shall include the detailed method statements for both the proposed factory witness tests and the site certification tests.
- (b) The equipment shall be subjected to routine tests at the manufacturer's works in accordance with the agreed method statements and the appropriate British Standards. Where the sets are to be enclosed within acoustic enclosures, the tests shall be carried out with the sets installed within their containers. The tests shall be witnessed by the Engineer if required and shall include the following as a minimum:
 - i) Visual inspection
 - ii) Check plant build-up against specification
 - iii) Record reference and rating data
 - iv) Preliminary starting and running checks/adjustments
 - v) Performance tests (initial set up checks)
 - vi) Load acceptance tests
 - vii) Governing and voltage regulation (cold conditions)

- viii) Load duration tests with detailed examination of the sets immediately following hot shutdown
 - ix) Governing and voltage regulation (hot conditions)
 - x) Transient switching tests
 - xi) Insulation resistance tests
 - xii) The standard tests and type tests listed in the Chartered Institution of Building Services Engineers Application Manual AM8
 - xiii) Acoustic performance tests
 - xiv) Proving of Building Management System and outgoing volt free contacts
 - xv) Parallel operation for multi set installations, including synchronisation and load sharing/shedding
- (c) The performance tests shall be carried out on a load bank capable of providing a power factor of 0.8 lagging. Each machine shall be tested at 100% load for a minimum of 6 hours, plus 110% overload for 1 hour. The seven hours of load testing shall be continuous for each set. The maximum step load performance of the sets shall also be demonstrated, this shall be as a minimum single step of 55% of full set capacity applied in one hit.
- (d) The Engineer may inspect the equipment at any stage of manufacture and witness tests. The Electrical Services Installer shall give the Engineer reasonable notice of the manufacturing and test programme to enable these inspections to be made.
- (e) On completion of the tests the manufacturer shall issue certificates, including copies of the test data and type test certificate to the Engineer for comment prior to delivering the set.

E417307 Site Tests

- (a) Following the erection of the equipment on site and the completion of the installation works to the satisfaction of the Engineer, including the fuel, cooling, exhaust, electrical and safety systems, the Electrical Services Installer shall carry out the following tests:
- i) Visual inspection
 - ii) Check reference and rating data with that of the work test
 - iii) Performance tests (initial set up checks)
 - iv) Load acceptance tests
 - v) Load duration tests with detailed examination of sets immediately following hot shutdown
 - vi) Acoustic performance tests
 - vii) Proving of Building Management System and outgoing volt free contacts
 - viii) Parallel operation for multiset installation including synchronization and load sharing/shedding. Where sets are load sharing, they shall equally carry the load between them within 5% of each other

- (b) Where available and adequate, the buildings electrical distribution may be used to provide a suitable load. Otherwise a suitably rated load bank multi stage capable of providing at least 110% of the rated output at a load power factor of 0.8 lagging shall be provided by the generating set manufacturer. The load bank shall be in such sections as will permit the part load tests to be carried out.
- (c) The set shall be started and run at the rated load and checked for output voltage, frequency and phase rotation, synchronisation, load acceptance and load sharing/shedding. The safety and protective devices shall be checked for proper operation. Engine temperatures, pressures, voltage and frequency shall be recorded.
- (d) The external supplies shall be disconnected and the sets performance shall be monitored in respect of load connection stages, times, voltages and frequencies shall be monitored to ensure compliance with this specification.
- (e) The set shall be subjected to a continuous run test at 100% of the rated load, with a minimum period of four hours during which the set temperatures, pressures, voltage and frequency readings shall be monitored at regular intervals. At the end of this period the set shall be run at 110% of the full rated load for one hour with the above parameters monitored.
- (f) In addition, the set shall be run at 25%, 50% and 75% of full load. The engine governor and alternator AVR steady state and transient switching performance shall be measured for load on, load off, from no load and as load increments. The tests shall include the application of the maximum step load as specified elsewhere.
- (g) During the test noise level readings shall be taken to ensure that the set is performing within the acoustic requirements of this specification. Any requirements of the Environmental Health Officer shall also be checked.
- (h) Multi-set installations shall be commissioned to demonstrate synchronisation with any combination of sets available and where specified elsewhere in parallel with the electricity supply authority. The Electrical Services Installer shall make all necessary arrangements with the supply authority for the witnessing of the load test and this shall include the demonstration of the G99 protection elements. The local and remote controls, emergency stop, protection devices and interlocking systems shall be demonstrated to the satisfaction of the Engineer. This shall include full functionality of the load shed or priority systems, PLC systems where specified and any interlock systems with the MV or LV switchgear.
- (i) Where the generator set is intended to supply power to large induction machines such as chiller motors, it shall be demonstrated that the generator is capable of starting the equipment.
- (j) The above tests shall be carried out as required by the CIBSE Application Manual AM8 and the data required by the manual shall be recorded. Copies of the data shall be sent to the Engineer for comment. Final copies shall be incorporated in the operating and maintenance instructions.
- (k) The Electrical Services Installer and Generator Manufacturer shall include for attendance and co-ordination with other package supplies during an integrated building test. Two days shall be allowed for these tests.

E417310 Information Plates

- (a) Information plates shall be fixed on the equipment enclosure and, where appropriate, the motor alternator unit giving the following information:
- i) Continuous Output - kW KVA
 - ii) Voltage V - phase wire
 - iii) Frequency - Hz
 - iv) Makers name
 - v) Makers serial number
 - vi) Makers contact number
 - vii) Year of supply
 - viii) Total weight

E417313 Drawings

- (a) Certified drawings shall be provided, showing a general arrangement of the equipment with details of cable terminations, control wiring and all associated trenches and ducts required for the proper installation of the equipment. Principal weights and dimensions of the equipment shall be shown. Drawings shall comply with the requirements of the Drawings and Documentation section of this specification.
- (b) Where applicable a general arrangement of the motor alternator, showing terminal markings, polarity, phase rotation and giving principal dimensions and weights shall be provided. A general arrangement of the starting battery shall be provided showing cable terminations and principal dimensions and weights. Battery ventilation requirements shall also be shown.

E44 PHOTOVOLTAIC SYSTEMS

E440100 GENERAL

E440101 Scope

- (a) The Electrical Services Installer shall employ a specialist to design, install, commission and set to work a complete photovoltaic system for the development including but not limited to:
- i) Solar PV modules either
 - Standard modules frame mounted
 - Roof tile module
 - Bespoke building integrated modules
 - ii) Module mounting frames and supports
 - iii) Inverters
 - iv) Power optimisers
 - v) Isolators (AC and DC)
 - vi) Combiner boxes
 - vii) G98/99 protection relays
 - viii) Over current and earth fault protection
 - ix) Surge protection devices
 - x) Cabling and containment systems
 - xi) Metering
 - xii) Earthing and lightning protection
- (b) Specific requirements shall be as set out within the scope of works.

E440104 Standards

- (a) The system components and installations shall comply with the relevant British and International Standards and Engineering Recommendations current at the time of installation including:
- i) BS 7671 - IET Wiring Regulations
 - ii) IET Code of Practice for Grid Connected Solar Photovoltaic Systems
 - iii) Energy Networks Association Engineering Recommendations G99 (G59) Recommendations for the Connection of Generating Plant to the Distribution Systems of Licensed **Distribution Network Operator / Independent Distribution Network Operator / Independent Connection Provider**.

- iv) Energy Networks Association Engineering Recommendations G98 (G83) Recommendations for the Connection of Type Tested Small-scale Embedded Generators (Up to 16A per Phase) in Parallel with Low-Voltage Distribution Systems
- v) Energy Networks Association Engineering Recommendations G5 Harmonic Voltage Distortion and the Connection of Non-Linear and Resonant Plant and Equipment to Transmission Systems and Distribution Networks in the United Kingdom
- vi) BS EN 61215-1-1 Terrestrial photovoltaic (PV) modules. Design qualification and type approval. Special requirements for testing of crystalline silicon photovoltaic (PV) Modules
- vii) BS EN 61646-1-3 Terrestrial photovoltaic (PV) modules. Design qualification and type approval. Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules
- viii) BS EN IEC 61730-1 Photovoltaic (PV) module safety qualification. Requirements for construction
- ix) BS EN 62109-1 Safety of power converters for use in photovoltaic power systems. General requirements
- x) BS EN 62109-2 Safety of power converters for use in photovoltaic power systems. Particular Requirements for Inverters
- xi) BS EN 50178 & BS EN 62477 Safety requirements for power electronic converter systems and equipment. General
- xii) BS EN 61724-1 Photovoltaic system performance. Monitoring
- xiii) IEC 62804 Photovoltaic (PV) modules. Test methods for the detection of potential-induced degradation. Crystalline silicon
- xiv) IEC 62930 Electric cables for photovoltaic systems with a voltage rating of 1.5 kV DC.
- xv) BS EN 62446 Photovoltaic (PV) systems. Requirements for testing, documentation and maintenance. Grid connected systems. Documentation, commissioning tests and inspection
- xvi) BS EN 62305 Protection Against Lightning
- (b) Harmonic distortion fed into the LV distribution system by the equipment shall be limited to a level that is below British Standard tolerances for normal operation of equipment, does not cause incorrect operation of switchgear or control systems and is within Energy Networks Association Recommendation G5.

E440107 Liaison with Distribution Network Operator / Independent Distribution Network Operator / Independent Connection Provider and Connection to the Grid

- (a) The Electrical Services Installer shall make all necessary applications for the connection of the distributed generation plant in accordance with G98 or G99 dependent on the size of the installation to the incumbent **Distribution Network Operator / Independent Distribution Network Operator / Independent Connection Provider.**

- (b) The Electrical Services Installer shall pay all necessary costs for the initial application and reimburse the **Distribution Network Operator / Independent Distribution Network Operator / Independent Connection Provider** for any inspections and or testing of the installations prior to energisation of the system and its parallel operation with the grid.
- (c) The Electrical Services Installer shall provide all necessary protection relays at the point of connection to comply with the requirements of G98 or G99 dependent on the size of the installation and any additional recommendations of the incumbent **Distribution Network Operator / Independent Distribution Network Operator / Independent Connection Provider**.
- (d) Any operation of the protection relay shall automatically disconnect the PV system from the electrical distribution network.

E440110 Warranties

- (a) The Electrical Services Installer shall provide the following component and system warranties:
- (b) Module performance warranty for a minimum of 25 years (note that where bespoke building integrated PV modules are provided the warranties are to be provided by the Façade Contractor)
- (c) Inverter warranty for a minimum of 10 years
- (d) Installation warranty in accordance with the contract particulars
- (e) Where noted within the scope of works, the Electrical Services Installer shall provide a performance/yield guarantee.

E440400 PHOTOVOLTAIC SYSTEM PERFORMANCE ESTIMATION AND EVALUATION

- (a) The PV specialist shall carry out an initial performance estimation of the system to ensure that required stated outputs noted within the scope of works or the developments energy strategy can be met for the life of the installation.
- (b) The evaluation shall include all necessary information and noted assumptions including but not limited to:
 - i) Module Information including any maintenance and degradation factors applied.
 - ii) Inverter information including any maintenance and degradation factors applied.
 - iii) Nominal array power used in calculations
 - iv) Orientation and pitch used in calculations
 - v) Site location
 - vi) Details of the irradiance files used (including the source of the data and the geographic location the irradiance data is based)
 - vii) Shading data and calculations including a description of both near and far shading and its effect on annual output of the array.

- viii) Financial payback calculations shall include all necessary assumptions such as interest rates and inflation rates etc.
- (c) Specific modelling may be required under an approved scheme, (for example Microgeneration Certification Scheme) this will be noted within the scope of works.

E440700 SYSTEM DESIGN AND INSTALLATION

E440701 General

- (a) The Electrical Services Installer shall be responsible for developing the design intent into a full design for the photovoltaic systems.
- (b) The design shall include:
 - i) Layout of all modules including orientation, pitch, spacing for safe access and maintenance
 - ii) Design of dc distribution
 - iii) Design of ac distribution up to the point of connection, including all protection
 - iv) Inverter selection
 - v) Isolation and switching including where required emergency switching
 - vi) Integration with energy storage systems where specified (refer to section E50)
 - vii) Earthing, lightning protection and surge protection
- (c) The Electrical Services Installer shall design the system to meet and or better the performance criteria noted within the project Energy Strategy and specification scope of works.
- (d) The Electrical Services Installer shall be registered under the 'Microgeneration Certification Scheme' (MCS) to ensure the installation provided shall be able to qualify for the Feed in Tariff (FIT) scheme.

E440704 Photovoltaic Modules

- (a) Unless the development benefits from bespoke building integrated PV modules as part of the Façade or building fabric the Electrical Services Installer shall supply all necessary modules, support frames and fixings.
- (b) Standard modules shall be crystalline silicon to BS EN 61215.
- (c) Where integrated into a glazed façade or roofing tile system the modules shall be thin film to BS EN 61646. Unless otherwise noted within the scope of works such systems will be provided by others with the Electrical Services Installer providing all installations from the module connectors to the point of connection to the grid.
- (d) All PV modules shall be Class A in accordance with BS EN IEC 61730.

E440707 Layout, Orientation and Pitch

- (a) The Electrical Services Installer shall review the design intent indicated on the services and architectural layouts and develop the full design to maximise the performance of

the array whilst maintaining good access for maintenance and ensuring that the layout conforms to any planning restrictions or limitations.

- (b) The array shall wherever possible, given the limitations of the development, be oriented to give maximum performance avoiding near, far and inter-row shading.
- (c) Pitch should generally allow for self-cleaning of the modules by rainfall.
- (d) Layouts shall take account of access requirements for maintenance of the Photovoltaic modules and other roof mounted services including rainwater drainage.
- (e) Modules, mounting frames and their fixing to the structure shall take into account any necessary snow loading and the effects of wind on the array.

E440710 DC System Design

- (a) The Electrical Services Installer shall develop the full design of the dc system to collect energy from the array to the inverters to ensure a safe system in terms of both personnel operating at the roof and within the array and also the prevention of fire.
- (b) The system shall comprise of multiple strings of photovoltaic modules connected to inverters utilising combiner boxes.
- (c) Each PV string shall be suitably protected against overcurrent and where sub arrays are connected prior to an inverter sub array overcurrent protection shall be provided with selectivity between the string and sub array protection.
- (d) Strings and sub arrays shall be capable of being individually isolated for maintenance purposes, and each inverter shall be provided with a dc switch disconnecter in accordance with BS EN 60947-1, BS EN 60947-3 and the Building Research Establishment's report: DC Isolators for Photovoltaic Systems.
- (e) Disconnectors shall isolate all live conductors and be rated to interrupt current flow in either direction.
- (f) Where multiple inverters are provided the sub array dc isolators shall be interlinked for the purposes of emergency switching in order to disconnect the full dc supply from the network.
- (g) Plug and sockets utilised for the connection of dc modules to the distribution system shall comply with BS EN 50521 connectors for photovoltaic systems.
- (h) DC cabling shall be selected for the maximum dc voltage and currents taking into account any necessary derating factors applied including environmental factors.
- (i) DC cabling shall be suitable for operating temperatures of 90 °C and shall comply with BS EN 50618 Electric Cables for photovoltaic systems and IEC 62930.
- (j) All PV String cables shall be suitable for a maximum voltage or 1.5kV and shall be double insulated.
- (k) All string and array cabling shall be installed on cable trays suitable for the environment in which they are installed.
- (l) On larger systems consideration shall be given to sub array earth fault monitoring and protection with selectivity to the protection provided to the array at the inverter, where earth fault monitors are utilised to provide an alarm prior to disconnection the alarms shall be displayed at the head end monitoring system.

- (m) In consultation with the local Fire Officer and or Building Control a remote fireman's switch may be required in order to isolate the system. The switch shall be located within the Fire Control Centre or other appointed location.
- (n) Additional warning labels at all point of connection that parts inside may still be live after isolation for the electrical network.

E440713 Inverters

- (a) Inverters shall comply with BS EN 62109 Safety of Power Converters for use in Photovoltaic Systems and or BS EN 62477 Electronic Equipment for use in Power Installations.
- (b) Inverters shall be type tested in accordance with either ENA G98 or EN G99 dependent on size of the system.
- (c) Domestic system shall be provided with single phase inverters up to a maximum size of 4kW unless otherwise specified.
- (d) Commercial inverters shall take the form either multi string three phase inverters with loading between 5-75kW or for large systems >1000kW centralised inverters.
- (e) The inverters shall synchronise the converted dc output with the grid voltage and frequency and switch off if the voltage or frequency go outside the agreed limits or in the vent of disconnection from the grid.
- (f) Inverters shall be sized in order to maximise the system efficiency taking into account the voltage range and inverter array power ratio whilst also considering life expectancy of the inverters.
- (g) Inverters shall monitor the dc circuits for earth fault and isolation faults.
- (h) Inverters shall be provided with dc arc fault detection such that a series or parallel arc can be detected. In the instance of a serial fault an alarm shall be raised on the monitoring system and the inverter shut down. On detection of a parallel fault a critical alarm shall be raised on the Monitoring System such that a specialist may be alerted to take the necessary corrective action.
- (i) Inverters shall be suitable for the circuit/array maximum voltages to which it is connected.
- (j) Where three phase systems are installed inverters and arrays shall be designed to ensure that any imbalance in respect of current is less than the requirements stated in ENA G99.
- (k) Inverters shall, wherever possible be suitable for external operation thus mitigating the introduction of dc voltages into the building envelope. Where it is necessary to install inverters internally they shall be located as close to the point of entry into the building as practicable and generally within a dedicated room or riser. If dc cabling is run extensively within the building a means of isolation such as a fireman's switch shall be provided enabling isolation of the dc services before they enter the building.

E440716 AC System Design

- (a) The ac system design shall comply with the requirements of BS7671 and the ENA Engineering Recommendations G98 or G99 dependent on system duty.

- (b) The photovoltaic system shall be installed on a dedicated circuit to the point of connection.
- (c) An overcurrent device shall be provided at the point of connection of the system to the grid. The overcurrent protection device shall be provided with fully adjustable settings the parameters of which shall be advised by the PV designer, the device shall be sized against the system.
- (d) The overcurrent device at the point of connection shall operate a circuit breaker which shall disconnect all live conductors from the supply.
- (e) Where agreed with the **Distribution Network Operator / Independent Distribution Network Operator / Independent Connection Provider** this device may also be utilised for the disconnection of the embedded generation system from the grid via the operation of the paralleling protection provided by the G99 protection relays, alternatively a separate contactor which shall disconnect all live conductors from the supply shall be incorporated into the system controlled by the G59 relay.
- (f) The G99 relay shall disconnect the photovoltaic system from the supply if:
 - i) Grid voltage is to high/low
 - ii) Grid frequency is to high/low
 - iii) A step change in frequency/vector shift is detected
 - iv) A loss of mains occurs
- (g) Note where a distribution system is provided with a standby generation plant for either life safety purposes or support of essential services during a loss of mains supply the photovoltaic generation system shall remain disconnected from the building infrastructure until such time as grid mains has been re-established.
- (h) Where a photovoltaic system is provided on a building where embedded generation supplies the grid as part of a STOR or DSR agreement the method of operation and connection shall be agreed with the **Distribution Network Operator / Independent Distribution Network Operator / Independent Connection Provider**.
- (i) Where the photovoltaic system is connected to a building infrastructure benefitting from one or more of the following systems the Electrical Services Installer shall ensure that there are no compatibility issues between systems.
 - i) Power factor correction
 - ii) Active/passive harmonic filtration
 - iii) Uninterruptible power supply system
- (j) Where multiple inverters are provided, each inverter shall be connected to a distribution board with overcurrent protection provided to the requirements of the individual inverter these devices shall provide full selectivity to that at the point of connection.
- (k) A suitably labelled, lockable central point of isolation for the system shall be provided which isolates all inverters. Isolators shall be accessible for ease of isolation and devices shall be either double pole for single phase system or four pole for three phase systems.

- (l) Local ac isolators shall be provided at each inverter for maintenance.
- (m) Additional warning labels at all point of connection that parts inside may still be live after isolation for the electrical network.

E440719 Earthing and Lightning Protection

- (a) All systems shall be effectively earthed in accordance with the requirements of BS7671 and the recommendations of the IET Code of Practice for Grid Connected Solar Photovoltaic Systems.
- (b) External metal works including frames and cable containment shall be bonded to the buildings lightning protection system in accordance with BS EN 62305.
- (c) The photovoltaic system shall also be provided with lightning current and surge protection devices in accordance with the requirements of BS EN 62305-4 and the recommendations of IET Code of Practice for Grid Connected Solar Photovoltaic Systems. All dc and ac cabling, including data and control cabling shall be fitted with surge protection devices. Refer to Section E88.

E440722 Mechanical and Civil Design Considerations

- (a) The Electrical Services Installer shall employ a suitably competent person to design the necessary framing and fixings for the photovoltaic modules and any necessary builders works in connection with the installations.
- (b) Fixing and or clamping of modules shall be carried out in accordance with the manufactures instructions.
- (c) Materials utilised for frames and fixings shall be suitable for the environment in which the modules will be installed. This includes where applicable the arrays proximity to any plant which may require the use of chemicals in either its day to day operation or regular maintenance routines.
- (d) Mounting systems shall be designed so as to allow clear rainwater run-off and also prevent the build-up of snow on the modules.
- (e) Spacing of module rows shall consider self-shading and access for maintenance and emergency services. Modules shall be clear of any designated escape routes.
- (f) The modules, mounting structures and fixing systems shall be designed to withstand the forces imposed on them over the expected lifetime of the system taking into account routine maintenance.
- (g) The Electrical Services Installers Specialist shall liaise with the project Structural Engineer and Architect in order to ascertain the necessary primary structural details and waterproofing arrangements.
- (h) The Electrical Services Installers specialist shall design all necessary secondary steel support work systems, framing systems, fixing and clamping systems taking into account the wind and snow loadings that may affect the design and provide details and calculations to the Project Structural Engineer and Architect for approval.
- (i) The Electrical Services Installers Specialist shall also develop the detailing of any necessary penetrations and subsequent sealing for the egress of power and control cabling.

E441000 MONITORING AND CONTROL SYSTEM**E441001 General**

- (a) The Electrical Services Installer shall design, supply install and commission a monitoring and control system for the Photovoltaic Installation.
- (a) The type of monitoring and control system shall be dependent on the installation.

E441003 Domestic Systems *Residential*

- (a) The Electrical Services Installer shall provide a monitoring and alarm system to enable the owner/occupier to monitor the performance of the photovoltaic generation system.
- (b) The system shall include:
 - i) Generation and export meter
 - ii) Simple alarm monitoring
 - iii) Performance information
 - iv) Data logging
- (c) The parameters should be displayed on a freestanding home display and also have the facility to relay all information to a phone or computer application.

E441006 Commercial Systems

- (a) The Electrical Services Installer shall provide a monitoring and alarm system to enable the operator to monitor the performance of the photovoltaic generation system.
- (b) The system shall include a high-level interface to allow the exchange of data to and from either the Building Management System or Power Management System to allow the monitoring of energy generation and alarms by these systems.
- (c) The System shall include a high-level interface to the energy management system for the exchange of energy data.
- (d) The system shall include:
 - i) Generation and export meter information
 - ii) Alarm monitoring for all system alarms down to module level
 - iii) Irradiance levels should be monitored by irradiance sensors located on each string.
 - iv) Cell temperatures to enable system performance to be monitored
 - v) Grid voltage and frequency
 - vi) Performance information including Performance ratio and calculation of performance index.
 - vii) Data logging

- (e) An independent master control should be provided including HMI interface and processors in order to receive, maintain and analyse data. However any critical alarms should be relayed directly to the building or Power Management Systems and energy monitoring information and data to the energy management system.

E441300 TESTING, COMMISSIONING AND HANDOVER

- (a) The Electrical Services Installer shall test and commission the complete photovoltaic generation system in accordance with the following:
 - i) PV Specialist/manufactures recommendations
 - ii) BS7671 - IET Wiring Regulations.
 - iii) IET Code of Practice for Grid Connected Solar Photovoltaic Systems
 - iv) Energy Networks Association Engineering Recommendations **G98/G99**
 - v) Any specific requirements of the incumbent **Distribution Network Operator / Independent Distribution Network Operator / Independent Connection Provider**
 - vi) Microgeneration Certification (where appropriate – for installations to be registered for the Feed In Tariff scheme)
- (b) On satisfactory completion of all commissioning and testing the Electrical Services Installer shall allow for demonstrating the system to the Employer including all alarm and monitoring systems and interfaces with other systems as may be installed.
- (c) Complete system documentation shall be provided including test certification for ac and dc systems, operation and maintenance manuals and record drawings.

E57 GENERAL LIGHTING INSTALLATIONS**E570100 GENERAL**

- (a) This section of the specification describes the general requirements for luminaires and accessories, including switching. Particular requirements are described within the services description.

E570400 LUMINAIRES

- (a) Luminaires and components shall comply with the requirements of all appropriate British Standards and Regulations as listed in the scope of works section of this specification. They shall comply with the requirements of the local Fire Officer.
- (b) Metallic louvres shall be provided with an equipotential protective conductor with a minimum size of 0.95 mm² between the main body of the fitting and the louver.
- (c) Any modifications required to the manufacturer's standard luminaires to comply with the requirements regarding mounting height shall be provided. Should extra-long suspensions be required, they shall be ordered concurrent with the luminaires.
- (d) Luminaires for internal use shall be provided with protection to a minimum of IP23 classification, as defined in BS EN 60529. Fluorescent batten type luminaires shall be fully enclosed with an IP rating to suit their location.
- (e) Lighting track systems for luminaires shall comply with BS EN 60570.
- (f) Lighting track for flexible display lighting shall be provided with power supply box, connection, fixing clamps, end plugs and spot light adaptors.
- (g) Luminaires shall carry an identification label giving manufacturers name and luminaire model reference. Labels shall be positioned such that they are easily visible within the ceiling voids but are not visible from below.

E570700 LUMINAIRE INSTALLATION

- (a) Luminaires shall comply with the relevant standard for manufacture and test, and shall be selected and erected in accordance with the manufacturer's instructions.
- (b) Luminaires shall be installed complete with control gear, lamps, louvres and diffusers, including any necessary fixings and steel supports. Where detailed specifically elsewhere the luminaire bodies to be installed in suspended ceilings shall be free issued to the Ceiling Specialist who shall install and fix bodies in the accepted way. The Electrical Services Installer shall connect all control gear and install lamps, louvres and diffusers.
- (c) Luminaires shall be suspended from, or fitted to, a small BS conduit box, unless otherwise agreed. Luminaires mounted in suspended ceilings shall be provided to suit the ceiling and with brackets suitable for mounting the luminaire from the top of the ceiling grid. White break joint rings shall be provided wherever necessary.
- (d) Conduit or chain suspensions shall be provided for all pendant luminaires. The stems of conduit suspension shall be screwed to ball and socket type dome lids with positive earth connection.

- (e) Within plant rooms, luminaires shall be provided with chain suspensions of adequate length to provide suitable illumination when all plant is installed. The final locations of luminaires within plant rooms shall be agreed on site with the Engineer. They shall be arranged to provide shadow free lighting ensuring safe access to plant.
- (f) Luminaires shall be cleaned prior to final handover, if necessary, with an anti-static cleaning agent, to provide clean, dust free lighting.
- (g) Lighting in office and similar areas shall be wired so as to facilitate modification by the Tenants to suit partitioning layouts. Wiring shall allow switching to be readily modified to suit alternative or additional switching.

E571000 LUMINAIRE WIRING

- (a) Lighting circuits incorporating B15, B22, E14, E27 or E40 lamp holders shall be protected by an overcurrent protective device of maximum rating 16 A.
- (b) Wiring installations shall comply with the wiring systems section of this specification.
- (c) Luminaires, except continuous type, recessed into suspended ceilings shall be connected using flexible cables from plug-in type ceiling roses. Flexible cables shall be of a minimum length to facilitate disconnection of the luminaire. It shall be at least 2 m long with a minimum conductor size of 1.5 mm².
- (d) Circuit cables shall not be routed through bulkhead or other fittings where the cables would be liable to undue temperature rise. They shall terminate in a fixed base connector in a conduit box mounted behind or adjacent to the fitting. Final connection to each fitting shall be carried out with silicone rubber insulated cable.
- (e) Steel conduit termination to aluminium fittings shall be provided with brass bushes to prevent corrosive action between the steel and aluminium components.
- (f) Luminaire internal wiring shall be arranged such that it is not visible when lamps/reflectors/louvres are in place.

E571300 PENDANTS AND LAMP HOLDERS

- (a) Pendants shall comprise a ceiling rose, the necessary length of heat resisting 24/.20 mm flexible cord for circuits up to 6 ampere, or 32/.20 mm flexible cord for circuits up to 15 ampere, and a lampholder.
- (b) Batten lamp holders or pendant set shall comply with BS EN 60598-1, BS 7895 and BS EN 61184-1.
- (c) Ceiling roses shall be white plastic and comply with BS 67. They shall have substantial terminals of the pinching screw type including earth connection and looping terminal. They shall be complete with an effective cable anchoring device. Roses shall be provided with an enclosed integral pattress incorporating knock-outs and a screw-on cover which shall conceal the fixing screws. The base shall be suitable for direct mounting onto a conduit box.
- (d) Plug-in type ceiling roses shall comply with the general requirements of BS 6972. The socket terminals shall take three 2.5 mm², single core, solid copper conductors. The socket shall have termination for live, neutral, earth, auxiliary and loop-in connections. The plug shall have terminations for live, neutral, earth and auxiliary

connections. Units shall be rated at a minimum of 6 amp, 230 Volts AC and shall be capable of supporting a 10 kg load.

- (e) Lamp holders shall be white plastic and comply with BS EN 61184 and BS 7895. They shall be shade carrier pattern with an effective cable anchoring device and be so arranged that the dome cannot become detached by removal of the lamp or shade carrier shield. They shall permit intermediate connection between the terminals and circuit wiring with heat resisting flexible cable.
- (f) Batten lamp holders shall be white plastic and comply with BS EN 61184 and BS 7895. They shall have substantial terminals including an earth terminal and completely shrouded looping terminal. They shall have an enclosed integral pattress incorporating knock-outs and the lamp holder attachment shall be independently secured to the base and shall conceal the fixing screws.
- (g) Lamp holders shall have non-rising terminal posts. They shall be provided with adequately ventilated L/O shields. Terminals shall be of the pinching screw type. Lamp holders, except for hand lamps and fluorescent bi-pin units, shall be non-ferrous metal type. SES and GES type lamp holders shall be so connected that the screw portion forms the neutral conductor.
- (h) The Electrical Services Installer shall provide lamp holders not supplied with the luminaires and shall ensure that all lamp holders are of a make and type agreed with the Engineer and Architect.

E571600 LED LUMINAIRES

E571601 General

- (a) LED Luminaires and components shall comply with the requirements of all appropriate British Standards and Regulations as listed in the Scope of Works Section of this specification. They shall also comply with the requirements of the local Fire Officer.
- (b) The LED Luminaire shall conform to the Safety Standards listed in BS EN 60598-1 when used for general lighting.
- (c) The LED Luminaire shall meet the Performance requirements listed in BS EN 62722-1 when used for general lighting.
- (d) The LED luminaire shall comprise of a solid state light source, electronic control gear (ballast or driver) and optics for controlling the light distribution.
- (e) The luminaire components shall be carefully selected and located within the luminaire body to optimise the optical, thermal, efficiency and life expectancy of the individual components.
- (f) The luminaire light distribution shall be controlled by a lens, diffuser or reflector. The optics shall be designed to minimise the optical losses and maximise the luminaire efficacy. The optical control devices shall also be provided to control glare.
- (g) LED luminaires shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.
- (h) LED luminaire housings shall be designed to transfer heat from the LED board to the external environment.

- (i) All hardwired connections to LED luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
- (j) All LED luminaires and power/data supplies shall be provided by a single manufacturer to ensure compatibility.
- (k) All products associated with installation and control of the LED system, including peripheral devices and software are to be provided by a single manufacturer.
- (l) Each LED luminaire shall have the capability to be set to a unique and individual address. Address shall be selectable through on board switches or by an external hardware or software method.
- (m) All LEDs used in the LED luminaire shall be high brightness and proven quality from established and reputable LED manufacturers. The LED modules shall meet the Performance requirements listed in BS EN 62717 when used for general lighting.
- (n) The manufacturer of LED nodes for luminaires shall utilise an advanced production LED binning process to maintain colour consistency.
- (o) LED luminaire shall be CE certified.
- (p) The manufacturer shall be able to provide supporting documentation of the product meeting third party regulatory compliance.
- (q) The LED luminaires shall not be installed within an ambient temperature exceeding the manufacturer's recommendations.
- (r) The LED luminaire shall incorporate a well-designed thermal management provision i.e. heat-sink; to ensure that the LED junction temperature is maintained within the design limits, throughout the life of the luminaire.
- (s) LED Luminaires shall carry an identification label giving manufacturer name and luminaire model reference. Labels shall be positioned such that they are easily visible within the ceiling voids but are not visible from below.
- (t) Any modifications required to the manufacturer's standard luminaires to comply with the requirements regarding mounting height shall be provided. Should extra-long suspensions be required, they shall be ordered concurrent with the luminaires.
- (u) The manufacturer shall provide installation guides and system wiring diagrams.
- (v) High power LED luminaires shall be thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware.
- (w) For wet and damp use, LED-based luminaire itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure.
- (x) The LED luminous efficacy shall achieve the specified performance requirements in terms of the energy performance of the lighting installation. The luminaire efficacy shall take account of the driver losses, thermal and luminaire optical losses as well as the efficacy of the LED modules.

- (y) LED components that form the luminaire shall be picked and placed in position within an environment of the correct temperature and humidity to avoid any early component failure.
- (z) Refer to the specification luminaire schedule for the Correlated Colour Temperature (CCT) requirements for each luminaire lamp package.
- (aa) The estimated useful life of LED luminaires shall be based on a lumen depreciation to 70% of the initial lumen output, L70. The Manufacturer's luminaire life claims are to be supported by lumen maintenance testing (up to 6,000 hours) for LED lighting samples per IESNA LM-79-08, BS EN 62612, BS EN 62717, BS EN 62722 or other equivalent standards.
- (bb) To ensure the colour consistency all LED modules shall be selected from a minimum centre of 3 bins.
- (cc) LED drivers shall comply with the IEEE recommendations IEEE Std 1789 'Recommended Practice for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers'.

E571604 LED Drivers

- (a) The driver associated with the LED luminaire shall either be an integral component of the luminaire or a separate component as specified in the schedule of luminaires.
- (b) A LED driver shall consist of two stages, a mains AC-DC rectifier and a current control unit for providing a constant current supply for stable operation of the LED.
- (c) Dimmable drivers shall be designed for a wider current range to suit the dimming operation of the LED lighting. The LED drivers shall incorporate the necessary devices to handle power quality issues such as power factor correction and the reduction of harmonic distortion.
- (d) The electronic control gear shall be designed in accordance with BS EN 62384, which specifies the performance requirements for LED electronic control gear.
- (e) The LED luminaire manufacturer shall carefully select the appropriate power rating of the LED module, i.e. mid-power drivers at 300 mA to 700 mA to optimise the module output and life expectancy or high-power modules at 900 mA and beyond to achieve the lumen output required.
- (f) Where the LED lighting is required to be dimmed, the manufacturer shall select the appropriate driver capable of delivering a broader range of driving current to meet the design light output range required by the specific application.
- (g) The Electrical Services Installer shall ensure that the manufacturers include for the necessary time and materials required to demonstrate, where required, the compatibility between the driver and the LED module.
- (h) Dimming of LED luminaires shall be dependent on the lighting control system specified for the project and drives shall be selected to suit. The dimming controls shall be integrated into a dimmable driver or provided by a separate dimmer as specified.
- (i) Dimmable drivers shall utilise pulse width modulation (PWM) switching techniques to dim the LED light output by regulating the total power and driving current supplied to the LED lighting.

- (j) The manufacturer shall provide the estimated life of the LED driver and the failure rate that it is based on.
- (k) Compatibility of new LED lighting with existing dimmer switches, if retained for re-use in a refurbishment project, the maximum load rating of the existing dimmers shall not be exceeded.

E571607 LED Photometric Data and Testing

- (a) Photometric data and test reports of the LED lighting from qualified independent or manufacturer-based laboratories shall be available to ascertain the overall performance claims of the LED lighting.
- (b) LED's shall be tested in accordance with LM-80 procedures. The LED lifetime is to be calculated using the TM-21 methodology to indicate the useful lifetime of the LED. The declared system lifetime must factor in the associated LED driver.
- (c) The colour stability of LED lighting as reflected by stability of chromaticity and colour shift over the useful life of the LED should be ascertained from manufacturer's test results. The colour stability shall be carried out with the luminaire in an installed condition to ensure the SDCM is 4 step or less.
- (d) The manufacturer shall ensure that products undergo and successfully meet appropriate design and manufacturability testing including Design FMEA, Process FMEA, Environmental Engineering Considerations and Laboratory Tests, IEC standards and UL/CE testing.
- (e) All LED luminaires (100% of each lot) shall undergo a flash test in the factory prior to packaging.
- (f) The manufacturer shall provide optical performance, polar diagrams, and relevant luminance and illuminance photometric data based on test results from an independent testing lab.
- (g) The manufacturer shall provide photometric data in IES file format in accordance with IES LM-63, based on test results from an independent testing lab.
- (h) Mock-up test of LED lighting samples in controlled environment to verify actual performance versus performance claims could be considered before bulk purchase.

E571610 Warranty

- (a) The manufacturer shall provide a written five year on-site replacement material, fixture finish, and workmanship warranty. On-site replacement shall include transportation, removal, and installation of new products including reprogramming of addresses and controls etc. Finish warranty must include warranty against failure or substantial deterioration such as blistering, cracking, peeling, chalking, or fading. The warranty shall cover:
 - i) Defective or non-starting LED source assemblies
 - ii) All power supply units (PSUs)
 - iii) Luminaires producing inadequately-maintained illuminance levels at end of warranty period

- (b) The warranty shall cover all light sources (LED package, LED array, or LED module) including, but not limited to the LED die, encapsulate, and phosphor. If the expected useful life of the luminaire system is not maintained, then the manufacturer shall replace the light source(s) or luminaire as necessary.
- (c) The Client may request an optional ten year replacement warranty for inadequately maintained illuminance levels, finish of luminaire, power-supply unit (PSU) or defective LED source assemblies. The terms of the extended warranty shall be negotiated by the Client and the luminaire manufacturer for an additional cost.
- (d) Warranty period shall commence on date of possession. The supplier shall provide the site owner with appropriate signed warranty certificates, which shall be issued prior to practical completion for the works.

E572200 LAMPS

- (a) Lamps shall be made by a manufacturer holding a British Standards Institution Licence for Electric Lamps. They shall be of the correct rated voltage.
- (b) Each luminaire shall be complete with a lamp for each way. Fluorescent lamps shall be of the appropriate size and rating, with bi-pin ends and complying with BS 1853-2 and BS EN 60081. Vapour lamps shall comply with BS EN 60188, BS EN 62035, BS EN 60662 and BS EN 60192. All lamps of each type shall be supplied by the same manufacturer.
- (c) Except where otherwise indicated, fluorescent lamps shall be tri-phosphor, of the high efficiency, low energy type with a colour temperature of 3500 K. They shall be compatible with the control gear supplied with the fitting.
- (d) Prior to purchase of the lamps, a sample area shall be provided to permit the Architect to inspect the colour rendition of the lamps against actual building finishes. The Architect shall confirm the colour temperature of the required lamps.
- (e) All lamps shall be new and unused at Practical Completion. Any lamps used prior to Practical Completion shall be replaced.

E573100 LOCAL MANUAL LIGHTING SWITCHES

E573101 General

- (a) Lighting installations to office areas shall provide, (or in speculative developments have the capacity to provide) local switching to:
 - i) Provide separate zones for office areas and circulation areas
 - ii) Provide separate zones to perimeter areas and zones around atria or lightwells
 - iii) Provide separate zones for every 40 square metres of office space
 - iv) Meet the switching requirements of the Building Regulations
- (b) Local switches shall be installed in positions agreed with the Architect and the Engineer. They shall comply with BS EN 60669-1, with the type and finish specified elsewhere.

- (c) Switches shall be of the slow break, AC only pattern in which the successful operation of the switch does not wholly depend upon the action of a spring. The operating mechanism shall be insulated from all live parts. Switches shall have a minimum rating of 20 amps and be suitable for inductive operation at their rated capacity.
- (d) Where more than one phase occurs in a switch box barriers shall be provided to segregate the circuits on different phases. A label engraved "Danger 415 Volts" shall be attached to or engraved upon the front cover plate.
- (e) All boxes used for fixing switches shall be supplied with an earth terminal or screw in the base of the box.
- (f) Where DC lighting circuits are to be switched, double pole, quick make, quick break switches with pillar type terminals and earthing straps shall be provided.
- (g) Any switch controlling equipment not visible from the switch point shall be engraved with a label identifying the final circuit it controls. Unless otherwise indicated, it shall be fitted with an indicating lamp.
- (h) Lighting switches shall be mounted in accordance with the Architects room elevations and BS 8300. The maximum height for any switch shall be 1200 mm above finished floor level to the top of the plate.

E573107 Grid Switches

- (a) Grid switches shall be provided with adjustable fixings and shall be complete with earth terminal.
- (b) The switch and grid shall be mounted in a sheet steel box not less than 40mm deep. For surface units they shall be complete with a steel cover plate fitting flush with the edge of the box and of matching colour. For flush units they shall be provided with metal or PVC covers finished as required. Boxes for surface installations shall not have knockouts, but shall be drilled on site as necessary.

E573110 Weatherproof Switches

- (a) Weatherproof switches shall be mounted in UV stabilised polycarbonate boxes with, neoprene seals and external fixing lugs.
- (b) They shall have a minimum protection of IP 66 in accordance with BS EN 60529.
- (c) Switches shall be suitable for mounting in direct sunlight.
- (d) Switches shall be rated at 10 Amp one or two way as indicated on the drawings.

E573113 Ceiling Switches

- (a) Ceiling switches, shall be 15 amp all white insulated pattern, cord operated type with a positive action capable of being operated when the cord is up to 30 degrees from the vertical.
- (b) Switches shall be suitable for mounting on a circular conduit box or purpose made pattress. Cords shall be capable of being replaced without removal of the cover.

E573116 Dimmer Switches

- (a) Dimmer switches shall be of the plate or grid switch pattern, suitable for operation at 230 volts and rated to the circuit load and type of luminaire to be controlled.
- (b) Each plate shall have a dimmer control on its own or control and switch to suit the application.
- (c) Plate finishes shall match the other switches in the same room.
- (d) The dimmer control shall be of the solid state type.

E58 EMERGENCY LIGHTING INSTALLATIONS**E580100 GENERAL**

- (a) Emergency lighting systems shall comply with local Fire Regulations. They shall be designed to meet the requirement of BS EN 1838, BS 5266, and BS 9999. Emergency luminaires shall comply with the requirements of BS EN 60598-2-22, BS EN 60598-1 and BS EN 13032-3. Emergency signs shall comply with BS INO 7101, BS ISO 3864-1 and BS ISO 3864-3.

E580400 SELF-CONTAINED SYSTEMS

- (a) Self-contained emergency lighting units shall incorporate solid-state switching, lithium iron phosphate (LiFePO₄) cells and automatic recharge facilities. They shall be provided as standalone units or as integral or remote conversion packs. Nickel cadmium cells will not be accepted as an alternative, due to the environmental impact of the raw materials and the shorter life expectancy of the cells.
- (b) Where conversion packs are provided, they shall preferably be incorporated into the body of the luminaire they serve. Where this is impractical, they shall be enclosed within a suitable remote enclosure and be installed within 1 metre of the luminaire in a concealed but accessible position. The remote conversion packs shall be independently supported of the ceiling installation and shall be fitted with safety chains to prevent injury.
- (c) The emergency luminaires shall be connected directly to the same mains supply powering the normal lighting in the area. In the event of mains failure the unit shall automatically connect to the battery. On restoration of the permanent supply the unit shall revert to mains operation. Internal wiring and connections shall be carried out in low smoke zero halogen cable. A green LED indicator shall be visible in normal use e.g. through the diffuser or louvre of the fitting to indicate when the batteries are on charge.
- (d) The emergency luminaire assembly shall be manufactured and tested in accordance with the requirements of BS EN 60598-2-22. The BS EN classification shall be clearly marked on the luminaire label.
- (e) The battery shall be capable of maintaining the luminaire for a minimum period of 3 hours throughout the life of the luminaire battery. The initial emergency standby period shall be increased accordingly in order to achieve the specified 3-hour standby period at the end of the battery design life.
- (f) The battery recharge facility shall be capable of fully recharging a totally discharged battery in a maximum period of 24 hours. Facilities shall be provided to prevent reverse polarity at low battery voltage
- (g) The life expectancy of the batteries shall not be adversely affected by the normal intermittent mains power supply interruptions expected during the commissioning phase of the project.
- (h) The emergency lighting units shall be offered with a minimum of a 5-year warranty covering all emergency luminaire components including the battery.

- (i) All emergency luminaires including exit signs shall be given a unique numerical address, which shall be clearly identified with a permanent approved device reference label, the numerical address shall correspond with the emergency lighting logbook luminaire identification reference and the as built drawings. The device reference shall be a logical alphanumeric reference, such as building, floor, area, luminaire number permanently and indelibly fixed to a visible part of the luminaire.
- (j) The emergency luminaire/battery supplier shall provide documentation in accordance with the Waste Batteries and Accumulators Regulations 2009 to acknowledge their obligation to take back free of charge, waste industrial batteries supplied to the end user and arrange for their correct treatment and recycling of the raw materials.

E581000 EMERGENCY LIGHTING TESTING AND CERTIFICATION

- (a) On completion of the works the Electrical Services Installer shall carry out pre handover testing to ensure that all durations and light levels are in accordance with the design criteria.
- (b) The Electrical Services Installer shall mark up and produce a set of record drawings of all recorder levels.
- (c) Once all verification has been completed the Electrical Services Installer shall arrange demonstrations to the Engineer and Building Control Officer for final sign off the systems including where installed remote automatic testing systems.
- (d) On successful demonstration to the Building Control Officer the Electrical Services Installer shall generate an Emergency Lighting Completion Certificate.
- (e) The Emergency Lighting Completion Certificates shall be issued as part of the Practical Completion Documentation.

E60 LIGHTING CONTROL SYSTEM**E600100 GENERAL REQUIREMENTS**

- (a) The lighting control system shall be fully addressable, automated and digitally controlled comprising of the following:
 - i) Front End PC and Gateway for supervision, override and configuration
 - ii) Dedicated 24 Hour Control Processor(s) to provide integration with other building systems
 - iii) Area Controllers located per floor or part floor
 - iv) A vertical spine bus network linking the Front End PC and Area Controllers
 - v) Lighting Control Modules (LCMs) providing luminaire plug and socket connections
 - vi) Intelligent local control devices; sensors, switch plates and other interfaces
 - vii) Local horizontal field bus networking between Area Controllers, LCMs, Sensors and Switches
- (b) The lighting control system shall be capable of offering the following functionality:
 - i) Manual control and override via switch plates (hard-wired, radio and infrared)
 - ii) Presence detection with time programmable group control
 - iii) Automatic dim control in response to the light levels from photocell measurement
 - iv) Control of RGB colour change or tuneable white luminaires including the creation of dynamic scenes where colour / colour temperature changes over a pre-set time period
 - v) Dynamic scene change over time
 - vi) Time control
 - vii) Cascaded presence linking (e.g. corridor hold)
 - viii) Programmable load shedding
 - ix) Fire Alarm override of light levels
 - x) Emergency lighting test including a fully integrated DALI solution
 - xi) Data Integration with other Building Systems via XML, BacNet or other open protocol as called for in the Services Description
- (c) The lighting control system shall enable a lighting group consisting of any luminaire combination or individual luminaires within the installation to be controlled by any combination of local control sensors within the installation; this shall be achievable at any time without the need for additional equipment.
- (d) The Lighting Control Modules (LCM's) shall provide a means to marshal both power and data (e.g. DALI) to the luminaires; they shall typically control small groups of

luminaires via plug and socket connectivity and shall be mounted within the vicinity of the luminaires to be controlled, or at the nearest permanently accessible location.

- (e) The system shall interface as standard to a range of lighting control gear including dimmable extra low voltage, dimmable fluorescent, mains filament, cold cathode and LED light sources.
- (f) The lighting control system shall be configured to achieve the control zones identified by the BREEAM credit Hea01, which requires the lighting control is arranged to provide separate occupant control within zoned areas in an open-plan Category A space. This shall mean creating zones of no more than 4No workstations or notional area of 40m², based on an occupancy density of 1 person per 10 m².
- (g) Combined sensors shall be installed on a 6 m x 6 m grid, with hand held infrared controllers being used to provide the local user control, to raise and lower the light level, where this is required, as called for in the Services Description.
- (h) When called for elsewhere in this specification, the system shall be designed and selected to offer an open protocol for the lighting control devices. This will generally be adopted where the Client requires the lighting control devices to be interfaced with other building services systems on the basis of peer to peer communications.

E600400 INSTALLATION, SYSTEM STRUCTURE AND CABLE REQUIREMENTS

- (a) The Electrical Services Installer shall install the lighting control system, make all connections and pre-test the installation; however the lighting control system shall be fully commissioned, set to work and demonstrated by the lighting control system supplier/manufacturer.
- (b) The Electrical Services Installer shall ensure that the lighting control system is installed in accordance with the tender drawings and electrical specification including the installation drawings and instructions provided by the lighting control system supplier/manufacturer.
- (c) The spine network shall interconnect the area controllers and the lighting control system head end processor. The spine shall be planned and installed to operate at an early stage to allow system access for commissioning by the lighting control system supplier/manufacturer.
- (d) The spine network shall be wired vertically, being continuous, located within each electrical riser, looping in and out of each of the area controllers on each floor. The spine bus, shall be separated from mains voltage cables, being installed within a dedicated conduit located within the electrical risers and shall be strictly in accordance with the recommendations of the lighting control system supplier/manufacturer.
- (e) Communication between the area controllers and the local LCMs shall be via the field bus which shall be capable of being incorporated within a pre-fabricated wiring system or lighting busbar and shall be strictly in accordance with the recommendations of the lighting control system supplier/manufacturer.
- (f) The LCMs shall function correctly with the communication wires connected with either polarity and shall not sustain damage in the event of mains voltage coming into contact with either or both of the field bus conductors.

- (g) It shall be possible for local control devices to communicate directly with area controllers via an independent cable or via connection to a local LCM. Ceiling mounted sensors shall also be capable of being connected to multi luminaire DALI control lines.
- (h) The local control devices shall operate independently and shall be uniquely addressable within the lighting control system, connected to the system via a low smoke zero halogen twisted pair cable providing both power and communication functions.

E600700 AREA CONTROLLERS

- (a) The area controllers shall provide the interface between local devices (LCMs, sensors, switches) and the system spine. The area controllers shall provide any processing necessary to control the local area as well as providing override, maintenance and test facilities.
- (b) The area controllers shall comprise of a metal enclosure for the containment of cable connections and include a panel facia with the following features:
 - i) Programmable emergency lighting test select and indication in two programmable groups
 - ii) Local area over-ride On/Off and dim switches with indication
 - iii) Bus status indicators
 - iv) Panel lock, key switch or password protected key pad
- (c) The area controller shall provide the following auxiliary connections as standard:
 - i) Dual volt-free load shed inputs – software programmable
 - ii) Volt-free alarm Input – for fire alarm override to full lighting level
- (d) Each area controller shall be capable of relaying its auxiliary contact status to all other area controllers on the spine bus, which may be programmed to respond accordingly, in this way it shall only be necessary to make the load shed and alarm connections at a single point.
- (e) Area controllers shall be located in the landlord and/or tenant electrical risers on each floor and shall be networked together using the vertical spine bus cable. The area controllers shall be capable of controlling a minimum of 100 LCMs as standard, without the need for additional equipment.
- (f) The area controller data and timekeeping shall be maintained in the event of loss of power.
- (g) The area controllers shall be capable of operating on a stand-alone basis and shall not be dependent of the front end PC to perform standard control functions.
- (h) It shall be possible to remotely upgrade all area controller firmware within a scheme from a single access point by using the system vertical spine; this shall allow future control system features to be installed with the minimum disturbance to the building occupiers.
- (i) Where specified, the area controllers shall be installed complete with Radio Interfaces to accept commands sent from radio switches supplied and installed during the fit out

stages. The lighting control system supplier/manufacturer shall confirm as part of their tender return whether this feature is readily available.

E601000 LIGHTING CONTROL MODULES

- (a) The lighting control modules (LCMs) shall be provided with, where specified, various port combinations, as indicated on the Tender drawings and described in the services description:
 - i) Pluggable (one luminaire per port) - with nine or ten ports, where general office recessed modular luminaires are to be used in an accessible ceiling
 - ii) Pluggable (multiple luminaires per port) - a minimum of three addressable or switchable ports, where suspended luminaires are to be installed and where luminaires are to be connected in short strings, controlled utilising addressable DALI gear; the LCMs shall be installed in an accessible location
 - iii) Pluggable (many luminaires per port) - a minimum of one switching or DALI port, where the LCM and its connections are required to be compact and mounted within a continuous luminaire infill or chilled beam installation
 - iv) Hard Wired Circuit Control LCM's shall have a minimum of four 10 A circuit control and emergency test relays
- (b) The LCM ports shall be independently controllable, where luminaires are to be dimmed, each LCM port shall provide an individually controllable DALI signal. Nine port LCMs shall have an additional switched fused port provided for the connection of low power auxiliary equipment, e.g. FCU controllers, water shut-off solenoid valves, etc.
- (c) The DALI LCMs shall allow DALI ballasts and DALI inverters to be connected to the same DALI control line. In the case of multi luminaire DALI control lines it shall also be possible to connect sensors to this line.
- (d) The enclosures of the LCMs, which are to be located within ceiling voids, or within electrical riser cupboards, shall be of metal construction or flame retardant polymer. When the LCMs are to be installed in the floor void they shall be of metal construction.
- (e) Where control switches and sensors are connected to LCMs, the LCM shall provide sufficient capacity for simultaneous connection of at least 10 devices; for this purpose a single device may consist of any of the following, each of which shall be individually programmable to perform a unique control function:
 - i) Presence detector
 - ii) Photocell
 - iii) Combined sensor with presence detector, photocell and infrared receiver
 - iv) Multi-button switch plate with LED indication
 - v) Multi-button programmable scene selection plate with pre-sets and manual raise/lower
 - vi) Multi-function programmable touch panel

- (f) It shall be possible to daisy chain sensors on one two wire cable, for example to connect between 6-10 devices into one LCM input port, each of which shall be individually programmable to perform a unique control function.
- (g) Should mains potential within a luminaire inadvertently come into contact with a ballast control signal connection any resultant damage shall be limited to the connected lighting control module, directly connected sensors and other luminaires connected to it, damage shall not be caused to any horizontal field network wiring or spread to other modules.
- (h) Pluggable LCM ports shall each consist of a single 5-6 pole socket into which a luminaire plug may be connected, with connections as follows:
 - i) SL Switched Live to Luminaire
 - ii) E Earth
 - iii) N Neutral
 - iv) ML Maintained\Emergency Live to local battery inverter (where specified)
 - v) -Ve Negative control connection (DALI)
 - vi) +Ve Positive control connection (DALI)
- (i) The plug connection shall provide for cable strain relief and shall have a mechanical latching mechanism, which retains the luminaire plug in the LCM socket. Each plug shall be manually releasable without the use of a tool or the requirement to remove another plug in order to gain the necessary access.
- (j) Where specified, the provision of an independent maintained\emergency Live shall allow testing of the NON-DALI equipped emergency luminaires without affecting the operation of normal luminaires.
- (k) For switching non-emergency luminaires, it shall be possible to use a three-pole plug to make SL, E and N connections, where dimming and/or emergency luminaires are required, a single six-pole plug shall be used in which all connections from a single 5-6 core cable can be terminated.
- (l) In order to provide for ease of installation and future servicing, LCMs should provide the following features:
 - i) The LCM Unique address shall be clearly labelled and legible from floor level
 - ii) The Luminaire port numbers shall be clearly labelled
 - iii) There shall be external mounting lugs for flat mounting to the soffit
 - iv) 9-10 Port pluggable LCMs shall provide for fixing via drop rod suspension in both horizontal and vertical positions
 - v) The LCM shall be of a “one piece” installation style via external fixings without the need to remove a lid. The power and data bus connections shall be via a pre-fabricated plug-in connector or other means of plug and play connectivity
 - vi) Where specified elsewhere, the LCM shall be supplied to site with the specified connector pre-fitted; the connector shall be free issued to the

lighting controls supplier/manufacture, who shall fit and test the complete assembly prior to delivery to site

- (m) The lighting control system supplier/manufacture shall free issue luminaire port number labels (e.g. 1 to 9) that shall be fixed to each luminaire plug by the Electrical Services Installer.
- (n) The Electrical Services Installer shall ensure that the LCM is equipped with the appropriate protective device, which shall provide full discrimination with the associated circuit protective device and the luminaire fuse
- (o) The fuse shall be externally accessible and replaceable without the need to unplug luminaires or dismantle the LCM.
- (p) The 9/10 Port pluggable LCMs shall be upgradeable by changing the control card, whilst the LCM remains in position, without the need to unplug luminaires. It shall be possible to upgrade the LCM performance from switching to dimming control.
- (q) Where specified the lighting control system shall provide LCMs to which the circuit connections are hardwired, they shall be used to switch circuits, where conventional wiring is more appropriate than plug and socket connection.
- (r) Where the hard wired LCMs are not equipped with output fuse, the LCM's shall be designed to accept lighting loads to suit a 10 A MCB and the luminaire flexible cables shall be rated accordingly.
- (s) The hardwired LCM shall have a minimum of four individually addressed switched outputs (10 amps per output); each of these outputs shall be capable of being independently fed from different incoming supplies. Each output shall also have its own permanent live feed relay for the supply of permanent mains to emergency inverters.

E601300 DALI CONTROLLERS

- (a) Where specified in the luminaire schedule, luminaires shall utilise control gear conforming to the DALI (Digitally Addressable Lighting Interface) standard IEC 62386. The lighting control system shall provide to each of these luminaires DALI control features including:
 - i) Ballast detection feedback
 - ii) Lamp fault feedback
 - iii) Short-addressing capability
 - iv) Broadcast addressing capability
 - v) Full digital control over the lighting range including off
 - vi) Fade processing support
 - vii) Ballast "Persistent Memory" programming
 - viii) Support for DALI Inverter control and monitoring
- (b) DALI short-addressing shall allow individual control of luminaires when connected to a single DALI control wire pair.

- (c) Where any short-addressing is to be utilised the controls provider shall:
 - i) Ensure all short-addresses are assigned as part of the initial commissioning process such that unique luminaire control can be demonstrated
 - ii) All short-addressing is to be carried out via the lighting control system without disturbing the LCM, luminaire, detectors or ceiling
 - iii) Ensure that drawings are provided for future maintenance, which show the short-address of all gear within luminaires

E601600 BLIND MOTOR CONTROLS

- (a) The lighting control system shall provide modules for the control of 230 VAC blind motors. Each blind module shall provide control ports for up to 8 blind motors, each consisting of a socket into which a plug may be connected, with connections as follows:
 - i) L-up Switched live to drive blind up
 - ii) E Earth
 - iii) N Neutral
 - iv) L-down Switched live to drive blind down
- (b) Each module shall provide local override test buttons for the purposes of testing and maintenance. It shall be possible to calibrate each blind drive characteristic to allow both local and remote control of vertical position and tilt and to configure the buttons of intelligent switch plates to control both lighting and blinds within a given area.

E601900 LOCAL CONTROL DEVICES

E601901 General

- (a) Local control devices shall consist of switches, presence detectors, photocells, infrared receivers and the like; these devices shall serve as the inputs to the lighting control system.
- (b) The Electrical Services Installer shall allow for the control plates to be finished to the architect's requirements or in accordance with the details contained within the technical schedules and to be custom engraved, where required.
- (c) Local control devices shall be of an intelligent addressable type.
- (d) It shall be possible to disconnect and service the local control devices by access only to the interior wall and ceiling surfaces, without the need to reach the LCM connection points within the ceiling void.
- (e) The control device cabling shall be of rugged construction. All cables subject to movement, for example a flying lead connecting to an LCM or ceiling mounted sensor shall be provided with strain relief to the cable sheath. Screw terminals and exposed cable cores shall be contained within a suitable cover.
- (f) If DALI control devices are to be utilised then:

- i) In order not to reduce DALI line current capacity for future ballast expansion, controls may only take power from the DALI Line provided that the remaining current capacity does not fall below 128 mA
- ii) Ensure any sensor, switch or other control devices connecting to the DALI line do NOT impede the designed capacity to connect and control individually up to 60 DALI devices on each DALI bus line. In order to provide for system future requirements the number shall be limited to a maximum of 55 devices. This figure shall not be exceeded without the written consent of the Engineer.
- iii) DALI compatible detectors shall also be capable of connection directly to the area controller or local LCM inputs.

E601904 Intelligent Local Control Devices

- (a) The intelligent control devices shall connect to the system using a single twisted pair cable, which shall provide power and communications, each device shall have its own unique address, allowing devices to be daisy chained, where required.
- (b) The device shall actively report itself onto the system providing its type, mode and status as well as control commands. The system shall automatically confirm that the correct control devices are connected to the system and are operating correctly; for example a presence detector should actively report both “detection” and “non-detection” states, “non-detection” should not be the same as “disconnection”.
- (c) Where local control devices are mounted remotely, for example at a reception desk or roof location, or otherwise when there are no local LCM ports, it shall be possible to make a daisy chained connection from the control devices directly back to the nearest local area controller.

E601907 Conventional Switches

- (a) Conventional Open/Close and retractive style switches shall be capable of being interfaced to the lighting control system. Once interfaced, the switches shall take on the intelligence so that each switch can be individually programmed with regard to its action and the lighting group that it controls. This feature shall also allow waterproof switches to be connected to serve external areas.

E601910 Intelligent Switch Plates

- (a) The system shall provide a range of programmable addressable intelligent multi-button switch plates, as indicated on the Tender drawings and specification.
- (b) As standard all switches shall, where appropriate, include LED indication of the current lighting state, where switches control the same lighting area the LED function shall track automatically.
- (c) Where push button switch plates with LED indication are used in combination with absence detection the LED indication shall track the lighting status when switched off by the absence detection.
- (d) For special requirements it shall be possible to combine switch plate types onto a single front plate, by daisy chain connection of the intelligent switches large multi gang control plates shall only require a connection to the lighting control system.

- (e) The switch buttons shall be individually programmable with both a short and long press action to provide any of the following actions:
 - i) Turn On or Off
 - ii) Select one of eight pre-sets with selected fade rate and override
 - iii) Cycle between pre-set levels
 - iv) Fade up, Fade Down in programmable steps
 - v) Recall last dim level

E601911 Touch Screen Switch Plates

- (a) The lighting control system shall provide for full colour graphical touch screen control plates, which the lighting control system supplier shall customise to provide multiple control function screens. This shall allow the user, from one plate, to adjust lighting, blinds and room temperature.
- (b) The touch screen switch plate shall be able to be either surface or recess mounted.
- (c) The touch screen switch plate shall accommodate centrally programmed scenes together with user programmable scenes. The scene name and lighting levels shall also be user editable.
- (d) The touch screen switch plate shall have the option to have downloadable graphics, which shall allow custom backdrops or a company's logo to be added.
- (e) The plate shall be firmware upgradeable, ideally via Bluetooth or via the system. The removal of the plate from its mounting shall not be required.
- (f) The plate shall provide a standby/low power mode to conserve energy when not in use, this shall be <0.5 watts.

E601913 Radio Switches

- (a) The system shall provide a range of addressable radio switch plates requiring no battery power based on the EnOcean 868 MHz Wireless Standard. Multiple radio receivers mounted locally on the ceiling and connected via a bus cable back to the area controller shall be capable of processing messages from a minimum of 30 radio switch plates per receiver. Each button on a radio switch plate shall be fully configurable to control different lighting levels or groups.
- (b) Radio receivers must be capable of working with 3rd party radio switches compliant to the EnOcean standard.

E601916 Presence Detectors

- (a) Presence detectors shall utilise quad element pyro-electric detectors in combination with a 360-degree multi-facet Fresnel lens. It shall be possible to configure presence control in overlapping groups with independent control of local and large areas.
- (b) Presence detectors shall be mounted within the ceiling tiles on a grid layout giving complete coverage of the open plan and cellular spaces. Typically the presence detector coverage shall be at least 2.5 x the ceiling mounting height (e.g. 2.5 x ceiling of 2.8 = 7 m diameter on the floor).

- (c) As described above, presence detectors must actively report to the control system in both the “detection” and “non-detection” modes, in particular a disconnected presence detector must not appear as “non-detection” with the possibility of a fault allowing controlled lighting to time out and turn off.
- (d) Where the presence detectors are intended to operate in absence mode to switch lights off when a space is vacated, they shall dim the lighting to 50% for a pre-determined period, prior to switching the lights off, to warn any remaining occupants.
- (e) The lighting control system shall be set up so that the presence detectors bring on the normal lighting, as required, during normal working hours. However outside of normal working hours the same presence detectors shall bring on a notional Security circulation route, for a predetermined period, to allow the security personnel to safely carry out their required duties.

E601919 Photocells

- (a) Light measurement shall be by means of a linear photodiode or equivalent with colour correction for daylight monitoring, the measurement range shall provide a nominal linear resolution of at least 1000:1 (10 bit reading). There shall be a light integration arrangement (e.g. Light Tube) that shall be separated from the focusing effect of any Fresnel lens. Light measurement by lower cost, lower performance devices e.g. Light Dependent Resistors looking through the Fresnel lens, will not be permitted.
- (b) It shall be possible to configure a single photocell sensor to control multiple lighting groups to different levels of illuminance, for example to achieve progressive daylight linked dimming of window rows.

E601922 Infrared Receivers and Controllers

- (a) The lighting control system shall provide hand held battery operated infrared controllers for use with ceiling mounted receivers.
- (b) The controller shall be of a universal non-addressed type where the control function shall be programmable and related to the receiver. The controller operation should be “directional” such that it will generally only control the receiver at which it is pointed.
- (c) Each controller shall have a minimum of four keys. When pointed at a given receiver the keys may be programmed either to select four different scenes in one area or to affect up to four different programmable areas (one group per key).

E601925 Combined Sensors

- (a) The system shall provide universal intelligent sensors, which combine any of the presence, photocell or infrared receiver functions into one unit. Each element shall be independently assigned to different groups of lights even though the combined head is supplied by one cable and one address. The sensor shall have an LED indicator mounted behind the Fresnel lens; which will light during testing modes.
- (b) The sensor must be capable of being mounted and removed from the internal surface only, for example by rotating spring clips; it shall be capable of fixing flush into material thickness of between 1 mm and 20 mm.

- (c) All sensor wiring terminations shall provide for cable strain relief and the enclosure of exposed cable cores. Wiring cables shall have core insulation and outer sheath both of Low Smoke Zero Halogen material.

E602200 LIGHTING CONTROL SYSTEM TOPOLOGY

- (a) The lighting control system shall be configured either as a series of DALI strings, with luminaires incorporating a DALI ballast wired on a common bus circuit, including both power and comms; or via DALI lighting control modules (LCM's), where the LCM contains the DALI addressing to the individual luminaire ports.

E602500 WIRING SYSTEMS

- (a) The wiring of the lighting circuits shall comprise of either multi circuit busbars or a prefabricated wiring system as called for elsewhere in the specification.

E603400 FRONT END GRAPHICAL PACKAGE, GATEWAY AND 24HOUR CONTROL PROCESSOR

- (a) The main central processor; shall be connected to the lighting control vertical spine network, where called for in the Services Description. The connection may require a Gateway or Network Interface according to system requirements and the choice of spine be it IP or bus-wired.
- (b) Where 24 hour features such as a DALI emergency lighting automated testing system or IP data exchange is required a dedicated control processor shall be provided and specifically designed for continuous operation without moving parts such as rotating hard drives or fans. The control processor shall be integrated together with the front end PC and any necessary gateways within a dedicated enclosure incorporating all necessary interconnections such that a reliable and well integrated solution can be maintained – rather than a collection of separate components subject to movement and disruption over time.

E603700 CENTRAL PROCESSOR SPECIFICATION

- (a) The PC itself shall have the following minimum specification:
 - i) Microsoft© Windows 7 Operating System, current version to suit software package
 - ii) 2.5 GHz basic processor speed
 - iii) Intel processor, I3 equivalent or greater
 - iv) 4 GB RAM
 - v) 120 GB HDD
 - vi) 23" 16:9 HD Flat Screen
 - vii) RS232 Serial Port, 9 Pin Standard D – for exclusive use by the lighting control system
 - viii) Keyboard, Mouse
 - ix) Available USB port for "Memory Stick" Data Backup and transfer

- x) 100/1000 Mbs Network Port

E604000 SOFTWARE PACKAGE AND LICENSE

- (a) The lighting control system provider shall install, test and demonstrate the front-end software package. Unless otherwise specified, a single project license shall be granted to cover the use for that central processor, and where additional local remote access PCs are specified, these shall be allowed for by the Electrical Services Installer.
- (b) There shall be facility to upgrade to allow remote access from any PC on the same network if required.

E604300 REMOTE ACCESS CONTROL

- (a) A separate price shall be provided for a remote access facility to remotely access the complete system central processor for future maintenance purposes, where called for in the Services Description. The Electrical Services Installer shall co-ordinate the provision of a suitable secure Internet access point.
- (b) The central processor shall allow the client full administrative privileges to install any remote access server packages.

E604600 FRONT END SOFTWARE FEATURES

- (a) The software shall be graphics based and operate within Microsoft Windows ©, it shall be capable of multi-tasking with other windows applications.
- (b) The system shall allow luminaires to be graphically joined and built into named groups that can be controlled by any control sensors within the system.
- (c) The graphical display shall be capable of providing a dynamic display of any complete floor plan; the display will indicate the status of all luminaires and control sensors on that floor and shall have a refresh rate of no more than 10 seconds. It shall be possible to select each device to immediately display further information including: percentage luminaire output, historical presence detection, photocell reading and switch status. It shall also be possible to select a switch plate or infrared control and issue a command as though generated manually at the device.
- (d) The front-end software shall provide central control and management functions for the entire controlled lighting installation of the building.
- (e) The graphical user interface shall provide the users with a choice of a multitude of automatically generated reports on the use of the lighting within the building, including trends of energy use and comparisons with previous periods.
- (f) The graphical user interface equipment shall provide a choice of LENI reports automatically so that the occupants can bench mark their lighting performance.

E604800 DATA EXCHANGE

- (a) The Electrical Service Installer/lighting control system supplier shall provide a data exchange server available for connection to the site wide Common Network System (CNS) IP network and MSI solution.

- (b) All data from the lighting control system supplier's sub-systems shall be made available for bi-directional communication with the MSI package integration device using Open Protocols. Supplier specific Application Programme Interfaces (APIs) shall not be accepted as an interface for lighting control functionality.
- (c) All outward data shall be published, per pre-agreed asset topic, on "change of state" via MQTT (native) from the lighting control system to include the minimum information per item within the data payload:
 - i) Time and Date stamp
 - ii) System Identifier
 - iii) Location Identifier (X/Y Co-ordinates)
 - iv) Device Identifier
 - v) Asset Identifier
 - vi) Asset Name
 - vii) Asset Type
 - viii) Asset Variable Description
 - ix) Event Description
 - x) Asset Status / Present Value
 - xi) Asset Measurement Units (where applicable)
 - xii) Alarm level / status clarification
- (d) Conversions of data from another protocol to MQTT shall not be accepted.
- (e) The Electrical Service Installer/lighting control system supplier shall be capable of accepting inbound messages from the MSI package within the same standard protocol, such as time and date synchronisation, and analogue and digital command instructions as a minimum.
- (f) The Electrical Service Installer/lighting control system supplier shall be capable of defining certain assets or parameters as read / write or read only as may be required within the data exchange.
- (g) The Electrical Service Installer/lighting control system supplier shall participate in latency testing with the appointed MSI contractor. The MSI and Networking contractors shall then be responsible for ensuring that lighting control command latency does not exceed 300ms from the point of interaction to the command being executed.
- (h) The Electrical Service Installer/lighting control system supplier shall allow for all hardware, software and programming to make the above available.
- (i) The Electrical Service Installer/lighting control system supplier shall allow for any power supply requirements as may be needed to complete the fixed installation of the data exchange equipment within his package.
- (j) The Electrical Service Installer/lighting control system supplier shall ensure the data exchange equipment is suitably contained in a housing that provides mechanical

protection and lockable access. The housing to be suitably labelled for ease of identification.

- (k) The Lighting Control System (LCS) will be based on a DALI addressable solution and will be fully integrated to the chosen MSI solution via MQTT (for data publishing) and BACnet (for actuation).
- (l) The Electrical Service Installer/lighting control system supplier shall ensure that the status and health of all equipment (i.e. Electronic Control Gear (ECG), Switches/Dimmers and Presence Infrared (PIR) Detectors) shall be viewed and controlled from the chosen MSI solution.
- (m) The connection with the Smart Building solution shall take place at the lighting control system's data processor head end via the CNS. The head end shall include both an MQTT client (for data publishing) and a BACnet device.

E604900 DALI BASED AUTOMATIC EMERGENCY LIGHTING TESTING SYSTEM

- (a) A DALI based automatic emergency lighting testing system shall be provided for testing self-contained emergency fittings and/or for testing DALI-ballasted emergency fittings supplied from a central battery system, where called for elsewhere in the specification.
- (b) The automatic emergency lighting testing system shall be part of the lighting control system package and shall be in accordance with the following standards:
 - i) BS 5266-1 Emergency Lighting Part 1: Code of practice for the emergency lighting of premises
 - ii) BS 5266-8 Emergency escape lighting systems
 - iii) BS EN 62034, Automatic test systems for battery powered emergency escape lighting
 - iv) DALI Battery Powered Emergency Inverters shall be in accordance with BS EN 62386-102 and BS EN 62386-202
- (c) The automatic emergency lighting testing system shall provide tools to define an out-of-hours period during which testing shall take place, typically overnight. The automatic emergency lighting testing system shall also provide a weekly schedule such that tests are only conducted on specific days and a calendar based ability to exclude specific dates.
- (d) The automatic emergency lighting testing system processor shall be standalone and functionally independent of the normal lighting control head-end. It shall be designed and rated for continuous operation, with no moving parts such as fans or hard drives and shall have the ability to automatically re-boot with full recovery following the loss of the mains supply.
- (e) The automatic emergency lighting testing system processor shall have a high-level integration interface to the central processor of the main lighting control system with full access to the lighting control diagnostics. Where specified an overview status and day-to-day commands shall be offered via a touch screen user interface or a graphical diagnostic viewer running on Microsoft Windows platform.

- (f) The automatic emergency lighting testing system processor shall continuously monitor all DALI based emergency luminaires for inverter circuit or battery failure without the need to interrupt lighting by conducting a function or duration test.
- (g) The normal ballast gear within self-contained emergency luminaires shall also be of a DALI type such that the automatic emergency lighting testing system processor shall continuously monitor the gear for lamp failure within an emergency luminaire without interrupting lighting. This shall provide for pre-emptive emergency lamp replacement at any time without the need for a function or duration test.
- (h) Where an automatic emergency lighting testing system is specified, the DALI components shall be in operation at all times, therefore the emergency override function of the area controller shall be disabled.
- (i) The following requirements shall be satisfied where self-contained emergency fittings are specified:
 - i) All emergency lighting test scheduling shall be organised and directly controlled by a central automatic emergency lighting testing system processor, all automatic self-testing within DALI inverters shall be turned off
 - ii) Tests on the DALI based emergency luminaires shall be conducted automatically by the automatic emergency lighting testing system processor in accordance with the time periods defined in the standards such that the only essential user intervention shall be to deal with maintenance requirements as indicated by the system
 - iii) The automatic emergency lighting testing system processor shall receive information from the main lighting control system, which shall define the location of each emergency luminaire within the building. The automatic emergency lighting testing system processor shall then automatically generate test patterns such that there is no possibility of any two adjacent emergency luminaires being tested for function or duration within the same test and re-charge period
- (j) Where the emergency luminaires are powered from a central battery system, the following specification shall also be satisfied:
 - i) The automatic emergency lighting testing system shall be able to test emergency lighting fitted with DALI ballasts conforming to IEC 62386-102, Edition 1 or later, supplied from one or more central battery systems that comply with EN 50171
 - ii) The automatic emergency lighting testing system shall automatically program emergency luminaires equipped with DALI ballasts so that it will light automatically upon local or global power failure, without the requirement for a changeover device to be fitted to emergency luminaire or for signalling cables to the emergency luminaires upon a power failure
 - iii) The automatic emergency lighting testing system shall carry out a test of the emergency luminaires, in the event of a signal being received from the central battery system that it is supplying power from the battery, and record the test results
 - iv) Where a volt-free test input is available to initiate the central battery system to supply power from battery, the automatic emergency lighting testing

system shall be able to initiate emergency lighting tests upon receipt of a user command or automatically. Separate configuration options shall be provided to enable automatically scheduled function and duration tests

- v) The data exchange interface shall provide remote indications of central battery system status and alarms via BACnet, XML or other open protocol as specified

E605200 AUTOMATIC EMERGENCY LIGHTING TESTING SYSTEM GEAR COMPATIBILITY

- (a) The Electrical Services Installer shall ensure the control gear offers full compatibility to the DALI gear standard IEC 62386.
- (b) The Electrical Services Installer shall note that the DALI control pair must be connected both to the DALI inverter and any DALI ballast; this shall be **CLEARLY SPECIFIED** when ordering luminaires.
- (c) The emergency luminaires shall be fitted with suitable DALI emergency gear such that the Automatic Emergency Lighting Testing System can monitor all luminaires and maintain complete system coverage thereby maximising through-life maintenance savings. Any emergency luminaires without DALI based monitoring shall be clearly identified and subject to a separate regime of manual testing procedures.

E605500 AUTOMATIC EMERGENCY LIGHTING TESTING SYSTEM COMMISSIONING

- (a) The automatic emergency lighting testing system shall continually test and monitor all DALI based emergency lighting. In order for the system to work all devices shall be installed and addressed exactly as defined on the drawings, as any inaccuracies will be identified by the automatic emergency lighting testing system as a fault.
- (b) Once fully commissioned, the automatic emergency lighting testing system shall operate by scheduling tests over weeks and months. This may not always meet the need to complete areas against the tight and variable timescales leading up to initial project completion - in this event conventional manual testing and witnessing of the emergency lighting may be employed; thereafter a further period should be allowed to rectify any issues highlighted as the automatic emergency lighting testing system conducts automatic tests.

E605800 DRAWINGS, PRE- COMMISSIONING, COMMISSIONING AND MAINTENANCE

- (a) The Electrical Services Installer shall ensure that the controls system provider is provided with AutoCAD © format files showing the building, partitioning and lighting layout as required. The lighting control system provider shall produce numbered drawings to indicate positions of LCMs and control devices such as PD's and switches. These drawings shall also indicate all the port numbers and DALI sub-addresses where appropriate. These drawings shall be used for help with the installation of the equipment and should be in accordance with the Tender documentation.
- (b) The final software configuration shall be based on the Electrical Services Installer's final record drawing of the lighting installation.
- (c) The lighting controls system shall have a pre-commissioned mode to allow The Electrical Services Installer a method of validating power and bus wiring during

installation and prior to making the system available for commissioning by the lighting control system provider.

- (d) Pre-commissioned test switches shall be provided at each area controller control panel; these shall include the ability to:
 - i) Globally turn on, off and dim lighting connected to all LCMs on the network
 - ii) Stimulate all local control devices with LEDs to indicate correct connection
 - iii) Provide a method for globally turning lighting off with a delay function to ensure that luminaires need not be left on when not required, e.g. overnight

E606100 COMMISSIONING

- (a) The Electrical Services Installer shall fully commission the lighting installation in conjunction with the lighting control system supplier/manufacturer. This includes the aiming/focussing/aligning of all luminaires as well as setting up control scenes, occupancy detection hold-on times and colour change.
- (b) Where daylight linking and/or constant lux is employed, commissioning shall include the setting up of individual luminaire dimming profiles to achieve constant illuminance on the working plane.
- (c) When the Electrical Services Installer has carried out this commissioning in full, he shall offer the installation to the Engineer for inspection and final adjustment. For naturally lit areas, this shall take place during the hours of darkness.
- (d) The Electrical Services Installer shall include for any adjustments to luminaires and control system required by the Engineer and shall ensure that the lighting controls specialist is present and equipped to make any required changes to the lighting control during the inspection. If necessary, this process will be repeated until the Engineer is satisfied.
- (e) The controls system supplier/manufacturer shall have available an experienced commissioning team under full-time employment consisting of at least 10 personnel available within daily travelling distance of the scheme each carrying full JIB and Electro-technical Certification.
- (f) The system shall be commissioned using the front-end graphical package, which shall be used to demonstrate correct system operation during witnessing – this is irrespective of whether the front-end package is purchased for permanent installation on site.
- (g) The system shall be capable of being fully pre-commissioned by reference to numbered drawings with no requirement to gather information on site other than, if applicable, any DALI short-addressing that may be required.
- (h) The system may be pre-programmed by access to area controllers only; such that when LCMs are powered the necessary settings will be automatically downloaded.
- (i) If DALI control is utilised, then before any commissioning takes place, sub-addressing of the luminaires to provide each DALI ballast, transformer and Emergency Inverters with their DALI “Short Address” is to be carried out. This shall be carried out by means of laptop or similar portable tool using software to address the gear etc. via the LCMs. These addresses will be as shown on the system providers installation drawings.

- (j) Once commissioned, the system shall be capable of automatically validating that all sensors are operational, the graphical interface shall be capable of indicating any sensors that are not operational without the need to stimulate the sensor locally.
- (k) Where independent commissioning witnessing agents are employed they must agree with the lighting control system provider the procedures for assessing the final system by either sampling or full testing.

E606400 MAINTENANCE

- (a) The lighting control system provider shall allow for a comprehensive update on each of the floors to incorporate client changes, partition modifications etc. up to 3 months after the granting of Practical Completion for that floor.
- (b) The lighting control system provider shall offer a maintenance contract to the building occupier; this shall include services for on-site response, remote dial-up and configuration data backup.
- (c) The lighting control system provider shall allow for client training. The training shall include a 1 day on site system familiarisation handover; also fully comprehensive classroom based training shall also be provided, where the client will receive in-depth project specific training.
- (d) The lighting control supplier/manufacture shall allow for return visits to the installation and for any necessary adjustments. These visits shall be carried out at 6 monthly intervals. The lighting control supplier/manufacture shall include for all visits required for the first 18 months following practical completion. Top up training shall also be given as necessary during these site visits.

E63 SMALL POWER INSTALLATIONS**E630100 GENERAL**

- (a) This Section of the specification describes the general requirements for equipment connected with the small power installation. Particular requirements are described within the services description of this specification.
- (b) Electrical wiring shall comply with the requirements of the Wiring Systems Section of this specification as defined in the services description.

E630400 WIRING SYSTEMS**E630401 General**

- (a) Small power systems shall be wired in accordance with BS 7671 with particular note being taken of requirements for high integrity earthing.
- (b) Size of cabling and type of circuits shall generally be as defined on the final distribution board schedules.
- (c) 13 Amp Socket Outlets shall be wired generally on ring circuits. 13 Amp fused connection units may be installed on a ring circuit.
- (d) Under floor power may be supplied by proprietary underfloor plug in busbar systems.
- (e) All other small power supplies shall be wired as radial circuits.

E630404 Ring Circuits

- (a) 13 Amp Socket Outlets shall be wired generally on ring circuits with a minimum cross sectional area of 2.5 mm² with a circuit protective conductor of not less than 50% of the line conductor and not less than 1.5 mm².
- (b) Cable armouring or steel conduits shall not be utilised as the protective earth.
- (c) Where ring circuits supply equipment with a combined earth leakage current in excess of 10 mA, the circuits shall be configured as follows:
 - i) Socket outlets shall be supplied by conventional ring circuits in accordance with BS 7671, with a protective conductor wired as a ring. No spurs from the ring circuit shall be permitted. The supply ends of the protective conductor ring shall be separately connected at the distribution board
 - ii) Twin sockets shall only be fed by single core cables in PVC conduit provided that the socket outlets are of the twin earth terminal type and the protective conductor shall not be less than 4 mm²

E630407 Radial Circuits

- (a) Cabling to radial circuits supplying fixed plant or single outlets shall be sized to suit the protective device but shall have a minimum cross sectional area of 4 mm² with a circuit protective conductor of not less than 50% of the line conductor and not less than 2.5 mm².

- (b) Cable armouring or steel conduits shall not be utilised as the protective earth.
- (c) Radial circuits shall not be issued to feed multiple socket outlets where high earth leakage circuits are anticipated.
- (d) Where radial circuits are to feed a single item of equipment the circuit shall comply with the following criteria:
 - i) Where the anticipated leakage is less than 3.5 mA no additional provision shall be required
 - ii) Where the anticipated leakage is between 3.5 mA and 10 mA the circuit shall either consist of a permanent board wired connection or the connection shall be made via a socket outlet complying with BS EN 60309-2
 - iii) Where the anticipated leakage is greater than 10 mA, the circuit shall comply with the requirements of BS 7671

E630700 WIRING ACCESSORIES

E630701 General

- (a) Wiring accessories shall be of the type and finish indicated on the associated drawings and schedules.
- (b) All accessories within a given area shall be of the same type, finish and manufacture.
- (c) Surface installations shall utilise metalclad accessories fitted to metal boxes with the same finish as the accessory plate. The boxes shall not have knockouts but shall be drilled on site to suit the installation.
- (d) Samples of all wiring accessories shall be submitted, via the Contractor to the Engineer for review and comment.

E630704 Alignment and Fixing Heights of Accessories

- (a) Fixing heights and alignment of all wiring accessories shall be in accordance with the Architects Room Elevations.
- (b) Mounting heights of equipment shall comply with the requirements of BS 8300 and Part M of the Building Regulations.
- (c) Where accessories are positioned on the same wall or surface they shall, where appropriate align horizontally and vertically.
- (d) No operating handle, fuse or other protective device shall be located more than 2000 mm or less than 300 mm above finished floor level.
- (e) Accessories shall be a minimum of 350 mm from any corner.
- (f) Where elevations are not provided the following standard heights shall be applied:

13 Amp Socket Outlet	General use	400 mm above ffl	Bottom of plate
13 Amp Socket Outlet	Above worktop	100 mm above fwl	Bottom of plate

13 Amp Socket Outlet	Plant rooms	1000 mm above ffl	Bottom of plate
5 Amp Lighting Socket Outlet	General use	400 mm above ffl	Bottom of plate
Fused Connection Unit	General use	1200 mm above ffl	Top of plate and adjacent to equipment supplied
Fused Connection Unit	Above worktop	100 mm above fwl	Bottom of plate
Flex Outlet Plate	General	400 mm minimum above ffl.	Bottom of plate and adjacent to equipment being supplied

- (g) Where accessories are to be installed in hazardous areas, such as underground car parks, gas meter rooms etc. the Electrical Services Installer shall ensure the equipment selected is suitable for installation in the hazardous area and installed at the appropriate height.
- (h) Care shall be taken to locate accessories in partitions such that they are not installed back to back to maintain fire and acoustic integrity.

E630707 Accessory Boxes

- (a) Where flush fitting accessories are utilised, boxes shall be manufactured from galvanised steel in accordance with BS 4662.
- (b) They shall have a minimum depth of 35 mm, and have brass earth studs and one or two adjustable lugs.
- (c) Surface accessory boxes shall be steel and manufactured in accordance with BS 5733 and have a minimum depth of 41 mm.
- (d) They shall be fitted with a brass earth stud.
- (e) Surface metal boxes shall have the same finish as the accessory to be installed and shall not have knockouts but shall be drilled on site.
- (f) Surface mounted PVC or urea moulded boxes shall only be utilised where specifically specified. They shall comply with BS 5733 and have a minimum depth of 44 mm.
- (g) They shall be fitted with a brass earth stud.
- (h) Where boxes are installed for the future installation of accessories by others a flat blank plate shall be installed. They shall be of the same finish as other accessories utilised within the area.

E630710 13 Amp Socket Outlets

- (a) 13 amp socket outlets shall comply with BS 1363.
- (b) Socket Outlets shall be either twin or single gang and either:
 - i) Un-switched
 - ii) Switched (Double Pole)

iii) Switched (Double Pole) with Neon Indicators

All as indicated on the schedules and drawings.

- (c) They shall be wired as ring circuits having conductors of not less than 2.5 mm² as indicated on the schedules and drawings.
- (d) Socket outlets shall not be spurred from a ring circuit.
- (e) Socket Outlets shall only be wired as a radial circuit where a single socket outlet is installed to supply a particular item.
- (f) Surface installations shall utilise metalclad socket outlets fitted to metal boxes with the same finish as the accessory plate.
- (g) Where a socket outlet supplies equipment which requires a high integrity earth in accordance with BS 7671 the outlet shall be provided with two earth terminals.

E630713 13 Amp Socket Outlets with integral USB Charging Sockets

- (a) Where specified 13 Amp socket outlets fitted with integral USB charging outlets shall be provided.
- (b) Socket Outlets shall comply with BS 1363 and charging outlets shall comply with BS 5733 and IEC 61558-2-16.
- (c) USB Charging shall be suitable for either USB 2 or USB 3 devices with a minimum charge rate of 2 Amp from any outlet. Each outlet shall be provided with overload and short circuit protection.
- (d) The USB charging outlets shall provide EMC compliance with BS EN 61000-6-1.

E630716 RCD Protected Socket Outlets (Internal Use)

- (a) Where specified BS 1363 socket outlets incorporating an integral residual current device shall be provided complying with BS 7288.
- (b) The residual current device shall be rated at 30mA and shall be fitted with mechanical test buttons and separate reset button.
- (c) Socket Outlets shall be either single or two gang as indicated on the drawings.
- (d) The residual current device shall not, unless otherwise specified, be sensitive to voltage fluctuations and dips and shall remain closed in the event of loss of supply.

E630719 RCD Protected Socket Outlets (External Use)

- (a) Where specified BS 1363 socket outlets incorporating an integral residual current device shall be provided complying with BS 7288 shall be supplied and installed in an IP 56 enclosure conforming to BS EN 60529.
- (b) The trip device shall be rated at 30 mA and shall be fitted with mechanical test buttons and separate reset button.
- (c) Socket Outlets shall be either single or two gang as indicated on the drawings.
- (d) The residual current device shall not, unless otherwise specified, be sensitive to voltage fluctuations and dips and shall remain closed in the event of loss of supply.

- (e) The Electrical Services Installer shall provide RCD/RCBO protection to all socket outlets with a rated current not exceeding 32A via a device with a rated residual operating current not exceeding 30mA, in accordance with the requirements of BS 7671.

E630722 5 Amp Socket Outlets and Plugs

- (a) 5 Amp socket outlets shall only be utilised for dedicated switched lighting circuits supplying either floor or table top luminaires. They shall comply with BS 546.
- (b) Socket outlets shall be of the shuttered type and plugs of the unfused pattern.

E630725 Industrial Socket Outlets and Connectors

- (a) Industrial Socket Outlets and connectors supplying current ratings greater than 13 Amp shall comply with BS EN 60309 series of standards.
- (b) They shall be wired on radial circuits.
- (c) Socket outlets and connectors shall be rated to suit the equipment they supply and shall be either:
 - i) 16 Amp
 - ii) 32 Amp
 - iii) 63 Amp

As indicated on the drawings and schedules.

Note where, due to volt drop, a cable size exceeds the terminal capacity of the socket outlet the next size of outlet shall be utilised.

- (d) They shall be rated and colour coded for the supply voltage:
 - i) 100-130 Volt Yellow
 - ii) 200-250 Volt Blue
 - iii) 380-415 Volt Red
- (e) Pin configurations shall be dependent on the voltage and earthing requirements of the equipment being supplied.
- (f) Outlets for internal use shall be rated at IP 44 and for external use IP 67 both in accordance with BS EN 60529 External units shall also be equipped with integral 30mA residual current devices to BS IEC 62873 series.
- (g) Outlets utilised to supply Façade Access Equipment shall be of the switched interlocked type. The Electrical Services Installer shall liaise with the Facade Access Installer to verify required ratings and pin configurations.

E630728 Fused Connection Units

- (a) Fused Connection units shall comply with BS 1363.
- (b) Fused Connection Units shall, where specified, be switched and shall contain a fuse of the appropriate rating for the appliance served.

- (c) Switches shall be double pole.
- (d) Where specified, the fused connection unit, shall incorporate an integral illuminated indicator.
- (e) Where located adjacent to the item of fixed equipment that they supply the fused connection unit may be fitted with a flex outlet with integral cord grip. The electrical services installer shall provide a suitably rated flexible cord from the fused connection unit and make the final connection to the item of equipment.
- (f) Where remote from the equipment being served a separate flex outlet plate complying with BS 5733, with fixed base connectors shall be provided adjacent to the item of equipment. The electrical services installer shall provide a hard wired connection between the fused connection unit and flex outlet plate in conduit and make the final connection to the item of equipment in a suitably rated flexible cord.
- (g) Connection units shall be engraved with the name of the appliance served and shall be connected into ring circuits wherever possible.
- (h) Where the fused connection unit is intended to serve a Smoke Control Damper classified (MA) it shall offer as a minimum, the same fire performance characteristics as that required of the smoke control system, in terms of time/ temperature criteria.

E630731 Multi Pole Isolation Switches

- (a) Where specified fixed equipment shall be supplied via radial circuits and provided with local multi pole isolators of the specified rating complying with BS EN 60669-1.
- (b) Isolation switches shall be rated to suit the equipment they supply and the protective device at their source.
- (c) Where specified isolators shall be provided with an integral illuminated indicator.
- (d) Where located adjacent to the item of fixed equipment that they supply the isolator may be fitted with a flex outlet with integral cord grip. The electrical services installer shall provide a suitably rated flexible cord from the fused connection unit and make the final connection to the item of equipment.
- (e) Where remote from the equipment being served a separate flex outlet plate complying with BS 5733, with fixed base connectors shall be provided adjacent to the item of equipment. The electrical services installer shall provide a hard wired connection between the isolator and flex outlet plate in conduit and make the final connection to the item of equipment in a suitably rated flexible cord.

E630734 Electrical Supplies to Fire Alarm Equipment

- (a) Electrical Supplies to Fire Alarm panels, voice evacuation amplifier racks, and emergency voice communication master stations etc. shall be carried out as individual radial circuits and terminate in a double pole key switch complying with BS EN 60669-1 in accordance with BS 5839-1 located adjacent to the item of plant.
- (b) Keys shall be suited throughout the building allowing a single key to operate any of the devices but only these devices.
- (c) The key utilised for the Fire Alarm System switches shall be of a different type to any others provided at the site.

E631000 UNDERFLOOR BUSBAR SYSTEMS

- (a) Underfloor busbar systems shall comply with BS EN 61534 series, BS EN 61439-6 and BS 7671 in particular those clauses which refer to high earth leakage.
- (b) It shall be assumed that for all under floor busbar installations the earth leakage exceeds 10 mA and therefore all busbars shall be BS 7671 compliant and provided with a dedicated internal earth segregated from the general circuit protective conductor.
- (c) Underfloor busbar trunking systems shall be rated at 63 Amps, although the circuit protective device may be less, they shall be spaced to provide adequate flexibility to serve all floor outlet locations.
- (d) Protective devices and cabling to busbars shall be as noted within the distribution board schedules. Cables shall be sized to suit the protective device but shall have phase conductors with a minimum cross sectional area of 10 mm² a circuit protective conductor sized in accordance with BS 7671 and a dedicated earth of minimum cross sectional area 10 mm².
- (e) Supply cables shall be identified at each end with their respective circuit reference.
- (f) Busbars shall be constructed to withstand a fault level equal to the maximum breaking capacity of the controlling incoming protective device.
- (g) Each trunking section shall be complete with all accessories including cable end feed unit, sealed end, fixings and supporting brackets.
- (h) Trunking shall comprise copper conductors fixed within a metal enclosure.
- (i) End feed units for connecting the supply cable to the trunking shall have a metal housing with terminals capable of accepting minimum 16 mm² conductors. The feed unit shall be suitable for connection to armoured cables or single core cables in metal conduit.
- (j) Trunking systems shall be provided with shuttered socket outlets spaced at 300 mm centres.
- (k) Plug in unit enclosures shall make positive contact to the housing before the phase conductor makes contact with the live busbars. Units shall be capable of being added to, or removed from, the trunking without disconnecting the power supply to the busbars.
- (l) Unfused plug-in units shall be provided with XLPE cable, enclosed in a metallic flexible conduit, in general the flexible cables shall be 3 or 5 metres long. Where the flexible cable exceeds a length of 5 metres, a fuse shall be incorporated into the busbar plug. All fused plug-in leads shall be clearly labelled and indicated on the 'As Fitted' drawings. Cable and conduit ends shall be suitable for terminating in a floor outlet box, desk module or a BS EN 60309 socket outlet.
- (m) It shall not be possible to connect the plug-in unit across the phases on three phase busbar trunking.
- (n) Trunking shall be installed within the floor void in accordance with the manufacturer's recommendations. Sufficient clearances shall be left to allow a floor outlet box or grommet to be fitted directly over the busbar trunking.

- (o) Each section of busbar trunking shall be clearly labelled to indicate the phase of the supplying circuit at each outlet location.
- (p) Three phase trunking, where used, shall be clearly identified with appropriate warning labels securely attached.
- (q) Underfloor busbar systems shall be tested in accordance with BS 7671 and the manufacturer's instructions.

E631300 FLOOR BOXES

- (a) The Electrical Services Installer shall supply and install floor boxes where specified, located as indicated on the drawings.
- (b) The floor boxes shall be of the open frame type with individual removable back boxes for each outlet compartment, a self-closing lid and be designed to accept a 5000 N load.
- (c) The height of the removable back boxes shall be adjustable to achieve a minimum clearance of 60 mm between the outlet plate and the inside face of the lid in order to accommodate both plug top connections and portable equipment transformers.
- (d) The floor boxes shall generally be 3 compartment or 4 compartment where additional power or audio visual services are required.
- (e) Socket outlets within floor boxes shall be fitted with integral 30 mA residual current devices.
- (f) Telephone, data and audio visual connectivity shall be as described within the services description. Where no connectivity is specified, modular removable plates shall be provided to enable the incoming tenant to retro fit connectivity as required.
- (g) They shall incorporate a reliable quick release mechanism to ensure a fast and simple installation.
- (h) Floor boxes shall be designed to support all data cabling technologies available at the time of installation.
- (i) The floor boxes shall be IP4X rated in accordance with BS EN 60529 and shall be equipped with integral residual current device protection unless otherwise specified.
- (j) The floor boxes shall be supplied fitted with a 3 or 5 metre flexible metal clad cable (suitable for its intended location), with four LSF insulated copper conductors fitted complete with a 32 amp un-fused busbar tap off to suit the specified underfloor busbar system.
- (k) The four cable cores shall comprise of live, neutral and two earths independently connected to earth terminal points to provide high integrity earthing in accordance with BS 7671.
- (l) The floor box shall be provided with the appropriate lid providing sufficient depth to accommodate the specified floor finish (generally 6 mm minimum).
- (m) Where the floor boxes are installed in areas consisting of laminate or vinyl type flooring, the floor box trim shall be suitably rebated into the surface of the floor tile to ensure that the floor box fixing frame fits against the surface of the floor finish.
- (n) For finish floor details refer to the architect's finishes drawings and specification.

- (o) The floor boxes shall be provided with a printed label to identify the circuit reference and busbar track to which it is connected.
- (p) Generally the floor boxes shall be located in one side of the tile, allowing the tile to be rotated to adjust the final location of the floor box. The Electrical Services Installer shall allow for the coordination with the Architect and installing the floor boxes in accordance with the current furniture layout.
- (q) The Electrical Services Installer shall be responsible for coordinating the depth of the specified floor box with the available floor void depth and the sub floor services. Only with the written approval of the Engineer shall reduce depth floor boxes be utilised.
- (r) The Electrical Services Installer shall provide drawings for the installation of all floor boxes and shall verify that all units have been installed in the correct locations.

E631600 FLOOR GROMMETS

- (a) The Electrical Services Installer shall supply and install floor grommets, where specified, located as indicated on the Tender Drawings.
- (b) The diameter of floor grommets shall be as noted elsewhere within the specification and schedules.
- (c) Floor grommets' shall be supplied complete with cover plates and accessories.
- (d) The Electrical Services Installer shall ensure the grommet cut-out is in accordance with the manufacturer's recommendations.
- (e) The removable cover of the grommet shall have the ability to accommodate the specified floor finish (generally 6 mm minimum). For finish floor details refer to the architect's finishes drawings and specification.
- (f) The Electrical Services Installer shall allow for being in attendance as required, during the furniture installation, for final grommet positioning and also allow for a return visit to install the power modules into the furniture and connect the equipotential bonding as required by the Engineer.
- (g) The Electrical Services Installer shall allow for the production of a final grommet position layouts prior to commencing the installation of the grommets, to ensure the optimum location is determined.

E631900 CLEANERS SOCKETS WITHIN FLOOR GROMMETS

- (a) Cleaner's sockets shall be located in a dedicated floor grommet with removable cover. The removable cover shall have the ability to accommodate the specified floor finish (generally 6 mm minimum). For finish floor details refer to the architect's finishes drawings and specification.
- (b) Where cleaners sockets are shown in floor grommets, the XLPE/SWA/LSOH feeder cables shall terminate directly into the grommet.
- (c) The cleaner's grommets shall be provided with a printed label to identify the circuit reference and the circuit shall be protected by a 30 mA RCBO rated to suit the circuit configuration (radial or ring).

E632200 FURNITURE MOUNTED DESK POWER MODULES

- (a) Where the office small power installation comprises of underfloor busbar directly feeding furniture power distribution modules, the tap offs shall be un-fused and not more than 5 m long and rated at not more than 32 Amps.
- (b) The tap-off cables shall be enclosed in flexible metal conduit and shall be routed via a floor grommet to feed the power modules on the furniture.
- (c) The furniture power modules shall be equipped with 32 mA RCD protective devices, in compliance with BS 7671.
- (d) The below desk power modules, unless specified elsewhere shall be 4 way with a further 2-way power module installed at desk top level and this shall plug into the 4-way module under the desk.

E632500 RESIDUAL CURRENT DEVICES

- (a) Residual current devices (RCD) shall be double or four pole devices and comply with BS IEC 62873 series and shall unless otherwise specified be provided with Type A or B 30 mA trip devices.
- (b) RCD's shall have a minimum fault rating of 15 kA.
- (c) RCD's shall be fitted with protection to protect against nuisance tripping caused by downstream transient surges and switching.
- (d) It shall not be possible manually hold an RCD in circuit under fault conditions.
- (e) RCD's shall incorporate protection to ensure that pulsating dc currents do not affect their operation.
- (f) RCD's shall have dolly operated control switches with clear indication of the ON, OFF and TRIP positions.

E632800 TIME SWITCHES

- (a) Time switches shall be self-contained units, programmable seven day 24 hour with solar functionality operating on the local AC voltage supply.
- (b) Time switches shall be capable of a minimum of four 'on' and four 'off' operations in any 24 hour period with day omission facilities.
- (c) Time switches shall have solar functionality with the facility for switching 'on' at sunset and 'off' at sunrise through the year and shall auto adjust for GMT/BST as required.
- (d) Time switches shall be controlled by or quartz movement with a spring or battery reserve to maintain the function of the switch for 36 hours in the event of a power failure. Contacts shall be rated at a minimum of 20 A resistive, 15 A inductive.
- (e) Terminals shall be fully shrouded and capable of accepting two conductors, each 2.5 mm² cross sections in each terminal. The switch shall be provided with a separate earth terminal.
- (f) Each time switch shall be encased in a dust-tight metal casing having a hinged front cover with a clear Perspex window. The casing shall be effectively earthed.

E633400 ELECTRICAL WORK ASSOCIATED WITH MECHANICAL SERVICES

- (a) Electrical work associated with mechanical services is described within the mechanical services specification and will be provided as part of those Works.
- (b) The work to be provided as part of this specification shall comprise the installation to and termination of all incoming power supplies to control panels, including power supplies to control panels on packaged equipment where such supplies are not from a mechanical control panel.
- (c) The Electrical Services Installer shall liaise with the Mechanical Services Installer to verify the correct size and type of cable terminations are provided on the control panels.
- (d) Where supplies are taken to control panels mounted on rotating equipment the Electrical Services Installer shall provide an isolator adjacent to the plant fixed either to the wall or on a floor to ceiling channel frame work with the final connection to the plant being carried out in single core cables enclosed in metal flexible conduit.
- (e) Electrical check metering (MID certified and approved) shall be provided to electrical supplies serving mechanical plant in accordance with the project metering strategy.

E70 FIRE DETECTION AND ALARM SYSTEMS**E700100 GENERAL**

- (a) This Section of the specification describes the general requirements for the fire detection and alarm systems. Particular requirements shall be as described within the services description of this specification.
- (b) The Electrical Services Installer shall utilise the services of a LPS 1014 registered fire alarm contractor and shall submit a valid certificate of conformity with the tender documentation.
- (c) The supplier shall be approved to BS EN ISO 9001 Quality System standards for the design and manufacture of the fire alarm systems equipment.
- (d) The fire alarm system shall be wired throughout utilising enhanced grade fire resistant cable, as defined in BS 5839-1. The cables shall be tested in accordance with BS EN 50200 including Annex E and BS 8434-2. The cable manufacture shall be selected from those specified in the schedules contained within this specification.
- (e) The wiring installation shall comply with the wiring systems section of the specification. Call points shall have conductors with a minimum size of 1.5 mm². Bell and sounder wiring shall have a minimum size of 2.5 mm². All wiring shall be of adequate section to prevent excessive volt drop in accordance with the requirements of BS 7671.
- (f) The fire alarm system shall be installed, completed, commissioned and witnessed by the Engineer at least one week before Practical Completion. Practical Completion will not be granted until the system has been operating faultlessly for at least one week. A system logbook shall also be handed to the Client suitably completed.

E700400 CONTROL AND INDICATION EQUIPMENT**E700401 General**

- (a) The control and indicating equipment shall form the central processing unit of the system, receiving and analysing signals from fire sensors, providing audible and visual information to the user, initiating automatic alarm response sequences and providing the means by which the user interacts with the system.
- (b) The control and indicating equipment shall be modular in construction to allow for future extension of the system. It shall incorporate two alternative methods to prevent unauthorised use of the manual controls (with the exception of the 'SILENCE BUZZER' control) using a key or a password.
- (c) The control and indicating equipment shall be microprocessor based and operate under a multitasking software program. Operating programs and configuration data shall be contained in easily up-datable non-volatile memory (EEPROM). The use of 'burnt' EPROM's will not be permitted.
- (d) The control and indicating equipment shall incorporate a real-time clock (accurate to within 1 minute per year under normal operating conditions and with daylight saving compensation). It shall comprise separate processors, cross-monitoring each other's

correct operation, for the major functions of the systems. In particular, different processors shall be used for the main control function, the detection input and alarm output functions, and the display and control function.

- (e) The control and indicating equipment shall have the capability to run up to 2000 addressable devices with the address code for each held within the addressable device and programmed via either the control and indicating equipment or a dedicated programming tool.
- (f) The control and indicating equipment shall be field configurable by USB device or PC with configuration data being capable of back up to a central storage system.
- (g) The control and indicating equipment shall meet the requirements of BS EN 54-2 and BS EN 54-4, shall be capable of being installed to BS 5839-1 and shall be approved, together with associated ancillary equipment, by the Loss Prevention Certification Board (LPCB).
- (h) The control and indicating equipment shall have achieved and be in compliance with, Safety Integrity Level (SIL) 2 as a measure of required performance determined by the International Electrotechnical Commission IEC EN 61508.

E700404 System Configuration

- (a) The control and indicating equipment shall be capable of working with either conventional or digital addressable types of automatic detection equipment. This should include ATEX approved intrinsically safe conventional detectors and digital addressable detectors suitable for installation in hazardous areas.
- (b) The control and indicating equipment shall be capable of sub-dividing each addressable loop into a maximum of 240 geographical zones with each zone circuit protected from faults in other sections by line isolator modules.
- (c) The control and indicating equipment shall be capable of driving and monitoring multiple repeater panels, providing a repeat of the fire panel indications and also incorporating the full set of system manual user controls.
- (d) The control and indicating equipment shall be capable of housing the AC Main power supply and batteries required to power systems of up to 80 zones, indicated by the use of LEDs.
- (e) The control and indicating equipment shall be capable of connection of external power supplies, either local or distributed throughout the system.
- (f) The control and indicating equipment shall be capable of the connection of an 80 character line printer, either locally via a parallel port or remotely via a serial port and to display via PC the information that would otherwise appear on the printer.
- (g) The control and indicating equipment shall be capable of interfacing directly to an electronic radio paging system and be capable of on-board communications module to allow local area networking to other controllers and shall be capable of interfacing with third party equipment via a MODBUS interface.
- (h) The control and indicating equipment shall only be opened with the use of a special tool or key.
- (i) It shall be possible for addressable input and output devices to be connected to the addressable loops capable of accepting 250 devices or greater.

- (j) It shall be possible for addressable input and output devices to allocate addresses to devices independently of their physical arrangement on the loops.
- (k) A mimic diagram shall be provided adjacent to the fire alarm control panel. The mimic diagram shall be silk screened and framed to match the main fire alarm panel. The diagram shall represent the building at each level and indicate the extent of each zone in contrasting colours. The diagram shall also give brief instructions on the use and operation of the fire alarm panel.
- (l) Where a graphical front end pc is included with the control equipment as a means of maintaining the fire alarm system, the graphics package shall be based on the current edition of AutoCAD. The modification of the graphics shall be a relatively simple task for a CAD operator employed by the Client.

E700407 Basic System Functions

- (a) The control and indicating equipment shall monitor the status of all devices on the addressable loops for fire, short-circuit fault, open-circuit fault, incorrect addressing, unauthorised device removal or exchange, pre-alarm condition and contaminated detector condition.
- (b) The control and indicating equipment shall monitor the status of internal connections and interfaces, including charger, battery and remote signalling functions.
- (c) The control and indicating equipment shall have an integral 8.4" TFT colour touch screen multilingual user interface -with a facility to manually check the LCD display function.
- (d) The control and indicating equipment shall provide facilities to drive visual indication LED mimic displays for each of the following zonal status: Alarm, Fault and Isolated.
- (e) The control and indicating equipment shall provide the following facilities for signalling the following system conditions to a remote (Central Station) and/or an on-site monitoring centre: Alarm, Pre-alarm, Fault and Zone Isolated.
- (f) The control and indicating equipment shall be capable of monitoring and controlling remote site devices, such as door release units and relays for the control of plants and dampers, directly from the addressable loops.
- (g) The control and indicating equipment shall be capable of monitoring fire doors such that, in the event of a fire alarm condition, an event is generated to warn of the failure of a fire door to close.
- (h) The control and indicating equipment shall provide programmable outputs to activate emergency lighting in the event of a mains supply failure.

E700410 Alarm Monitoring Functions

- (a) The control and indicating equipment shall interrogate each addressable device at least once every 5 seconds.
- (b) The control and indicating equipment shall incorporate fire decision algorithms specifically adapted to the response characteristics of the digital addressable detectors employed. Algorithm processing in each detector will not be permissible.

- (c) The control and indicating equipment shall meet the response time requirement of the relevant part of EN 54 and shall not exceed 10 seconds.
- (d) The control and indicating equipment shall have a special scanning sequence so that designated manual call points provide alarm indication and warning within 3 seconds of operation.
- (e) The control and indicating equipment shall have a facility to automatically adjust the sensitivity of addressable detectors to a higher level for periods of time when the building is unoccupied.
- (f) The control and indicating equipment shall have as an optional software enhancement, with the ability to annunciate a pre-alarm condition designed to give the earliest possible warning of a potential fire condition without raising the full alarm condition.
- (g) The control and indicating equipment shall have as standard, the ability to automatically adjust the alarm and pre-alarm threshold levels to compensate for changes in detector sensitivity due to contamination over a period of time.
- (h) The control and indicating equipment shall have as standard, the ability to provide automatic warning that a detector has reached a level of contamination which requires it be replaced or serviced.
- (i) The control and indicating equipment shall have the ability to display the levels returned from the sensors in a meaningful way i.e. temperature in degrees C, smoke in %/m and carbon monoxide in ppm.

E700413 Alarm Output Function

- (a) The control and indicating equipment shall provide the necessary outputs, driving a sounder load of up to 500 mA, to separately operate two monitored circuits of common system sounders.
- (b) The control and indicating equipment shall be able to monitor and control the integrity of zonal sounder circuits, via a suitable addressable module.
- (c) The control and indicating equipment shall be capable of providing a two-stage alarm sounder facility that can be programmed, either on a zonal basis or common system basis, to meet the requirements of the fire authority. Three possible sound output signals shall be available including:
 - (d) Alert pulsed tone (1 second ON, 1 second OFF)
 - (e) Evacuate continuous tone
 - (f) User definable tone for specialised events, for example bomb alert
- (g) The control and indicating equipment shall have the facility to change, on a per sounder zone basis, the sound output signal dependent upon whether the source of alarm is an automatic detector, a manual call point, an EVACUATE command, a non-fire event (for example plant alarm etc.).
- (h) The control and indicating equipment shall be capable of generating client definable time delay sequences to upgrade alarm sounder responses, without the need for external timers, as follows: Silent to Alert, Alert to Evacuate, Silent to user defined tone.

- (i) The control and indicating equipment shall provide an interface using a dual path signal to drive a public address system.
- (j) The control and indicating equipment shall have the ability to delay the transmission to the Fire Brigade of fire alarm signals from automatic detectors in pre-determined detection zones. Configurable to a maximum of 2 minutes, extendable to 10 minutes if required. This function should be automatically inhibited when the building is unoccupied and should not apply to alarms generated by manual call points, which shall be transmitted immediately.

E700416 Supervision and Fault Reporting

- (a) The control and indicating equipment shall monitor all critical system components and interconnections (internal and external). In the event of a failure occurring which prevents correct operation of the alarm functions, a FAULT indicator will light and a message shall be given on the graphical display within 100 seconds of occurrence.
- (b) The control and indicating equipment shall provide text messages to indicate the precise location of where a fault has occurred in the system and be capable of monitoring and indicating the status of auxiliary units, such as a remote signalling transmitter.
- (c) The control and indicating equipment shall have the facility to delay the generation of an event to confirm operation of the monitored device. This shall be either 6 seconds for normal de-bounced contacts, or 40 seconds for fluctuating contacts, e.g. sprinkler flow valve switches.
- (d) The control and indicating equipment shall be able to display 240 site plans in response to selected alarms to illustrate graphically the location of alarms.

E700419 System Management Facilities

- (a) The control and indicating equipment shall incorporate comprehensive system management facilities that can be restricted to customer manager access level or above.
- (b) The control and indicating equipment have an event log capable of storing up to the last 10,000 events that have occurred. It shall be possible to view the content of the log via the alphanumeric display.
- (c) The control and indicating equipment be capable of providing audible and visual warning when a weekly system test, as defined in BS 5839-1: 2013, is required.
- (d) The control and indicating equipment be capable, via a suitable timer unit, of isolating a group of selected detectors in areas of the building where maintenance work is carried out. The detectors shall be automatically re-instated after a pre-determined time.
- (e) The control and indicating equipment provide short circuit wiring fault isolation to every detector on the loop.

E700422 Technical Specification

- (a) The control and indicating equipment shall operate on a mains power supply of 240 Vac +10% -6% @ 50 Hz +/- 2 Hz or 115 Vac +15% -10% @ 50/60 Hz.

- (b) The control and indicating equipment, standard power supply unit and standard repeater unit shall comply with the following environmental conditions:
- i) Operating temperature range: 8 °C to +55 °C
 - ii) Storage temperature: -20 °C to +70 °C
 - iii) Relative humidity: up to 95% RH (non-condensing)
 - iv) IEC protection category: IP30 minimum
- (c) The control and indicating equipment, standard power supply unit and standard repeater unit shall comply with, at least, the EMC requirements described in BS EN 54-2 and BS EN 54-44.

E700700 AUTOMATIC DETECTORS

E700701 General

- (a) Detectors shall be selected to suit the type of system described in the services description of this specification. Detectors shall be compatible with the environmental conditions appropriate to their location without resulting in false alarm conditions being generated.
- (b) The automatic fire detectors shall be approved and listed by the Loss Prevention Certification Board (LPCB).
- (c) Detectors shall provide separate fire and fault signals. They shall also be capable of transmitting information regarding their condition and the environment. Each detector shall be provided with an integral LED which shall illuminate when the unit is in the alarm state.
- (d) Detectors shall be fixed to the installation by means of plug-in detector bases, suitable for direct mounting to conduit boxes. The bases shall incorporate the optional feature of being able to lock the detector into position once plugged-in.
- (e) The addressable base must incorporate all the circuitry required for communicating detector status to the control and indicating equipment, including the means of addressing.
- (f) Addressable detectors and modules must be able to transmit to the control and indicating equipment a pre-set and unique identifier to detect unauthorised changes in the system configuration.
- (g) It shall be possible to connect and mix automatic detectors, manual call points and addressable modules within the same zone sub-division of an addressable loop.
- (h) When called for elsewhere in the specification, intrinsically safe versions of the automatic detectors, plug-in bases, line isolators and monitoring modules shall be provided. The intrinsically safe devices shall be designed to comply with BS 5501-7 and be certified by BASEEFA to EEx ia IIC T5.
- (i) It shall be possible to connect several circuits of intrinsically safe addressable devices to a standard addressable loop via standard BASEEFA approved safety barriers from the loop as spurs.

- (j) Both the conventional and addressable detector bases shall be capable of driving a separate alarm LED indicator module.
- (k) The automatic detectors shall be designed to have high resistance to contamination and corrosion.
- (l) The automatic detectors shall include RFI screening and feed-through connecting components to minimise the effect of radiated and conducted electrical interference.
- (m) Smoke sampling detectors shall be designed to prevent small insects from creating nuisance alarms.
- (n) Heat detectors shall have a fully coated thermistor to resist environmental contamination.
- (o) The Automatic detectors shall have the option of a built in Short Circuit Isolator (SCI), as required.
- (p) Detectors shall have automatic self-test functionality on individual sensing channels.
- (q) Detectors shall have separate Fire and Fault LED indication built in to the device.
- (r) Carbon Monoxide (CO) cells used in the construction of gas detection channels shall have an extended service life of 10 years before requiring replacement.
- (s) Smoke sampling optical chambers shall have an extended service life of 20 years (in a benign environment) before requiring replacement.

E700704 Multi – Criteria Detector

- (a) Multi-criteria detectors shall be approved and listed by the Loss Prevention Certification Board (LPCB) and shall combine heat (designed in accordance with BS EN 54-5), optical smoke (designed in accordance with BS EN 54-7) and carbon monoxide detection.
- (b) Multi-criteria detectors shall be capable of being configured as one or more of the following operating modes:
 - i) High false alarm immunity (employing all three detection technologies)
 - ii) Universal (employing all three detection technologies) High performance optical, A1R Rate of rise heat, combined heat and CO, Toxic gas (complying with EN 50291)
- (c) Multi-criteria detectors shall be capable of operating as a single address employing all three detection technologies and as a multiple addressed device using 3 addresses.
- (d) When employing all three detection technologies the operation of the optical chamber in the multi-criteria detector shall be enhanced by the presence of CO and/or heat.
- (e) Each detection technology shall be monitored individually such that the failure of a single detecting element shall not affect the operation of the remaining two elements.
- (f) The optical chamber within the multi-criteria detector shall employ the pedestal principle to enhance the monitoring of the chamber and the detector ability to detect both thin burning white smoke and thick black smoke.

- (g) The multi-criteria detector shall be capable of being programmed for a “double knock” system.
- (h) The optical smoke detector shall incorporate a separate fire and fault LED, clearly visible from the outside, to provide indication of an alarm or fault actuation.

E700707 Optical Smoke Detectors

- (a) The optical smoke detectors shall be capable of detecting visible combustion gases emanating from fires.
- (b) The optical smoke detectors shall employ the forward light-scatter principle, using optical components operating at a wavelength of 4.35 nm.
- (c) The design of the optical smoke detector sensing chamber shall be optimised to minimise the effect of dust deposits over a period of time.
- (d) The optical smoke detector shall incorporate an LED, clearly visible from the outside, to provide indication of alarm actuation.
- (e) The optical smoke detectors shall incorporate screens to minimise the effect of small insects.
- (f) Optical smoke detectors shall comply with BS EN 54-7.

E700719 Heat Detectors

- (a) The heat detectors shall be capable of detecting rapid rise in temperature and fixed absolute temperatures.
- (b) The heat detectors shall employ two heat sensing elements with different thermal characteristics to provide a rate of rise dependent response.
- (c) The temperature sensing elements and circuitry of the heat detectors shall be coated with epoxy resin to provide environmental protection.
- (d) The heat detectors shall include RFI screening and feed-through connecting components to minimise the effect of radiated and conducted electrical interferences.
- (e) The heat detector shall incorporate a separate fire and fault LED, clearly visible from the outside, to provide indication of an alarm or fault actuation.
- (f) Heat detectors shall comply with BS EN 54-5.

E700725 Linear Beam Smoke Detectors

- (a) The beam smoke detectors shall be capable of detecting the presence of smoke in large open-type interiors.
- (b) Either point to point or reflective beam smoke detectors shall be utilised.
- (c) The beam smoke detectors shall project a modulated infrared light beam from a transmitter unit to a receiver unit. The received signal shall be analysed and, in the event of smoke being present for a pre-determined period, an alarm condition is activated.

- (d) The detectors shall be capable of providing cover in open areas up to 100 m in length and up to 14 m wide, giving an effective protection area of up to 1400m².
- (e) The fire alarm output of the detectors shall be activated in the event of smoke reducing the signal strength between 40% and 90% for a period of approximately 5 seconds.
- (f) In the event of a power failure at the transmitter unit or if the transmitted signal is reduced by more than 90% for a period in excess of 1 second, then a fault alarm condition shall be indicated. This condition shall inhibit the fire alarm until the signal is restored.
- (g) The receiver unit of the detectors shall be capable of performing an automatic reset, approximately 5 seconds after a fault is indicated, if the fault is no longer present.
- (h) The detectors shall include Automatic Gain Control (AGC) circuitry capable of providing compensation for long-term degradation of signal strength caused by component ageing or build-up of dirt on the optical surfaces of the transmitter and receiver unit lenses.
- (i) The receiver unit of the detectors shall incorporate an alignment/fault lamp, clearly visible from the outside, to provide indication of both alignment and fault conditions.
- (j) Linear beam smoke detectors shall comply with BS EN 54-12.

E700728 Aspirating Smoke Detectors

- (a) The aspirating smoke detectors shall be capable of detecting the presence of smoke particles in air samples drawn from many different locations.
- (b) The aspirating smoke detectors shall provide a continuous analogue profile of ambient air conditions.
- (c) The detectors shall be capable of responding to a developing fire situation with multiple staged alarms.
- (d) The fire alarm output of the detectors shall be programmable to allow sufficient time for action to be taken; from a detailed investigation of the cause of the alarm to a full-scale evacuation.
- (e) The design of the detectors shall be such that they can be integrated with a fire alarm system and guard against specific pieces of equipment, such as computers, equipment racks, power boards and telecommunications switching racks, as well as entire rooms or floors.
- (f) The detectors shall include a facility to allow sensitivity threshold adjustments to suit the needs of particular environments.
- (g) Each detector shall be capable of monitoring an area up to 2000 m² using easy to install ABS pipework. (Depending on the level of risk or hazard involved, it may be appropriate to use a greater number of detectors).
- (h) The detectors shall incorporate a LED indicator, clearly visible from the outside, to provide indication of alarm or fault condition.
- (i) Aspirating smoke detectors shall comply with BS EN 54-20.

E700734 Remote Indicator Modules

- (a) The remote indicator module shall provide a remote indication for any conventional or analogue addressable detector that may be located in an enclosed or locked compartment.
- (b) The remote indicator module shall be driven directly from its associated local detector.
- (c) The connection to the remote indicator module shall be monitored for open and short-circuits.

E701000 ASSOCIATED ANCILLIARY EQUIPMENT**E701001 General Requirements**

- (a) The Fire Alarm Contractor shall have available a comprehensive selection of manual call points and line modules for direct connection to the system addressable loops including intrinsically safe version (designed to comply with EN 50014 and EN 50020 and be ATEX certificated by BASEEFA to EEx ia IIC T5.) of the addressable contact monitoring module for connection of 'simple apparatus' such as conventional manual call points.
- (b) Equipment connected to the system addressable loops, either directly or via interfaces, shall be proofed against electrical noise, high frequency pulses and electromagnetic influences from other equipment.

E701004 Addressable Manual Call Points

- (a) The addressable manual call points shall meet the requirements of BS EN 54-11 to monitor and signal to the control and indicating equipment the status of a switch operated by a 'break glass' assembly.
- (b) The addressable manual call points shall be capable of operating by means of thumb pressure and not require a hammer and shall be capable of being mounted in weather-proof enclosure affording protection to IP65.
- (c) The addressable manual call points shall incorporate a mechanism to interrupt the normal addressable loop scan to provide an alarm response within less than 3 seconds.
- (d) The addressable manual call points shall be field programmable to trigger an alert or an evacuate response from the control panel and shall be capable of being tested using a special 'key' without the need for breaking the glass.
- (e) The addressable manual call points shall provide an integral red LED to indicate activation.
- (f) Manual call points shall be fixed at a height of 1.4 m above finished floor level, at easily accessible, well-illuminated and conspicuous positions free from potential obstruction. They shall be sited against a contrasting background to assist in easy recognition.
- (g) Manual call points shall comply with BS 5839-2 and BS EN 54-11.

E701007 Conventional Detector Interface Module

- (a) The conventional detector interface module shall monitor and signal the status of up to 20 conventional detectors and manual call points and shall signal alarm, open-circuit fault, short-circuit fault and power supply fault status.
- (b) The conventional detector interface module shall be capable of monitoring automatic detectors and manual call points from existing conventional systems.
- (c) The conventional detector interface module shall provide integral red LED indication when in the alarm state.

E701010 Addressable Relay Output Module

- (a) The addressable relay output module shall provide a volt free changeover relay contact operated by command and shall have contacts rated at a minimum of 2 Amps at 24 Vdc.
- (b) The addressable relay output module shall monitor the relay coil for open-circuit and transmit the fault signal to the control and indicating equipment and shall be capable of deriving its operating power from the addressable loop.
- (c) The addressable relay output module shall provide a red LED indication that the relay has operated.

E701013 Addressable Contact Monitoring Module

- (a) The addressable contact monitoring module shall provide monitoring of the status of switched input signals from either normally open or normally closed contacts.
- (b) The addressable contact monitoring module shall provide a red LED indication when the contact has operated.
- (c) The addressable contact monitoring module shall be capable of deriving its power directly from the addressable loop.

E701016 Addressable Sounder Driver Module

- (a) The addressable sounder driver module shall be capable of monitoring and driving a circuit of alarm sounders and be rated at 500 mA.
- (b) The addressable sounder driver module shall be capable of operating the sounders in a pulsing or continuous mode
- (c) The addressable sounder driver module shall provide the facility to monitor the wiring to the sounders for open or short-circuit and transmit the necessary fault signal to the control and indicating equipment
- (d) The addressable sounder driver module shall provide the facility to monitor for failure of the power supply for the sounders and transmit the necessary fault signal to the control and indicating equipment
- (e) The addressable sounder driver module shall provide a red LED indication that the sounder circuit has been actuated.

E701019 Loop Powered Addressable Sounder Driver Module

- (a) The loop powered addressable sounder driver module shall be capable of deriving its power directly from the addressable loop and be capable of providing 24 Vdc up to a max of 75 mA.

E701022 Sounder Booster Module

- (a) The sounder booster module shall be capable of monitoring and driving a heavy duty circuit of sounders up to 15 Amps.
- (b) The sounder booster module shall of interfacing either to the common sounder outputs of the control and indicating equipment or to the output of the addressable sounder driver module.
- (c) The sounder booster module shall be designed to maintain the monitoring of the sounder circuit and transmit a fault signal either via the addressable sounder driver module or directly to the control and indicating equipment.

E701028 Addressable Power Supply Module

- (a) The addressable power supply module shall derive its power from the 115/240 Vac mains supply and be capable of supplying up to 24 Vdc, 3 Amps power to local sounder circuits and ancillaries.
- (b) The addressable power supply module shall be able to contain and maintain in a charged state a 24 V battery set of up to 15 Ah capacity.
- (c) The addressable power supply module shall monitor the mains power supply and the battery and transmit a fault signal as appropriate.

E701031 Line Isolator Module

- (a) Line isolation shall be by the use of either separate modules, line isolator detector bases or line isolation built in to ancillary modules.
- (b) Line isolation shall provide protection on the addressable loop by automatically disconnecting the section of wiring where a short circuit has occurred and provide an LED indication that the module has tripped.
- (c) Line isolation shall derive power directly from the addressable loop.

E701034 Door Control Module

- (a) The door control module shall comply with the requirements of BS 7273-4 as a category A actuator.
- (b) The door control module shall provide output required to control a hold open fire door device, an electromagnetic release on a means of escape, or a sliding door on a means of escape.
- (c) The door control module shall also provide an input to monitor an emergency breakglass call point to release the device whilst taking only one address on the addressable loop.

- (d) The door control module shall be fully addressable and provide one volt-free changeover relay contact rated at 24 Vdc @ 2 Amps.
- (e) The door control module shall incorporate an integral line isolator.
- (f) The door control module shall include a monitored and controlled changeover relay contact.
- (g) The door control module shall derive its power directly from the addressable loop.
- (h) The door control module shall have a clearly visible red LED, to provide an indication of relay operation.

E701037 Multiple Input / Output Module

- (a) The multiple input / output module shall be fully addressable, provide all 3 inputs and 4 outputs to interface and provide 2 volt-free changeover relay contacts rated 24 Vdc @ 2 A and 4 outputs to operate an external high voltage relay interface rated at 240 Vac @ 10 A.
- (b) The multiple input / output module shall provide monitored and controlled changeover relay contacts
- (c) The multiple input / output module shall derive its power directly from the addressable loop.

E701040 Single Input / Output Module

- (a) The single input / output module shall provide an input and an output. The module shall, however, take only one address on the addressable loop.
- (b) The operation of the input and the output shall be independent (i.e. the output must not have to follow the input).
- (c) The single input / output module shall be fully addressable and provide a volt-free changeover relay contacts rated 24 Vdc @ 2 A.
- (d) The changeover relay contacts of the single input / output module shall be monitored and controlled by commands signalled from the monitoring system control panel via the addressable loop
- (e) The single input / output module shall be capable of monitoring a single external relay contact.
- (f) The module shall derive its power directly from the addressable loop.

E701043 Loop Powered Beam Detector Module

- (a) The loop powered beam detector module shall provide power to, and monitor the fire and fault outputs of an infrared optical beam detection.
- (b) The loop powered beam detector module shall derive its power directly from the addressable loop.
- (c) The loop powered beam detector module shall be capable of powered and monitoring reflective and point to point beam detection.

- (d) The loop powered beam detector module shall be capable of monitoring multiple external relay contacts.
- (e) The loop powered beam detector module shall have a clearly visible red LED to provide an indication of relay operation.

E701046 Addressable Loop Powered Sounder / Beacon

- (a) The loop powered sounder shall be capable of producing a sound output of 103 dB at 1 m.
- (b) The loop powered sounder shall have the option of an integral LED beacon for Equality Act 2010 compliance.
- (c) The loop powered sounder shall have two volume settings, 16 selectable tones and two flash rates (for the LED beacon).
- (d) The loop powered sounder shall be configured by a trained engineer during system configuration and commissioning. The facility to change the volume and tone settings shall not be available in the sounder.
- (e) The loop powered sounder shall incorporate an integral line isolator.
- (f) The loop powered sounder shall be self-monitoring such that if the sounder fails to operate during a test or a genuine fire activation, an appropriate fault message is displayed on the control and indicating equipment.
- (g) The loop powered sounder shall derive its power directly from the addressable loop.
- (h) The loop powered visual alarm devices shall be fully compliant with the requirements of BS EN 54-23.

E701300 ASPIRATING SMOKE DETECTOR INSTALLATION

E701301 General

- (a) Aspirating smoke detection (ASD) installations shall be designed, installed, commissioned and maintained in accordance with the following documents:
 - i) BS EN 54-20
 - ii) FPA Code of Practice for design, installation, commissioning and maintenance of aspirating smoke detection (ASD) systems.
- (b) The ASDs shall be approved and listed by the Loss Prevention Certification Board (LPCB).
- (c) The ASD installation shall be provided for primary or secondary sampling in the areas listed in the services description within this specification. Each installation shall comprise of an addressable detector unit, incorporating all necessary control, indication, monitoring, interface equipment and sampling pipework connecting the detector directly to the volume where the sensitive detection is required.
- (d) The ASD installation shall be selected in accordance with Table 2 of the FIA (Fire Industry Association) Code of Practice, which covers the following sampling types:
 - i) Primary detection

- ii) Secondary detection
- iii) Localised sampling
- iv) In-cabinet sampling
- v) Duct sampling
- (e) The table makes recommendations for the selection of the appropriate ASD sensitivity.
- (f) The standard forms contained within Appendix H of the Code of Practice shall be utilised to record the detailed information required at the various project stages, including planning, design, installation commissioning and maintenance.

E701304 Design Considerations

- (a) A single aspirating detector shall cover an area no greater than 2000 m² in order to comply with the zoning requirement identified in BS 5839-1. Failure of any single aspirator/fan or other critical component within the ASD installation shall not remove protection from an area greater than 2000 m².
- (b) The system shall be designed and installed in accordance with the manufacturer's recommendations. The detector sensitivity shall be designed and selected by the manufacturer.
- (c) Systems shall be interfaced with the main fire alarm panel via addressable input modules to separately indicate each of the 3 input levels, (alert, pre-alarm, fire) as well as a common fault signal or alternatively fully integrated to provide detailed performance of the device, subject to the levels required for early warning. The fire alarm panel shall initiate the fire alarm sequence within the building on receipt of the fire signal.
- (d) Programming of the system shall be carried out by the system specialist. The parameters for the various functions shall be agreed with the Engineer prior to programming.
- (e) The aspirating smoke detectors shall be capable of detecting the presence of smoke particles in air samples drawn from many different locations.
- (f) The aspirating smoke detectors shall provide a continuous analogue profile of ambient air conditions.
- (g) The detectors shall be capable of responding to a developing fire situation with multiple staged alarms.
- (h) The fire alarm output of the detectors shall be programmable to allow sufficient time for action to be taken; from a detailed investigation of the cause of the alarm to a full-scale evacuation.
- (i) The design of the detectors shall be such that they can be integrated with a fire alarm system and be used to protect individual items of equipment, such as computers, equipment racks, power distribution boards and telecommunications switching racks, as well as entire rooms or floors.
- (j) The detectors shall include a facility to allow sensitivity threshold adjustments to suit the needs of particular environments.

- (k) The detectors shall incorporate an LED indicator, clearly visible from the outside, to provide indication of alarm or fault condition.
- (l) For the aspirating detector to operate correctly, it is essential that the sampling pipework is designed and installed correctly to ensure the air and combustion products are transported from the protected area to the sensor. The manufacturer's design software tools shall be utilised to identify the most suitable design for the pipework installation, including the location and size of the sampling holes.
- (m) The spacing of the sampling points shall comply with the recommendations for the spacing and positioning of smoke detectors identified in BS 5839-1, depending on the particular type of building, ceiling heights, structural beams and pitched roofs.
- (n) The ceiling height of the areas being protected by the ASD systems shall be within the limits identified in Table 3 of the code of practice.
- (o) Where the validation of the ASD system is to be carried out by performance testing, they shall be carried out in accordance with the standard performance test methods provided in the annexes of the code of practice.

E701307 Aspirating Pipework Installation

- (a) The sampling pipework shall be installed strictly in accordance with the manufacturer's installation instructions.
- (b) The length of sampling pipework shall not exceed the maximum pipe length recommended by the manufacturer.
- (c) The pipework and fittings shall be manufactured from ABS (Acrylonitrile Butadiene Styrene), which has a good chemical resistance and high impact strength.
- (d) The pipework and fittings shall be suitable for use in ambient temperatures from - 40 °C to +70 °C and shall be easy to joint.
- (e) The pipework products shall have been tested by LPCB to EN 54-20 clause 5.7.
- (f) The solvent cement shall only be that recommended by the manufacturer of the pipework and fittings.
- (g) Jointing shall be carried out strictly in accordance with the manufacturer's instructions.
- (h) The expansion and contraction of the pipework lengths shall be calculated based on the variation in ambient temperature and the temperature at which the pipework was installed.
- (i) The pipework installer shall make appropriate provision for the change of length in the pipe system, whether it is due to expansion or contraction, so that any stresses generated by the change in temperature will not cause damage to the system, this shall be achieved by installing:
 - i) Expansion Loops
 - ii) Expansion Joints
 - iii) Flexible arms

- (j) Pipe brackets shall be made with the inside diameter of the bracket marginally larger than that of the pipe outer diameter to allow for free linear movement of the pipe, and avoids inhibiting expansion or contraction. They should also be smooth, to avoid damage to the outer surface of the pipe.
- (k) The pipework support shall be spaced strictly in accordance with the manufacturer's recommendations based on the predicted ambient temperature conditions.
- (l) The pipework installer shall issue detailed pipework calculations to the Engineer, detailing the size, number and location of the sampling holes, for review prior to the installation work commencing.
- (m) When aspirating detectors are used in areas of restricted access (lift shafts, MV switchrooms etc.) the pipework system shall be looped so that the end is terminated adjacent to the detector unit with plugged test point.
- (n) In damp environments the pipe system shall incorporate a drainage point and release valve as required by the manufacturer's design.
- (o) Performance testing of the ASD installation shall be carried out during the commissioning stage of the fire alarm system to verify their performance.

E703100 DRAWINGS AND TECHNICAL INFORMATION

- (a) The drawings produced by the Engineer are for Tender purposes only and are essentially schematic in nature. The Electrical Services Installer shall be responsible for the provision of all fire alarm equipment required to comply with this specification in compliance with the FOC requirements, the local Fire Officers recommendations and the appropriate British Standards.
- (b) At the time of tendering, the Electrical Services Installer shall fully and accurately describe the proposed fire detection and alarm system and its design concepts, providing a complete set of layout drawings and a specification describing all aspects of the system, including:
 - i) Detailed component and equipment lists with model and manufacturers part numbers
 - ii) Product sheets for each item of equipment
 - iii) Theory of operations with description of system functions
 - iv) Written confirmation that a manufacturer trained representative will provide on-site supervision during system installation, perform all final testing and commissioning of the installed system and instruct operating personnel on all system operations
- (c) The Electrical Services Installer shall provide a complete set of contract documents describing the system and its design concepts, installation, final testing, commissioning, and required operating and maintenance procedures. These shall include the following documentation:
 - i) System description
 - ii) Checklist of equipment and components
 - iii) Installation instructions

- iv) Equipment connection diagrams showing wiring detail of Addressable Device positions with addresses
 - v) Standby battery calculations showing system power requirements and formulas used to calculate specified power
 - vi) Final testing instructions
 - vii) Commissioning instructions
 - viii) Certification documents
 - ix) Logbook
 - x) System operating instructions
 - xi) Routine maintenance instructions and schedules
 - xii) Remote monitoring link description and operating instructions (if this option is being provided)
- (d) As a minimum, the following drawings shall be provided for the system:
- i) System schematic diagram
 - ii) Cabling and wiring diagram
 - iii) Detailed equipment connection diagrams
 - iv) Building plan showing zoning and location of fire controller, detectors, call points, sounders and ancillary devices
 - v) Prior to Practical Completion, Record Drawings with operating and maintenance instructions for the installation shall be provided along with the system logbook suitably completed for issue to the operator. A full address chart indicating each device type, address, location and text programmed shall be provided.
 - vi) Drawings and technical information shall comply with the Drawings and Documentation Section including numbers of copies, preliminary and final issues. Two additional sets of all issues shall be provided to the Engineer for issue to the Employer's Insurers.

E703400 INSTALLATION

- (a) The installation shall be in accordance with the recommendations of BS 5839: Pt 1 and BS 7671.
- (b) The Electrical Services Installer shall be responsible for the correct siting of all equipment and components of the system in accordance with previously agreed plans and drawings.
- (c) All cabling and wiring shall be tested before they are connected to the fire controller and its associated devices.

E703700 TESTING AND COMMISSIONING

- (a) The fire controller and associated devices and modules shall be tested in accordance with the guidelines set out in BS 5839-1 and the testing instructions provided by the manufacturer. These tests shall include the following:
 - i) Witness tests on the Fire Alarm Cables for insulation resistance and electrical continuity
 - ii) Demonstration of the interface with the Voice Alarm System where provided, including the fault monitoring of both systems
 - iii) Test the functional operation of the break glass units, smoke/heat detectors and sprinkler monitoring devices
 - iv) Battery discharge test with a full 30 minute operation at the end of the specified battery autonomy period with the system in its quiescent state
 - v) Test of the Building Management System interface volt free signals
- (b) The Electrical Services Installer shall test all functions of the system, including the software, to ensure that it operates in accordance with the requirements of the design specification and relevant standards.
- (c) The Electrical Services Installer shall carry out audibility tests in order to demonstrate the suitability of the system installed. This shall involve an element of out-of- hours working, which shall be included for in the tender submission.
- (d) Following the satisfactory completion of installation, testing and start-up, the Electrical Services Installer shall demonstrate to the customer that the system successfully performs all of the functions set out in the design specification.
- (e) The Electrical Services Installer shall provide the customer with an agreed quantity of spare parts testing equipment and consumables, which are to be used during routine maintenance, and testing of the system.
- (f) The Electrical Services Installer shall provide a customer appointed fire system supervisor with on-site training in the use, operation and maintenance of the system and explain the procedures to be followed in the event of fire and false alarms. The system supervisor shall also be shown how to carry out routine maintenance and testing procedures, and how to keep the logbook. (Also see Section 9).
- (g) The Electrical Services Installer shall prepare a report detailing all tests performed during installation and commissioning of the system. The report shall include the results of the tests and details of any specific settings or adjustments made. Any outstanding tasks or activities, which are to be completed at another time, shall also be included in the report.

E704000 MAINTENANCE

- (a) The Electrical Services Installer shall include for any normal service and maintenance required during the Defects Liability Period.
- (b) The scope shall include a comprehensive maintenance and emergency call out service for the whole of the fire alarm installation for a period of 12 months from the certified completion date.

- (c) Regular examination and any adjustment of parts etc. as necessary to suit the type of equipment installed and keep it in a satisfactory operation shall be provided.
- (d) A separate sum shall be submitted as a quotation for a comprehensive Maintenance Contract commencing after the expiration of the Defects Liability Period for separate periods of five and ten years.
- (e) The sums for these contracts shall be on fixed price basis, with a declared formula for variations with time. Details of the scope of such a Contract including frequency of inspection visits shall be provided.
- (f) The Electrical Services Installer shall as a minimum include for periodic examination in accordance with the British Standard, Health and Safety at Work Act and Statutory regulations together with the manufacturers.

E72 EMERGENCY VOICE COMMUNICATION SYSTEMS

E720100 GENERAL

- (a) The Emergency Voice Communication System (EVC) shall be designed, installed and commissioned in accordance with BS 5839-9.
- (b) The EVC system shall provide a hard wired, secure, emergency communication system between the fire command centre (FCC), security control centre (SCC) and fireman's designated entry point; to a number of remote outstations (fire telephones) located in the stair cores and disabled refuges, for use in a fire situation.
- (c) The EVC System shall be fully monitored and independently powered.
- (d) The system shall operate automatically by simply activating one of the remote outstations, located in the areas specified in the services description and indicated on the drawings.

E720400 EVC SYSTEM TOPOLOGY

- (a) The EVC system topology shall be configured as either loop wired circuits, with multiple outstations installed on each loop, or radial circuits with a single outstation per circuit.
- (b) The Electrical Services Installer shall provide a loop wired EVC system unless specified otherwise in the services description of this specification.

E720700 LOOP WIRED TOPOLOGY

E720701 Control Panel

- (a) The system control panel shall be modular in construction to allow for future expansion of the system and shall incorporate a lockable door to prevent unauthorised use of the manual controls.
- (b) The system shall be microprocessor based and operate under a multitasking software program. Operating programs and configuration data shall be contained in easily updatable non-volatile memory (EEPROM). The use of 'burnt' EPROMs will not be

- permitted. Separate processors shall also be utilised for the display and control function at each panel.
- (c) The control panel shall have the capability to run up to 127 addressable outstations with the address code for each held within the outstation and shall be programmed via a dedicated programming tool.
 - (d) The control panel shall be wall mountable, surface or flush as specified and be available in either 'RAL 7038' grey or brushed stainless steel finish.
 - (e) It shall be possible to add slave panels to the system, to enable the system to be operated from multiple locations. The slave panels shall have the facility to be configured to communicate with remote outstations on the system.
 - (f) The master and slave control panels shall incorporate a button for each of the remote outstations on the system.
 - (g) The control panel shall have the option to be activated in response to an emergency, signalled by a building's fire detection system (disabled refuge remotes only, all other remote devices shall remain active at all times) and have the facility to be manually overridden to the active state. When in non-active state a short 'system in standby' message shall be played if the disabled refuge call button is pressed.
 - (h) The control panel shall include batteries to provide system power in the event of mains power failure. The batteries shall be housed within the control panel or remote enclosure. The duration of battery backup shall be for 24 hours in quiescent mode followed by three hours at full power.
 - (i) The control panel shall have an auto commission feature that automatically addresses each outstation – it shall also be possible to manually address each outstation.
 - (j) The control panel shall enable local area networking to other controllers and shall be capable of interfacing with third party equipment via a RS232 interface.
 - (k) The control panel shall monitor the status of all outstations on the addressable loops.
 - (l) The control panel shall have a status display which indicates:
 - i) Mains supply healthy
 - ii) Battery high and low
 - iii) Charger fault
 - iv) Fuse fault
 - v) Common fault
 - vi) Processor fault
 - vii) Processor restart
 - viii) Handset fault
 - ix) Lamp test button
 - (m) The control panel shall have an independent call button, call status and fault LED for each outstation; with each button capable of being labelled with the location of the remote outstation.

- (n) The control panel shall monitor all critical system components and interconnections (internal and external). In the event of a failure occurring which prevents correct operation of the alarm functions, a FAULT indicator will illuminate within 100 seconds of occurrence.
- (o) The control panel shall monitor the loop circuits for short and open circuit. In case of an open circuit the loop shall be bi-directional and shall provide short circuit wiring fault isolation to every remote outstation on the loop.
- (p) The control panel shall monitor the status of all internal connections and interfaces, including charger, battery and remote signalling functions and be capable of monitoring and indicating the status of remote outstations, such as a disabled refuge outstation.
- (q) There shall be an external call output option that causes a pair of contacts to operate after a delay if a call comes in but the handset is not lifted. The delay shall be adjustable from immediate to approximately three minutes.

E720704 Remote Outstations General

- (a) The EVC manufacturer shall have available the following types of remote outstations for direct connection to the system loops:
 - i) Addressable disabled refuge (Type B) outstation
 - ii) Disabled toilet alarm
 - iii) Addressable loop toilet alarm interface
- (b) Addressing of the outstations connected to the system will be carried out in a manner that does not require manual setting of switches or the use of programming cards.
- (c) Addressable outstation configuration changes shall not prevent a call taking place.
- (d) It shall be possible to connect and mix outstation devices on the loop and shall be possible to typically connect 20-30 outstations per loop.
- (e) Each remote device shall be powered from the line so no local power is required and shall incorporate a system healthy indicator.

E720707 Disabled Refuge Outstation

- (a) Disabled refuge units shall be green in colour or have a brushed stainless steel finish. The stainless steel option shall be provided with separate green signage.
- (b) Each unit shall have a call button, which when activated alerts the main control unit.
- (c) Speech shall be speech steered and the occupant will be able to alert the main control panel by simply talking into the unit, once the call button is pushed and the call answered.
- (d) Once the outstation has been activated, the main panel shall have the facility to 'listen in' to occupied refuge areas – this link must remain open until the remote unit is reset at the control panel.
- (e) The front panel of the outstation shall have LEDs showing 'System Healthy' and 'Occupied'.

- (f) The unit shall be resettable via the control unit or via the unit's key switch. There shall be a volt free contact, which shall be active when occupied, to operate over door lamps, silence a local speaker/sounder etc.
- (g) Each outstation shall be supplied as surface mountable, with the option to flush mount by using a bezel which shall be available separately.
- (h) Where specified three disabled refuge remote shall be clearly marked Fire Refuge in both Braille and tactile text and shall have a built-in induction loop for the hearing impaired.

E720719 Cables

- (a) The outstation loop circuits shall be wired utilising 1.5 mm² enhanced fire resistant 4-core cable with screen, allowing up to 200 m cable run between outstations, and between outstations and the control panel. A repeater unit shall be used if distance between units exceeds 200 m.
- (b) It shall be possible to place disabled refuge, fire telephone, combined disabled refuge/fire telephone and toilet alarm units on the same addressable loop.
- (c) It shall be possible to connect 20-30 remotes per loop and a repeater unit shall be used to connect the toilet alarm units to the system.
- (d) Wiring between Master Control Panel and Slave Panels shall require 2 x 4-core 1.5 mm² enhanced fire resistant cables configured as a loop circuit.

E720722 Graphical User Interface

- (a) Where a Graphic User Interface (GUI) is specified in the services description of the specification, the system shall be designed for use with a touchscreen/mouse (with optional keyboard) and must support connection of a separate monitor.
- (b) The Electrical Services Installer shall be responsible for the installation, commissioning, configuration and servicing of the GUI for the EVC system. The EVC system manufacturer shall design the GUI layout.
- (c) The graphical user interface software shall be designed, written and owned by the company manufacturing the EVC system and provide the means of annunciation, status, display, and control of the EVC system.
- (d) The GUI shall support network panels with up to 127 remote outstations connected to the system. Providing operator control via mouse, optional keyboard or touchscreen with multimedia compatibility.
- (e) The GUI shall display the precise location of events, using a combination of symbols, floor plans, pictures, text, audio and video and store a fault and history log of all events centrally. When an event is registered at any EVC control panel, the graphics system shall display the first screen image for the first activated device.

E721000 RADIAL WIRED TOPOLOGY**E721001 Control Panel**

- (a) The control panel shall be modular in construction to allow for future extension of the system and shall incorporate a lockable door to prevent unauthorised use of the handset.
- (b) The control panel shall be microprocessor based and operate under a multitasking software program. The operating programs and configuration data shall be contained in easily up-datable non-volatile memory (EEPROM). The use of 'burnt' EPROMs will not be permitted.
- (c) The control panel shall have the capability to run up to 16 outstations per control or network expansion panel.
- (d) The control panel shall be wall surface or flush mountable and be available in either 'RAL 9005' black or brushed stainless steel finish and it shall be possible to add one further control panel to enable the system to be operated from two different locations. It shall have the facility to be configured to communicate with any outstations on the system.
- (e) The control panel shall have a bright and clear LCD screen and the operation shall be via a rotary encoder, which shall display call status, remote device location and faults etc.
- (f) The enclosed handset shall be red complete with hearing aid compatible earpiece. Opening the door to access the handset shall initiate the LCD display to automatically change from 'home' screen to an index of all outstation devices.
- (g) The control panel shall be capable of having the option to be activated in response to an emergency, by a building's fire detection system (disabled refuge remotes only, all other remote devices shall remain active at all times) and have the facility to be manually overridden to the active state.
- (h) The control panels and network expansion panels (NEP) shall have integral batteries to provide system power in the event of a mains power failure. The secondary battery backup shall be for 24 hours in quiescent mode followed by three hours at full power.
- (i) The control panel shall have an auto commission feature that automatically identifies connected outstations. It shall be possible to manually name each outstation.
- (j) The Control Panel shall prevent access to the handset without the use of a key, with system programming and set up via the front panel, removable SD card or by connection of a laptop to the Ethernet port.
- (k) The control panel shall monitor the status of all outstations, lines and network loop, indicating via an LCD display, calls to the control panel, where it shall be possible to accept, put on hold and clear the call.
- (l) The control panel shall monitor all critical system components and interconnections (internal and external). In the event of a failure occurring which prevents correct operation of the alarm functions, a FAULT indicator shall light and a message shall be given on the lamp display within 100 seconds of occurrence.

- (m) The control panel shall monitor the network loop and radial circuits for short and open circuit. The network loop, in the event of a break, shall be bi-directional. It shall also monitor the status of all internal connections and interfaces, including charger, battery and remote signalling functions.
- (n) It shall provide discrete visual indications for all key functions, including at least one yellow LED and be capable of monitoring and indicating the status of the remote outstations, such as a disabled refuge outstation.
- (o) The system shall have indicators for 'power', 'incoming call', 'refuge areas active', 'system healthy', 'processor restart', 'common fault', 'processor fault'. These shall be on the front of the control panels either as LEDs or via LCD display. There shall be a fault relay for indication at fire panel.
- (p) There shall be an external call output option that causes a pair of contacts to operate after a delay if a call comes in but the door is not opened. The delay shall be adjustable from immediate to approximately three minutes.
- (q) The master and NEP units shall be supplied as four-way as standard. It shall be possible to expand the panels up to 16 way by the addition of the four-way expansion modules. Each module enables the addition of four outstations.
- (r) It shall be possible to have two control units on a network system. One shall act as the 'master' with the other being a 'slave' unit.
- (s) It shall be possible to connect up to sixteen outstations to each panel. The 'master' control panel shall operate all outstations on a networked system.
- (t) The EVC system shall have network expansion capabilities by way of network expansion panels. It shall be possible to connect up to fifteen network expansion panels on one system, or fourteen if installing two 'control' panels.
- (u) Each NEP shall be supplied with a four-way line card for connection to four outstations, for more, four-way expansion kits shall be fitted, in the same way as for the control panel.
- (v) The Control Panel and NEP shall be surface mountable, an optional flush mount bezel shall be available; the enclosure shall include integral battery backup.
- (w) A network card shall be added to each 'control' panel for inclusion on a networked system. NEP panels shall be supplied with factory-fitted network cards as standard.

E721004 Remote Outstations General

- (a) The EVC manufacturer shall have available the following types of remote outstations for direct connection to the system:
 - i) Disabled refuge remote
- (b) The outstations shall be connected to the control panel by screened two core radially connected enhanced fire resistant cable.
- (c) It shall be possible to connect and mix outstation devices on the system, with each remote device powered from the radial circuit so that no local power is required and the units shall have a system healthy indicator.

E721007 Disabled Refuge Outstation

- (a) Disabled refuge units shall be green in colour or have a brushed stainless steel finish. The stainless steel option shall be provided with separate green signage. Each unit shall have a call button, which when activated shall alert the main control unit. The unit shall be resettable from the control panel.
- (b) Speech shall be speech steered and the occupant will be able to alert the main control panel by simply talking into the unit, once the call button is pushed and the call answered.
- (c) Once the unit has been activated, the main panel shall have the facility to 'listen in' to occupied refuge areas – this link shall remain open until the remote unit is reset at the control panel.
- (d) The front panel of the outstation shall have LEDs showing 'System Healthy' and 'Refuge Occupied'.
- (e) There shall be an induction loop output to feed an optional external amplifier.
- (f) Each outstation shall be supplied as surface mountable, with the option to flush mount by using a bezel which shall be available separately.

E721019 Cables

- (a) The outstations shall be wired utilising 2-core 1.5 mm² screened enhanced Fire resistant cable.
- (b) It shall be possible to install Disabled Refuge, Fire Telephone, Emergency Telephones and Toilet Alarm units on the same system.
- (c) Wiring between Master Control Panel and the slave NEPs shall be carried out in 2No 2 core 1.5 mm² enhanced fire resistant screened cable, wired as a ring circuit.

E721300 POWER SUPPLIES

- (a) A label shall be fixed to the battery indicating its date of installation. The label shall be located so that it can be read without disturbing the battery.
- (b) Every isolator or protective device that can isolate the supply to the fire alarm system, other than the main isolator of the building shall be labelled either:
 - i) **EMERGENCY VOICE COMMUNICATION SYSTEM** in the case of a protective device that serves only the EVC circuit but incorporates no switch; or
 - ii) **EMERGENCY VOICE COMMUNICATION SYSTEM DO NOT SWITCH OFF** in the case of a switch (whether incorporating a protective device or not) that serves only the fire alarm circuit; or
 - iii) **WARNING THIS SWITCH ALSO CONTROLS THE SUPPLY TO THE EMERGENCY VOICE COMMUNICATION SYSTEM** in the case of any switch that disconnects the mains supply to both the EVC system and to other circuits
- (c) Labels shall be clear and in durable red fade resistant material.

E721600 EVC SYSTEM TESTING

- (a) Where specified the manufacturer shall allow for the EVC equipment to be inspected and tested at works. These procedures shall include the following:
 - i) Visual inspection
 - ii) Functional test of the fire telephone system
 - iii) Test fault monitoring system
- (b) Following the erection of the equipment on site and the completion of the installation works to the satisfaction of the Engineer, the Electrical Services Installer shall carry out the following tests:
 - i) Visual inspection
 - ii) Witness tests on the EVC system cables including 500 V d.c. insulation resistance and electrical continuity. The equipment shall be disconnected from the cables to be tested, prior to every insulation test being carried out to prevent equipment damage. The test results shall be properly recorded and included within the Operating and Maintenance Manual
 - iii) Function test of the EVC system
 - iv) Test of the fault monitoring system
 - v) Verify the audibility and intelligibility of speech channel for each outstation
 - vi) Battery discharge test with full 180 minutes operation at the end of the specified battery autonomy period, with the system in its quiescent state
- (c) Test the Building Management System interface volt free contacts.

E76 SMOKE CLEARANCE SYSTEMS**E760100 CONVENTIONAL HARD WIRED SYSTEM**

- (a) The smoke control dampers, actuators and the smoke control panel shall be supplied and installed by others.
- (b) The Electrical Services Installer shall supply and install the local power supplies, 24V or 240V, as necessary and the necessary power and control wiring for the system from the smoke control panel.
- (c) The smoke control dampers shall be motor open/motor closed. Fail safe closed type with spring closure device shall not be permitted. Smoke control dampers shall not contain a device that is able to change the position of the damper once it has reached the required position.
- (d) The smoke control dampers shall incorporate remote signalling of both the open and closed positions. The dampers should achieve the required position open or closed within 60s upon receiving the activation signal.
- (e) The smoke control systems shall operate automatically when fire is detected in the building, the source of the fire being identified by the addressable fire detection system.
- (f) The smoke control dampers shall be classified as Automatic Activation (AA) where firefighter's manual override is not called for. Once the dampers achieve their required position, no further functionality is necessary from the equipment, other than to maintain the same position in the presence of a fire.
- (g) The power and control cables serving the (AA) smoke control dampers shall be Category 2 cables in accordance with BS 8519 table 1.
- (h) The smoke control dampers required to incorporate a firefighter's manual override or manual intervention shall be classified as (MA). The (MA) classification requires the smoke control damper to open and then close after up to 25 minutes of fire exposure (at approximately 825°C at 25 min) to maintain the fire compartmentation.
- (i) The damper, actuator and associated power and control components shall be located outside the fire compartment, where the fire originates, i.e. the products of combustion being contained within the fire rated ductwork. The smoke control dampers classified as (MA) shall have a thermal protective enclosure or "hot box".
- (j) The power and control cables serving the (MA) smoke control dampers shall be Category 3 cables in accordance with BS 8519 table 1, including the actuator cable.
- (k) Firefighter override controls shall be as follows:
 - i) Labelled 'for fire fighter use only'
 - ii) Manual control points labelled according to their use
 - iii) Where controls have an operational mode this shall be labelled auto
 - iv) Due to the possibility of keys being misplaced manual control points for firefighting use shall not be key operated

- v) Control panels shall be simple and logical to operate in fire conditions without due reliance on operational manuals
- vi) Manual control points for firefighter use shall be coloured deep orange (RAL 2011)
- vii) Manual control points which are for maintenance only and not for firefighting use shall be coloured white
- (l) Damper actuators operating at 240V shall be provided with a means of local isolation, which shall offer the equivalent fire survival time as that of the smoke control damper /actuator assembly.
- (m) The damper power supply, control and status monitoring signals and any ancillary components such as fire alarm interface modules, local isolators, junction boxes, etc. shall offer as a minimum, the same fire survival characteristics as that required of the smoke control system, in terms of time/ temperature criteria.
- (n) Where specified the manufacturer shall allow for the equipment to be inspected and tested at works. These procedures shall include the following:
 - i) Visual inspection of the equipment
 - ii) Function test of the smoke clearance system
 - iii) Test fault monitoring system
- (o) Following the erection of the equipment on site, and the completion of the installation works to the satisfaction of the Engineer, the Electrical Services Installer shall carry out the following tests:
 - i) Visual inspection
 - ii) Witness tests on the smoke control, system cables including insulation resistance and electrical continuity
 - iii) Function test of the smoke control system including the test of the full cause and effect software for the various alarm conditions
 - iv) Test of the fault monitoring system
 - v) Test the Building Management System interface volt free contacts

E760400 ADDRESSABLE SYSTEM

- (a) Where specified the manufacturer shall allow for the equipment to be inspected and tested at works. These procedures shall include the following:
 - i) Visual inspection of the equipment
 - ii) Function test of the smoke clearance system
 - iii) Test fault monitoring system
- (b) Following the erection of the equipment on site, and the completion of the installation works to the satisfaction of the Engineer, the Electrical Services Installer shall carry out the following tests:
 - i) Visual inspection

- ii) Witness tests on the smoke clearance, system cables including insulation resistance and electrical continuity
- iii) Function test of the smoke clearance system including the test of the full cause and effect software for the various alarm conditions
- iv) Test of the fault monitoring system
- v) Battery discharge tests with full 30 minutes operation at the end of the specified battery autonomy period, with the system in its quiescent state
- vi) Test the Building Management System interface volt free contacts

E86 EARTHING AND BONDING

E860100 METHODS OF EARTHING

- (a) Any metal work exposed in an electrical system including exposed metal work in fittings, shall be connected to earth to ensure at all times an immediate discharge of electrical energy without endangering personnel or equipment. Earthing shall be in accordance with BS 7671 and BS 7430. Should there be any conflict between these standards then the former shall take precedence.
- (b) Exposed or extraneous metalwork shall be connected to earth via one or more of the following methods:
 - i) The metallic sheath of the supply cables
 - ii) An earth continuity conductor carried in the cable
 - iii) Metallic conduit, trunking or duct containing the wiring
 - iv) A special conductor or tape run to a suitable earth point
 - v) A separate earth wire enclosed in conduit or trunking

E860400 EARTHING AND BONDING GENERAL

- (a) Copper earthing leads, bonding leads and circuit protective conductors, unless otherwise specified herein, shall be sized in accordance with BS 7671.
- (b) Circuit protective and bonding conductors, other than copper tape or where contained in a composite cable or flexible cord, shall be protected by LSF or heat resisting insulation as appropriate, identified as detailed in regulation 514.3.1 of BS 7671. Copper earthing or bonding tape run under floors, in ducts, or damp situations shall be LSF sheathed.
- (c) Copper earthing tapes, bare or LSF sheathed, shall be fixed by means of a single hole fixing gun metal "Holdfast" type saddle of a correct size to hold the tape firmly at intervals not greater than 600 mm.
- (d) The armouring of LSF sheathed cables shall terminate in a suitable compression gland fitted with a purpose made earth tag. A suitable protective conductor shall connect the earth tag with the apparatus earthing terminal. The earth tag shall be manufactured from a high conductivity material compatible with the cable gland.

- (e) Connections between earth bars, equipment frames etc. and stranded copper cables shall be made with the appropriate compression lug, bolt, washers, nut and lock nut. Contact surfaces shall be thoroughly cleaned and tinned prior to connection. The ends of every earth continuity conductor, whether stranded or solid, shall be connected with spring washers and lock nuts, pinching screws or to pipes with a clamp.
- (f) Bonding connections to gas or water services shall be made as near as practicable to the point of entry of those services into the building. Should there be any insulated section in the service run, the connection shall be made to the metalwork on the building premises side of the insulated section. These bonding connections shall be made with the appropriate pipe clamps and precautions shall be taken to avoid damage to these pipes.
- (g) A label complying with BS 7671 and embossed with the words **SAFETY ELECTRICAL EARTH - DO NOT REMOVE**, shall be permanently fixed at the main earth terminal and the bonding connection of all incoming services.
- (h) The earth continuity of metal conduits, metal trunking and metal sheathing and armouring of cables shall be maintained by efficient bonding between the conduit, trunking, cable sheath, armouring or gland and the metal case of the main switch fuse, distribution board or other metal clad accessory or appliance at which they terminate. Where the length of armoured cable is excessive, additional earth connections shall be made to provide an earth loop impedance within the value allowed for the protective device. Metal fittings, accessories, enclosures and cable tray shall be efficiently earthed.
- (i) For PVC conduit installations and for LSF insulated, LSF sheathed wiring systems circuit protective conductors shall be run to lighting points, switches, socket outlets and other accessories. For ring circuits the earth continuity conductor shall also be connected in the form of a ring.
- (j) The telephone and data cable tray shall be bonded to the main electrical earth.
- (k) Each conduit installation shall be electrically continuous throughout, forming completely bonded systems. Every complete final circuit earth loop impedance comprising conduits, cable sheaths, core conductors and transformer windings shall be tested.

E860700 FUNCTIONAL EARTHING SYSTEMS

- (a) Equipotential bonding and earthing in buildings accommodating information technology equipment shall be installed in accordance with the requirements of BS EN 50310.
- (b) Earthing systems that are both protective and functional shall comply with regulation 543.5.1 of BS 7671.
- (c) Where a connection to earth is required for proper functioning of electrical equipment it shall be not less than 2.5 mm² cross section.
- (d) Functional earthing conductors associated with telecommunications equipment shall be coloured cream in accordance with BS 7671 and BS 6701. Functional earth conductors shall be clearly identified at each point of termination using a suitable engraved permanent label.

- (e) Where a functional earth system is called for, it shall be terminated at a suitably located main functional earth bar or terminal.
- (f) A functional earth conductor shall be connected from the main electrical earth bar in the low voltage switchroom to the main functional earth bar or terminal.

E861000 CLEAN EARTH SYSTEMS

- (a) Clean earth conductors shall be connected from the main earth bar in the switchroom to the isolated earth bar or terminal in the distribution equipment or outlet. Clean earth conductors shall be not less than 2.5 mm² cross section and shall be clearly identified at each point of termination using a suitable engraved permanent label. Enclosures of clean earth busbar systems shall be coloured red and clearly identified at not less than 600 mm centres.
- (b) Socket outlets associated with clean earth installations shall be of the non-interchangeable type with separate terminals for the isolated earth pin connection and the safety earth. Each terminal shall be clearly identified as to its purpose.
- (c) Clean earth installations for computer services shall be carried out in accordance with the equipment manufacturers requirements.

E861900 EARTH CONTINUITY TESTS

- (a) The electrical installation earthing system shall be subject to earth loop impedance tests in accordance with BS 7671-6. Tests shall be carried out on all systems, plant and equipment. Earthing systems shall be re-tested thirty days prior to the end of the Defects Liability period. The Engineer shall be given at least seven working days' notice of the visit to site to carry out the tests.
- (b) Tests shall be carried out on all socket outlets. They shall also be carried on a minimum of two and a half percent of lighting points with a minimum of five shall be tested for earth fault loop impedance. Should any lighting point not comply with the test requirements then a further two and a half percent shall be tested. On failure of one further point all lighting points shall be tested.
- (c) Miscellaneous plant, machinery and equipment shall be tested for earth fault loop impedance. Equipotential bonding to extraneous metal work shall be visually inspected and tested for earth fault loop impedance.
- (d) Faults discovered during the tests shall be corrected.

E862200 MAIN EQUIPOTENTIAL BONDING

- (a) Main equipotential bonding shall be in accordance with BS 7671 and shall include but not be limited to:
 - i) Incoming gas supplies
 - ii) Incoming water supplies
 - iii) Lightning protection system
 - iv) All incoming electricity supply earths

- v) Building structure
- vi) Main LV switchboard
- vii) Generators and earthing resistors

E862500 SUPPLEMENTARY BONDING OF METALWORK

- (a) Conductive parts simultaneously accessible to other conductive parts shall be bonded to ensure that in the event of an earth fault, the voltages between all simultaneously accessible parts are of such magnitude and duration as not to cause danger. The requirements shall include consideration of portable appliances connected from socket outlets.
- (b) Where necessary, supplementary equipotential bonding shall be provided. In areas where the system of wiring is concealed, the supplementary bonding conductor shall also be concealed up to the point of termination.
- (c) Tests shall be carried out during construction to ensure that where supplementary bonding conductors are required, they can be installed within the construction programme and without the need to disturb finishes.
- (d) The electrical continuity of mechanical services installation is required by the specification for that section of the work. The Electrical services Installer shall complete the bonding to bring the Mechanical Services Installation to an equipotential level with simultaneously accessible conductive parts. On completion of the installation, tests shall be carried out to verify compliance with this clause.
- (e) The following extraneous conductive parts shall be bonded electrically:
 - i) Ductwork
 - ii) Insulation metal facing
 - iii) Pipework
 - iv) Hot and cold water services
 - v) Sinks and sink services
 - vi) Water and gas incoming services
 - vii) False floors at every level
 - viii) Sprinkler services
- (f) The false ceiling installation is no longer considered to be either exposed-conductive-parts or extraneous-conductive-parts; as a result bonding of the ceiling installation is no longer required.
- (g) The installation of the fixed wiring within the ceiling void should be continuously supported or at appropriate intervals independently of the ceiling.
- (h) Where items are not included in the list but require to be bonded, the Electrical Services Installer shall ensure that any additional electrical bonding is installed.
- (i) The method of support shall be such that no damage or undue strain occurs to the conductors, their insulation or terminations.

- (j) Consideration shall be given to the necessity of bonding to metallic hand rails and window frames.

E87 LIGHTNING PROTECTION**E870100 GENERAL**

- (a) The electrical services installer shall supply and install a complete lightning protection system for the building in accordance with the requirements of BS EN 62305 and BS 7430.
- (b) The system shall comprise an air termination network, down conductors, earth termination network and cross bonding of extraneous metal work as necessary.
- (c) Conductor tapes shall be 25 mm x 3 mm high conductivity annealed copper tape with PVC outer sheathing of a colour to match the building fabric to which is shall be installed.
- (d) Conductors shall be fixed using proprietary fixings at 1000 mm intervals on the horizontal and at 500 mm intervals on the vertical. Where conductors are installed beneath the outer roof covering the method of fixing shall be agreed with the Engineer. Under no circumstances shall fixings perforate waterproofing or insulation systems.
- (e) Conductors shall be run parallel and perpendicular to the structure.
- (f) Joints between similar metals or alloys shall be protected by water repellent conductive paste.
- (g) Joints between dissimilar metals or alloys shall be protected by proprietary inhibitor paste and taped with bitumastic bandage to prevent corrosion.

E870400 AIR TERMINATION NETWORK

- (a) The air termination network shall generally comprise perimeter roof tapes and in board tapes forming a grid 10 m x 20 m across the roof, where necessary solid copper finials shall be fixed to exposed structural elements. The Electrical Services Installer shall provide full details of the finials, the precise locations and details of fixing methods for the engineer's comment/agreement prior to installation.
- (b) Generally tapes shall be fixed surface to copings or parapets and roof finishes using proprietary fixings. The electrical services installer shall ensure that such fixings do not penetrate the waterproof membrane of the roof.
- (c) Where roof paving and shingle are used as protection on flat roofs tapes may be run under the finishes. The electrical services installer shall submit the method of fixing to the Engineer for acceptance prior to carrying out any installation works.
- (d) It shall not be permissible to utilise elements of the roof structure as part of the air termination network without the written permission of the Engineer. Should the electrical services installer wish to utilise any element he shall submit full details to the engineer including types of material, thickness, method of jointing between elements and method of jointing the air termination/down conductor network.
- (e) The Electrical Services Installer shall include for bonding all plant, TV aerial and satellite dish arrays and their support systems, flues, louvres, pipework, facade cleaning systems, cable trays, railings, steel access gantries and any other extraneous metalwork to the air termination network.

- (f) Bonds to extraneous metalwork shall be carried out individually to each element such that the disconnection of any bond shall not affect the earthing of any other element of the system.

E870700 DOWN CONDUCTORS

- (a) The air termination network shall be connected to the earth system via down conductors.
- (b) Down conductors shall be provided at intervals not greater than 20 m around the perimeter of the building for buildings less than 20 m high and at intervals not greater than 10 m for buildings in excess of 20 m. Generally down conductors shall be 25 mm x 3 mm copper tapes with PVC over sheath to match the exterior of the building.
- (c) The electrical services installer shall ensure that where the air termination network joins the down conductor's re-entrant loops are not constructed.
- (d) Down conductors shall be continuous throughout their length and shall run vertically with no-off sets.
- (e) Down conductors run internally through the building shall be only installed with the written permission of the engineer. The connection of the air termination network and the down conductor in this instance shall be via a solid copper puddle flanged rod which the electrical services installer shall free issue to the main contractor for installation and weatherproofing into the roof structure. Connections onto the rod for both the air termination network and the down conductors shall be via proprietary clamps. Care shall be taken to ensure that the roof level connection is engineered so as not to form a trip hazard.
- (f) Internally run down conductors shall be sheathed in low smoke and fume material.
- (g) With the written permission of the Engineer the building structure may be utilised to form down conductors. In such instances the method of connections to structural steelwork shall be agreed with the Structural Engineer. Where accessible the connection to the air termination network and earth termination network should be via pre-drilled holes in the structural steel and the air termination network tape shall be bolted to the steelwork with brass bolts, compression washer's nuts and lock nuts. Where the connection point is inaccessible the tapes shall be welded to the structural steel.
- (h) Where the down conductors comprise of reinforcing steelwork within the columns, continuity shall be achieved by clamping or welding of the reinforcing bars. In accordance with BS EN 62305, the use of lashing wire is unsuitable for long term electrical continuity.
- (i) Welding to the structure, shall be accepted by the structural engineer in writing, prior to the commencement of the works.
- (j) When welding of lapped steel bars is to be carried out, the length of the welded seam shall be not less than 30 mm. Where the welding of the reinforcement is not permitted, a secondary conductor shall be installed by clamps across the lap joint.
- (k) When joints between the reinforcing rods in concrete and the bonding conductors are made by means of clamping, two bonding conductors shall be used for safety reasons, since the joints cannot be inspected after the concrete has set.

- (l) The down conductors shall terminate at height of 1200 mm above the ground where a test point shall be fitted. A tape shall be taken from the test point directly to the earth termination network.
- (m) Where the building cladding incorporates steel elements the cladding contractor shall have carried out bonding between the individual panels. The Electrical Services installer shall verify that the steel elements are continuous throughout the cladding system and bond the system to the down conductors at the top and bottom of the building. Where the system is found not to be continuous the electrical services installer shall submit a report to the Engineer noting any areas which are isolated from the building structure.
- (n) The Electrical Services Installer shall carry out all necessary cross bonding to prevent side flashing to external metal components of the façade including metal rainwater goods, balconies, steel windows and external steel escape stairs etc.
- (o) Where internal fixed metalwork cannot be positioned a sufficient distances to prevent side flashing, the elements shall be bonded to the lightning protection system. Internal bonds shall be 50% the cross sectional area of the main conductors.

E871000 EARTH TERMINATION NETWORK

- (a) The lightning protection system shall be connected to an earth termination network complying with BS EN 62305 and BS 7430.
- (b) The earth termination network shall generally comprise earth rods driven into the ground 1000 mm from the edge of the building. A concrete earth inspection pit shall be provided at each earth point location.
- (c) Rods shall be copper, molecularly bonded to steel rods with a minimum overall thickness of 0.25 mm of copper. Rods shall be driven into the ground using driving heads, where more than one rod is required at the earth point bronze alloy couplers shall be utilised of sufficient length to fully enclose the rod threads.
- (d) Where the earthing system utilises the building structure or pile caps the down conductors shall terminate in a test point 1200 mm above the lowest finished floor level.
- (e) An exposed reinforcement bar 16 mm diameter shall be welded to the pile reinforcement system and protrude 600 mm above the finished floor level adjacent to the column or load bearing wall. Where steel reinforcement bonding conductors are brought through a concrete wall, particular attention shall be paid to protect against chemical corrosion.
- (f) A tape connection shall be made between the test point and the reinforcement bar utilising a proprietary rod clamp. The connection point shall be treated with inhibitor paste and taped with bitumastic bandage to prevent corrosion. The Electrical Services Installer shall clean the rebar and paint with a corrosion inhibiting paint. A 1000 mm length of 75 mm x 75 mm trunking shall be installed over the rebar and joint to provide mechanical protection to the rebar and connection point.
- (g) The lightning protection system shall be bonded from the two nearest test points to the building main earth bar. The connection shall be carried out in 25 mm x 3 mm tape.

- (h) The Electrical Services Installer shall bond all lift guide rails to the lightning protection system. The bonds shall be located at the bottom of the guide rails within the lift pit. The electrical services installer shall liaise with the lift installer to agree the final connection detail to the guide rails. The bonding connection shall be carried out in 25 mm x 3 mm tape.
- (i) All piles identified for use as earthing or lightning protection earth terminals shall be tested and the results witnessed and recorded, prior to the piles being incorporated into the Basement raft construction.

E871300 TESTING

- (a) On completion of the lightning protection system the Electrical Services Installer shall carry out a complete test of the earthing and lightning protection system and provide a completion certificate.
- (b) The Electrical Services Installer shall allow for a retest of the system prior to the expiry of the defects liability period.

E88 PROTECTION AGAINST TRANSIENT OVERVOLTAGES**E880100 GENERAL**

- (a) The electrical services installer shall supply and install surge protection devices for the fixed electrical installation in accordance with the requirements of BS 7671. Particular attention is drawn to the requirements of:
- Chapter 44 Protection against voltage disturbances and electromagnetic disturbances
 - Regulation 534 Devices for protection against overvoltage
- (b) The Electrical Services Installer shall be responsible for the design and installation of the surge protection devices to comply with the requirements of BS 7671 and shall, where necessary, employ the services of a lightning protection specialist to identify the appropriate solution to minimise the risk from transient overvoltages.
- (c) Protection against transient over-voltages shall be provided as described in the following clauses.

E880400 MAIN POWER DISTRIBUTION SYSTEMS

- (a) Type 1, Type 1/2 or Type 2 surge protection devices shall be installed at, or close to the origin of the electrical installation in accordance with BS 7671.
- (b) Type 1 or Type 1/2 surge protection devices shall be installed within all sub-distribution panels, motor control panels and distribution boards, which supply or could supply external equipment, such as external lights, mechanical equipment, security equipment, other remote buildings, etc. which could present a path for transient overvoltages.
- (c) Type 2 surge protection devices shall be installed close to sensitive equipment to further protect against switching transients originating from within the building, for example within comms room power distribution units (PDUs).
- (d) The surge protection devices installed within an installation shall be sourced from a single manufacturer to ensure that the appropriate level of coordination is achieved between the surge protection devices.
- (e) Surge protection devices shall protect all power circuits entering or leaving the building, to protect equipment connected to the power distribution system against the effects of transient overvoltages.
- (f) The Electrical Services Installer shall carefully select equipment energized directly by the low voltage distribution system, according to its rated impulse voltage category.
- (g) The test requirements of the surge protection devices shall comply with IEC 61643-1 for power systems and IEC 61643-21 for telecommunications and signalling systems.
- (h) The selection and installation of the surge protection devices shall be in accordance with BS EN 62305-4 including Annex C.
- (i) Surge protection devices shall have continuous indication of their protection status, either normal condition or device failure. They shall incorporate volt free changeover contacts for indication of their status to a building management system.

- (j) Surge protection devices shall be installed in accordance with the manufacturer's recommendations.

E90 INSPECTION AND TESTING

E900100 GENERAL

- (a) The entire Works shall be inspected, tested and commissioned in accordance with all relevant British Standard Specifications and Codes of Practice, the details given in this specification and to the entire satisfaction of the Engineer.
- (b) Installations shall be inspected and tested in sections as the work proceeds and reports and test results issued accordingly.
- (c) The Engineer or an insurance company may require to inspect or test any equipment during manufacture at the manufacturer's works.
- (d) No section of the works shall be concealed prior to testing and inspection. Subsequent concealment, where applicable, shall only take place following written authority from the Engineer.
- (e) The Electrical Services Installer shall draw up a testing and commissioning programme which shall include the details of the proposed inspection dates by the Engineer both at the manufacturer's works and on site. The documentation provided shall include detailed method statements as to how the tests are proposed to be carried out and any associated health and safety risk assessments necessary.

E900200 CONTRACT LAUNCH MEETING

- (a) At the commencement of the Contract, a Contract Launch Meeting shall be arranged by the Contractor with the Engineer and Services Installers in attendance. The purpose of this meeting is to:
 - i) Confirm to the Contractor and Services Installers the terms of the Engineers Appointment
 - ii) Agree protocols to be adopted for the project
 - iii) Confirm allowances included within the Engineers Appointment for inspections, witnessing and off site tests
 - iv) Clarify specification requirements in respect of Technical Submissions and alternative manufacturers. Review the schedule of Technical Submissions required
 - v) Clarify requirements for Practical Completion

E900400 INSPECTIONS AND WITNESSING BY THE ENGINEER

E900401 Benchmark Standards

- (a) Installation quality and standards shall be agreed by undertaking initial sample installations prior to the commencement of the main installations works.

- (b) Representative areas shall be identified by the Contractor for the Services Installers and other associated trades to coordinate their work, for quality control, benchmark and installation standards, and shall be either:
 - i) Separate areas, on-site or off-site, where the installations will not be incorporated into the final Works. The designated area shall be retained for the duration of the installations works and be kept available for inspection at any time.
 - ii) Initial areas, where the installation shall form part of the final Works. The designated area shall be retained for the duration of the installations works and be kept available for inspection at any time.
- (c) The inclusion of associated trades, such as ceilings, lighting, floors and finishes shall be agreed by all parties to maximise the use of the Representative Area.
- (d) Upon request, the Engineer will undertake inspections of the Benchmark works, for quality and specification compliance and provide comment.
- (e) Other areas shall be installed to the agreed Benchmark standard, inspected by the Contractor and certified as ready for final inspection.

E900404 Inspection by the Engineer

- (a) The number of inspection visits by the Engineer is defined in the Engineers Appointment and will be clarified at the Contractors launch Meeting or upon request.
- (b) The Engineer will undertake site inspections to specific areas only.
- (c) The Contractor shall provide certification to show the area has been inspected and is in compliance with the benchmark before being offered to the Engineer for final inspection.
- (d) Final inspections will form the Defects Inspection for Practical Completion.

E900407 Witnessing by the Engineer

- (a) The extent of witnessing by the Engineer is defined in the Engineers Appointment and will be clarified at the Contractors Launch Meeting or upon request.
- (b) The Engineer will carry out sample witnessing, where part of his Appointment, only after the submission of documentation demonstrating that testing and commissioning has been successfully completed and witnessed by the Contractor or Specialist Commissioning Manager.

E900700 ATTENDANCE

- (a) Tests shall be arranged in co-operation with the Engineer who shall be given five working days' notice in writing of the time, location and nature of the test to be performed. No test shall be considered valid unless the Engineer or his appointed representative is present.
- (b) All necessary skilled and unskilled labour shall be provided for attendance duties during testing and commissioning, including pre and post-test activities. Fuel, water,

electricity, gas and other consumables required for testing and commissioning shall be provided by the Electrical Services Installer.

- (c) All fuel tanks, lubrication systems and the like shall be left fully charged at Practical Completion. Batteries shall be left in a fully charged condition.
- (d) Representatives present during inspection and testing shall be fully conversant with the system concerned and the method of system and instrument operation. Manufacturers or specialist representatives shall attend where specifically indicated elsewhere in the specification or where necessary to ensure that the Works are tests and commissioned in accordance with the requirements of the specification.
- (e) All items concerned with electrical supplies shall be certified ready for use by the Electrical Services Installer.
- (f) The Electrical Services Installer's Commissioning Engineer shall attend site at regular intervals from commencement of the project in order to fully familiarise himself with the Works, monitor the progress of the installation and to ensure that all test facilities required for commissioning are correctly installed.
- (g) The Electrical Services Installer's Commissioning Engineer shall attend programme and liaison meetings with other individual Services Commissioning Engineers and the appointed Specialist Commissioning Manager in order to agree sequencing of works and regimes applying to the works from individual component testing to full building System Integration and Black Building Tests.
- (h) The Electrical Services Installer's Commissioning Engineer shall inspect all installation works and carry out all necessary pre-checks and testing, ensuring that the system or systems meet the requirements of the contract specification, drawings and 'Status A' technical submissions prior to offering systems or part thereof to the Specialist Commissioning Manager and Engineer for inspection and witness testing.

E901000 TEST EQUIPMENT

- (a) Facilities, measuring and recording instruments for inspection or testing purposes shall be provided, checked or calibrated as necessary before use. The Engineer reserves the right to call for a demonstration of the accuracy of any instruments provided.
- (b) The Services Installer shall provide any specialist equipment required in order to satisfactorily test, commission and or verify the installation as required by the specification.

E901300 TEST CERTIFICATES

- (a) Signed test certificates together with signed copies of all pre checks and commissioning records shall be provided prior to each witness test as part of the testing method statements. These will be countersigned by the Specialist Commissioning Manager and Engineer on successful completion of the witness tests.
- (b) Note that the documentation may form part of an Electronic Commissioning Record.
- (c) The test certificate shall give the following particulars:

- i) Project title
- ii) Apparatus or section under test
- iii) Maker's number (if any)
- iv) Nature, duration and condition of test
- v) Result of test including all relevant data particular to the test
- (d) Details of the test equipment including serial number and calibration certificate date.
- (e) Identification and signatures, with dates, of persons carrying out and witnessing test including Company Details
- (f) No test shall be valid until the signed witness test certificate is provided.

E901600 FAILURE OF TEST

- (a) Defects occurring at any time during the test duration shall be made good and a complete re-test carried out.
- (b) Where failure during a test, inspection or commissioning process results in damage to the building fabric, to any services, or requires subsequent builders work in connection to be carried out, then the remedial works shall be carried out without charge to the Contract.
- (c) The Engineer reserves the right to charge the Electrical Services Installer with the costs and expense of attending subsequent tests consequent upon the failure of a test.

E901900 WORKS TESTS

- (a) The Engineer will be entitled, at all reasonable times during the manufacture, to inspect, examine and test all equipment to be supplied.
- (b) All tests shall be offered in accordance with the specification.
- (c) The Contractor shall prepare a schedule of all such equipment with the dates when the equipment is expected to be ready for inspection or testing at works.
- (d) The Engineer shall be given written notice of the date and place at which such equipment will be ready, at least 10 working days before such date. The Engineer shall also be provided with a detailed testing and commissioning method statement plus a set of the updated manufacturer's drawings.
- (e) Where the supplier has obtained items from a secondary supplier, either as complete units or components incorporated into units assembled by the supplier, the Engineer may require facilities as described above to inspect or test such items at the secondary supplier's works.

E902200 SITE INSPECTION AND TESTING

- (a) The Engineer shall be permitted to inspect all works in progress and upon completion. Tests shall be carried out in the Engineer's presence to demonstrate that all materials, equipment, workmanship and systems are wholly satisfactory and comply with this specification.

- (b) Such Inspection and testing may include the withdrawal and reinstatement of cable to/from the conduit.
- (c) Upon completion the installation or any section therefore subject to concealment or about to be energised prior to completion of the installation shall be tested. The installation shall be tested as specified in BS 7671, the BS appropriate to the equipment or system or as described elsewhere in this specification, together with such other tests as may be required by the Engineer in order to determine compliance with this specification.

E902500 COMMISSIONING

- (a) Upon satisfactory completion of final inspection and tests each section of the electrical installation shall be commissioned and left in fully working order.
- (b) A commissioning schedule shall be prepared detailing the systems and sections to be commissioned including the time required with dates for specific operations. The schedule shall include details of other services and attendances required by others. The commissioning schedule shall be made available to the Engineer in draft form for comments not less than four weeks in advance of the date on which commissioning is to commence.
- (c) Operations carried out in connection with the commissioning and putting into operation of the installation shall be carried out in a safe and competent manner and in accordance with the provisions of the Electricity at Work Act, Health and Safety at Work Act and associated Statutory Regulations, the Electricity Regulations and to the complete satisfaction of the Engineer.
- (d) The Electrical Services Installer shall operate, and rigidly adhere to a "Permit to Work" system.
- (e) The Electrical Services Installer shall appoint an "Authorised Person" as defined in the Electricity at Work Regulations. The Person or Persons shall be qualified according to the supply voltage at the point of connection. The name of such person shall be advised in writing to the Engineer.
- (f) No plant, equipment or systems shall be charged, energised or operated without the prior agreement of the Authorised Person.

E902800 STARTING UP

- (a) The Electrical Services Installer shall energise electrical distribution circuits, equipment and systems after they have been inspected and tested provided they are capable of being energised with complete safety.
- (b) Electrical protective devices and systems shall be set as required by this specification, the independent protection study, BS 7671 or as may be directed by the Engineer.
- (c) After starting up, the performance of all plant, equipment and systems shall be verified and adjusted as necessary to obtain optimum performance.
- (d) After completion of all starting up and commissioning procedures, each item or equipment and system shall operate continuously and satisfactorily under normal operating conditions for a period of 72 hours without defects of any kind. Defects shall

be repaired and replacements, adjustments or modifications carried out and the test recommenced. Notwithstanding the above the term of any warranty (12 months minimum or as detailed in the Contract preliminaries) shall commence from the date of Practical Completion.

E903100 INTEGRATED SYSTEM TESTING

- (a) The Building Services installation shall be subject to an integrated systems test.
- (b) The integrated systems tests shall be carried out following completion of all commissioning and successful testing of individual systems including demonstrations and sign off by the Commissioning Manager, the Engineer, the Client and where necessary Statutory Authorities such as Building Control, Fire Brigade and Distribution Network Operator.
- (c) The Services Installer shall allow for attendance of all required personnel including representatives of specialist contractors and manufacturers at the integrated systems tests.
- (d) The Services Installer shall allow, unless otherwise directed for all integrated systems testing to be carried out 'out of hours'.
- (e) The Integrated Systems Test shall demonstrate that all building services systems operate correctly and in accordance with the various cause and effects for specific systems under the various failure scenarios including but not limited to:
 - i) Utility mains failure including individual mains and complete mains failure where the building is served by multiple feeders.
 - ii) Fire Alarm Activations including pre alarm and full alarm during other failure scenarios.
 - iii) Correct operation of life safety systems.
 - iv) Correct operation of all mechanical services systems including mission critical systems.
 - v) Correct operation of standby generation, uninterruptable power supplies, changeover switches, automatic transfer switches and digital static transfer switches etc.
 - vi) Correct operation of Vertical Transportation Systems under both mains failure and fire alarm operations
 - vii) Correct operation individual systems to verify level of redundancy including as necessary individual component failures to ensure that they have no detrimental effect on other systems
 - viii) Correct operation of Security, Building Management, Power Management, Energy Management and Generator Control Systems
 - ix) The Services Installer in association with the Contractor, Specialist Commissioning Manager, other Services Installers and specialist manufacturers produce detailed method statements of all tests to be carried out which shall include the expected effects on the various systems under the various failure scenarios.

- x) All tests shall be recorded and documentation shall be incorporated into the operation and maintenance manuals.

E903400 DOCUMENTATION

- (a) On completion and prior to the issue of 'Practical Completion' of Project the Electrical Services Installer shall provide copies of all completed test certification for the project together with Completion Certificates for the Electrical Installation, Lightning Protection Fire Alarm Installation, Emergency Lighting and other ancillary systems as may be required under the terms of the contract.
- (b) All test results and certificates shall be included within the Operation and Maintenance Manuals in the format required.

E91 TECHNICAL SUBMITTALS

E910100 TECHNICAL SUBMITTALS

- (a) Technical Submittals which do not comply with the following clauses will be rejected.
- (b) For each equipment supplier or manufacturer to be included within the Services Installers Technical Submittals, copies of their current ISO 9001 and ISO 14001 Certification shall be submitted to the Engineer with the first relevant Technical Submittal.
- (c) Where the Technical Submittal is for a supplier who is not on the Hilson Moran Recognised Suppliers List but is being submitted in accordance with Clause E012500/E022500, additional supporting information from the supplier shall accompany the technical submittal. At their discretion the Engineer may also require the supplier to complete the Hilson Moran RSL Application Questionnaire.
- (d) Technical submittals must be specific for the project. Standard literature and extracts from manufacturer's catalogues will not be acceptable.
- (e) Technical submittals shall be submitted for each item of equipment and system components proposed prior to placement of orders. Submittals shall be issued to the Engineer allowing a minimum of 10 working days for comment by the Engineer (unless otherwise agreed), and giving adequate time for comments to be incorporated before equipment orders need to be placed. The issue dates and commenting periods for all technical submittals shall be scheduled by the Electrical Services Installer and agreed with the Engineer at the commencement of the contract. Once agreed, this schedule shall be updated by the Electrical Services installer to reflect any changes in programme. Technical submittals issued not in accordance with the agreed date schedule may take longer to return.
- (f) The first page of each technical submittal shall be a standard proforma as set out in Technical Schedule E979100, unless an alternative format has been agreed by the Engineer. It must contain a specific compliance statement confirming that equipment is fully in compliance with the specification, or if not, stating which clauses are not being complied with and in what specific regard. Any variations from the specified requirements must be clearly and specifically stated on each submittal. General comments regarding compliance will not be acceptable.
- (g) Technical submittals shall include an assessment of the impact on the design resulting from the equipment proposed, including the impact of any non-compliance to the required specification.
- (h) The Technical Submittals for each item of equipment shall include the following information as a minimum:
 - i) Confirmation of all data contained within the technical schedules which form part of this specification
 - ii) All data identified in the technical schedules as 'to be confirmed by the manufacturer' specified design conditions, the actual conditions achieved by the proposed equipment and the performance of the equipment at the specified design conditions

- iii) Manufacturer's specifications and data sheets for the equipment proposed
 - iv) Performance curves and noise data
 - v) Any certification or accreditation relevant to the product
 - vi) Type test certification where requested elsewhere within this specification
 - vii) A detailed method statement to cover all torque settings, the checking and sign off process for all electrical connections including cable lugs, terminals, devices, etc.
- (i) Technical Submittals will be reviewed using the following notation:
- i) A - No comments. Fabrication, manufacture, procurement or installation can proceed
 - ii) B - Fabrication, manufacture, procurement or installation can proceed provided any comments are incorporated into the works. If the Contractor cannot incorporate all comments, the submission is to be amended and re-submitted
 - iii) C - The submission is rejected for the reasons noted and is to be re-submitted

Technical Submissions will be reviewed for compliance with the design intent and any comments made do not relieve the Electrical Services Installer of his obligations under the Contract to coordinate the works and comply with the Contract Documents in all respects unless specifically agreed otherwise.

- (j) Technical submittals are expected to achieve A Status within two submittals. Multiple submittals for the same item as a result of not achieving the requisite standard, or failing to address previous Engineers comments may attract a charge levied to the submitting party for the additional time spent reviewing non-compliant submissions.

E92 DESIGN AND CONSTRUCTION DOCUMENTATION

E920100 TENDER DRAWINGS

- (a) The Tender Drawings are prepared by the Engineer to show the general arrangement of the plant, equipment and services, which form the intended Contract. The drawings are prepared, in conjunction with the specification, allow competitive Tenders to be submitted.
- (b) The Electrical Services Installer shall be responsible for interpreting the drawings, making due allowance for offsets to avoid the building structure or other services, whether indicated or not and shall take all necessary steps (including visiting the site where appropriate) to fully appreciate the nature and extent of the works and shall inspect the architectural, structural and other services drawings associated with the works.
- (c) No claim for loss or expense due to the above factors will be considered.

E920400 CONTRACT DRAWINGS

- (a) The Contract drawings are issued by the Engineer when the Contract is placed. They will comprise the Tender drawings as described, modified to include any variation to the Contract since the issue of the Tender Drawings.
- (b) Variations to the Contract, requiring further drawing information will be carried out by the Engineer by issuing updated copies of the Contract Drawings or supplementary sketch drawings until such times as the working drawings are available for marking up or in such other manner as the Engineer decides.

E920700 DIGITAL DATA

- (a) A digital copy of the Engineers drawings (in 2D or 3D Format) may be made available to the Electrical Services Installer to assist in the preparation of the Installers working drawings should a request for the information be made to the Engineer in writing. Drawings will be issued in the current version of AutoCAD or in DXF format as required.
- (b) The Electrical Services Installer shall be solely responsible for the modification of the digital information to provide the installation drawings as required by this specification. The modified drawings shall accurately reflect the equipment and installation proposed by the Electrical Services Installer as if the drawings had been drawn without the benefit of the digital data. They shall also take account of the most recent Architectural and Structural information. The Electrical Services Installer's particular attention is drawn to the following conditions which apply to the use of any digital information provided by the Engineer:
 - i) Any 3D Digital models made available to the Electrical Services Installer are provided for information only unless explicitly stated otherwise
 - ii) It is an express condition of the contract under which data is supplied that the Electrical Services Installer is responsible for satisfying himself regarding its accuracy, correctness and completeness. The drawings and data have not

specifically been prepared for use by the Electrical Services Installer and may not fully reflect his needs

- iii) The Engineer accepts no liability or responsibility whatsoever for any loss or damage suffered by the recipient arising out of or in connection with the use or misuse of this digital data
- iv) While all reasonable steps have been taken to ensure that the digital data is free from computer viruses, the Engineer cannot be held responsible for any damage or loss that might result from their presence
- v) The copyright of the digital data belongs to the Engineer. Measurements taken from information which is not dimensioned are at the Electrical Services Installers own risk

E921300 MANUFACTURERS DRAWINGS

- (a) Manufacturer's drawings and details of all plant and equipment shall be issued to the Engineer for comment. Drawings and details shall be certified by the Manufacturer as being applicable to the particular items being supplied.
- (b) Drawings shall include general layouts and assembly drawings, details of materials and construction, methods of support and fixing and electrical wiring diagrams. The information shall be in sufficient detail to allow the Engineer to comment. Where particular requirements for drawings are listed in the appropriate clauses for equipment or systems then these shall also be provided.

E921600 INSTALLATION DRAWINGS

- (a) The Electrical Services Installer shall produce fully detailed and dimensioned installation drawings of each service to be installed, including all purpose made plant and equipment. The location of all plant, equipment and services shall be fully dimensioned from each other, from other work and from the building structure.
- (b) The Electrical Services Installer shall ensure that all services, including those provided by others are fully co-ordinated with each other and with the building structure and finishes, including obtaining the necessary information from others and for the indication of the service routes for all trades on composite drawings.
- (c) The Electrical Services Installer shall allow for plant, equipment, pipework, ductwork or electrical installation to be moved during the preparation of installation drawings up to one metre from the position inferred by the Tender Drawings.
- (d) Installation drawings shall include fully dimensioned details and positions of supports and fixings. They shall clearly define the detail and arrangement of installed equipment and systems including access allowances for service and maintenance. Where plant is to be supported on steelwork, the Electrical Services Installer shall provide setting out dimensions for the steelwork and fixing details of the particular plant to be supported. Weight of plant items with point loads shall be provided.
- (e) Installation drawings shall be produced in accordance with a programme which is to be agreed with the Contractor to suit the overall programme for the Works. Reasonable allowance shall be made for incorporating any comments made by the Engineer.

- (f) The installation drawings shall include the following fully coordinated drawings, in addition to any separate single service trade's drawings which may be required. Single service and coordinated drawings shall be produced at the same scale:

	Area	Minimum Scale
i)	Floor Layouts	1:50
ii)	Ceiling Layouts	1:50
iii)	Plant and Switchroom Layouts and Sections	1:20
iv)	Riser Shafts and Service Voids Layouts	1:20
v)	Services Layouts in Congested Areas	1:20
vi)	Schematic Diagrams of each Electrical Service	
vii)	Metering Strategy Schematics	
viii)	Controls Schematics	
ix)	Details	As required
x)	Cause and Effect Schedules for fire detection and alarm systems	

- (g) Plant and equipment shall be shown in outline with positions of connections and access space clearly shown including space for withdrawal of internal parts. On 1:50 scale drawings electrical distribution equal to or larger than 100 mm shall be shown to scale in double line. Circular distribution shall also have the centre line shown. 1:20 and larger scale drawings shall be similarly detailed, except that distribution equal to or larger than 40 mm shall be shown to scale in double line.
- (h) Dimensions shall be clearly shown to locate plant, equipment and distribution from the building structure or fabric and from each other. Inverts or levels above datum shall be shown for all distribution services.
- (i) Installation drawings shall include details and locations of any residual risks as defined under the CDM Regulations which the installers need to be aware of. Where installation drawings have been generated from a 3D installation Model, these residual risks shall also be resident within the 3D Installation Model.
- (j) All plant and equipment shown on drawings shall include and identify a unique asset reference, in a format set out in the contract or agreed with the Engineer that is cross referenced to plant and equipment schedules and operating and maintenance documentation.

E921900 WIRING DIAGRAMS

- (a) The Electrical Services Installer shall produce fully detailed wiring diagrams of electrical work in connection with the medium and low voltage switchboards, generator control panels and other control systems as may be specified.
- (b) Wiring diagrams shall generally be presented on A3 size sheets.

- (c) Computer generated diagrams on A4 sheets may alternatively be presented provided the information is clearly legible. Where diagrams have to be produced on more than one sheet then information shall be grouped as far as possible to minimise cross-referencing between sheets. Diagrams which due to non-compliance with the above are difficult to read will be rejected by the Engineer.
- (d) Wiring diagrams shall clearly indicate the extent of the wiring system, including numbers and sizes of cables with loadings and relevant cable identification and be provided with a legend detailing all symbols utilised including references.

E922200 BUILDERS WORK DRAWINGS

- (a) In addition to the working drawings of the engineering services, the Electrical Services Installer shall produce drawings indicating builders work requirements in connection with the services. These drawings shall include details of penetrations through the structure, builders work supports and bases. Full details of access requirements for commissioning, servicing and maintenance through suspended ceilings and floors, together with access to riser ducts and the like shall also be provided as well as fire stopping arrangements and continuation of thermal insulation through penetration through building fabric.
- (b) The drawings shall only be prepared after the working drawings have been finally agreed with the Engineer and shall be based on the detail of these working drawings. The drawing production programme shall take this fully into account.

E922500 ISSUE OF DRAWINGS

- (a) Copies of installation drawings, wiring diagrams and builders work drawings shall be submitted to the Engineer for comment. Where an electronic document control system is employed for the project this shall be used for the transfer of all drawings and other documentation utilising the protocols agreed for the project. Where an electronic document control system is not being employed, electronic and/or printed copies of all drawings shall be distributed by the Electrical Services Installer as directed by the Engineer. A period of fifteen working days shall then be allowed for comment on the drawings by the Professional Team.
- (b) Where drawings are submitted for comment they will be reviewed by the Engineer and any comments returned, either by marking directly on the drawing, or by correspondence. Drawings will be marked with A, B or C status with the definition of each category being as follows:
 - i) A No comments. The drawing is to be re-issued for Construction and installation works can proceed
 - ii) B Comments provided by the Engineer. The drawing is to be amended to incorporate all of the Engineers comments and marked for Construction. Installation work can proceed but must incorporate all comments made by the professional team
 - iii) C The drawing is inadequate and is to be redrawn and resubmitted for comment. No installation work can proceed until a Status A or B is achieved

The giving of an 'A' status does not relieve the Electrical Services Installer from ensuring that the drawings meet the requirements of the contract documentation.

- (c) The status of installation drawings does not relieve the Electrical Services Installer from his obligations to progress and complete the works in line with the agreed programme. Should the Electrical Services Installer elect, in order to meet the programme, to proceed with installation work before 'A' status working drawing is achieved, this shall be at his own risk. Should unacceptable work be installed, it will be the responsibility of the Electrical Services Installer to ensure it is removed and replaced in a manner acceptable to the Engineer. No claims for delay or payment will be entertained in this respect.
- (d) When the drawings have been amended to incorporate any comments they shall be issued as the construction issue. The same preliminary and construction issue distribution of drawings shall apply to any subsequent revisions of installation drawings.

E922800 DIMENSIONS

- (a) The Electrical Services Installer shall take site dimensions during the preparation of the drawings and be responsible for their accuracy. Setting out of the works on site shall be carried out by the Electrical Services Installer and any errors arising from inaccuracies in setting out shall be the Electrical Services Installers responsibility.
- (b) The Electrical Services Installer shall be solely responsible for the accuracy of the drawings and for any equipment shown being suitable for the purpose for which it is intended and in accordance with the design drawings and specifications.

E923100 SITE COPIES

- (a) One set of prints of installation drawings, manufacturing drawings and installation drawings as necessary to provide a complete record of the Works shall be kept on site. The drawings shall be available at all times for inspection by the Engineer.
- (b) The drawings shall be kept in good condition and be marked up, at least once a week, to show the progress of work on site and incorporate all alterations, omissions, variations and amendments agreed during the progress of the works.

E94 PROTECTION STUDY AND SYSTEM COORDINATION

E940100 GENERAL

- (a) The Electrical Services Installer employ an independent specialist protection engineer to carry out a detailed fault analysis, protection and breaker setting study of the medium and low voltage infrastructure.
- (b) The protection engineer shall produce a fully detailed report including all methodology, calculations, graphical representations, schematics and commissioning data together with an executive summary.
- (c) Where software is utilised in order to produce the protection studies and fault level analysis a copy of the software licence shall be included within the report.
- (d) The study shall include fault level calculations for the complete network taking into account 'as installed' lengths of cables and busbars, attenuation of devices and possible contributions to fault levels from rotating plant. The method of calculation shall comply with IEC 60909.
- (e) The study should incorporate all alternate supply paths including emergency or standby supply paths, including where required alternate settings for breakers when the supply is routed from an alternate source.
- (f) The Electrical Services Installer shall be responsible for the coordination of all protective devices.

E940400 PROGRAM

- (a) The protection study and fault level analysis shall be carried out in two stages.
- (b) The first stage in order to verify the correct selection of protection devices and to establish the suitability of the specified fault rating of switchboards and devices prior to order.
- (c) The first stage should include any recommendations in respect or dual settings for different operating scenarios.
- (d) The first stage shall also review any necessity for blocking schemes to be employed within the network.
- (e) The results of the protection study shall be made available at the factory tests of the switchboard, to allow injection tests to be carried out at the required settings.
- (f) A secondary review of the protection settings shall be carried out prior to the commissioning activities to ensure that all site or design development modifications have been incorporated.

E940700 SITE RECORDING

- (a) The Specialist shall provide all necessary tabulated information to allow the settings to be set by the manufacture at site and verified by the Electrical Services Installer.

- (b) The required settings shall be set up by the manufacturer as a part of the on-site commissioning and shall be offered to the Engineer for inspection prior to energising of the switchboard.
- (c) The final protection study document and the signed off protection setting tables shall be incorporated into the operation and maintenance manuals.

E941000 CAUSE AND EFFECT OF SUPPLY FAILURES

- (a) The Electrical Services Installer shall develop a full cause and effect schedule for all automatic-changeover systems and load shedding systems from the design information provided at tender.
- (b) The schedule shall include all scenarios from main supply failure to load circuit failure.
- (c) Where traditional load management schemes are installed the load steps shall be developed by the Electrical Services Installer from the design information provided by the Engineer.
- (d) The Electrical Services Installer shall also provide all necessary time settings for the individual auto-changeover systems for the acceptance of the Engineer.
- (e) The completed schedules shall form the basis of the commissioning requirements for the systems and the final integrated systems tests.
- (f) All cause and effect and timer schedules shall be incorporated into the Operation and Maintenance Manuals.

E95 RECORD DOCUMENTATION

E950100 BUILDING REGULATIONS COMPLIANCE DATA

- (a) In addition to the requirements for the Health & Safety File, Building Log Book or Tenant Guides as required by the Contract, the Contractor and Electrical Services Installer shall provide the information required to allow the Building Regulations Compliance and EPC Assessments to be completed.
- (b) Information required a minimum of six weeks prior to practical completion:
 - By Contractor
 - i) Details of any installed renewable technologies (to include predicted annual yield calculation (In kWh/year), size and location and manufacturers datasheets)
 - By Electrical Services Installer
 - ii) Installed Lighting Power Density for all areas (in total circuit watts/m²) and design illuminance (in Lux)
 - iii) Location and type of presence detection and connected zones
 - iv) Location and type of daylighting control and connected zones
- (c) Information required a minimum of three weeks prior to practical completion:
 - By Contractor/Commissioning Manager
 - i) Power Factor Correction
 - ii) Confirmation whether the Building Management System includes monitoring and targeting with alarms for out of range values

E950200 ENERGY PERFORMANCE CERTIFICATION

- (a) On Contracts where the Electrical Services Installer has a design responsibility, when requested, the Electrical Services Installer shall provide the information required to the person responsible for producing the Energy Performance Certificates (EPC's).

E950400 ASSET REGISTER

- (a) The Electrical Services Installer shall complete an asset register of all equipment supplied under the contract. A standard form may be provided by the Employer and shall be used for this purpose. Where no standard form is provided, the Electrical Services Installer shall provide a template and obtain the Engineers agreement. All information shall be incorporated in the operation and maintenance manuals and supplied separately to the Employer in electronic format for inclusion in an overall asset document.

E950700 BUILDING LOG BOOK

- (a) The Electrical Services Installer shall unless notified otherwise, produce the Building Log book to meet the requirements of the Building Regulations Approved Document in accordance with CIBSE TM31: Building Log Books and Standard Templates.
- (b) The Building Log Book shall be issued one week prior to Practical Completion. Failure to issue the completed Building Log Book will prejudice the issue of the Practical Completion Certificate.
- (c) Where the Electrical Services Installer is not the Building Log Book author, he shall issue the required information to the Contractor in good time for onward transmission to the Log book Author to allow the completed log book to be issued one week prior to Practical Completion. Failure to issue the required information may prejudice the issue of the Practical Completion certificate.

E951000 BUILDING USER GUIDE

- (a) The Electrical Services Installer will be required to contribute to a non-technical building user guide which describes the operation and environmental performance of the building.
- (b) The Electrical Services Installers contribution shall include guidance on all engineering systems covered by this specification and shall be issued to the Building User Guide author promptly when requested.

E951300 MANUALS

- (a) All record documentation shall be available in a digital format. Where a Computer Aided Facilities Management (CAFM) system is used by the Employer or identified within the Contract, all record documentation shall be issued to accommodate the software platform in use by the Employer and adopt any protocol required by that system.
- (b) Where no specific requirements are specified, manuals should consist of one electronic copy and up to four sets of printed manuals. Both electronic and printed copies shall incorporate all test certificates and acceptances. At least six weeks prior to Practical Completion draft copies of the manuals shall be submitted for comment. One week before Practical Completion final agreed manuals shall be handed over to the Employer.
- (c) Failure to issue the manuals in time for incorporation into the Health and Safety File will result in failure to achieve Practical Completion.
- (d) Where a development includes residential units, each individual residential unit shall be provided with its own set of Operating and Maintenance instructions.
- (e) The manual shall be arranged as follows:
 - i) **Section 1** Index
 - ii) **Section 2** Description of the Design Intent

- iii) **Section 3** Description of the Operation Routine. The description shall include specific instruction for start-up, operation and shut down of each system, procedures for emergency shutdown, making safe potentially dangerous plant, precautions necessary to overcome known hazards when operating each system, bringing into operation standby equipment, instructions on fault finding and emergency in case of plant malfunction or equipment failure and control sequences for all systems. Health and safety matters identified in the Health and Safety Plan and relevant to the operation, maintenance and replacement of the installation shall be described with precautions envisaged as necessary
- iv) **Section 4** Planned Maintenance Instructions. These shall detail the procedures appropriate to the maintenance tasks. Instructions shall include dismantling and reassembly, replacements, adjustment, calibration and testing, reference to parts, identification lists, special tools, test equipment and auxiliary services, hazards which may arise and precautions to be taken, fault finding routines
- v) **Section 5** Maintenance Schedules. These shall detail recommendations for the nature and frequency of inspections, examinations, tests and maintenance tasks to keep the plant, equipment and systems in a safe and efficient working order in accordance with the manufacturers recommendations or where no recommendations are available, in accordance with recognised industry guidance on maintenance standards such as SFG20 as published by the Building and Engineering Services Association. Guidance shall be given on the nature of deterioration and defects to be looked for. Activities shall be listed for daily, weekly, monthly, quarterly, bi-annual and annual routines. The maintenance schedules shall include provisional switching schedules to allow routine maintenance of the electrical infrastructure
- vi) **Section 6** Dismantling. Description of the methods and processes to be used in draining down and emptying of all systems including safe disposal of the contents. Description of the methods envisaged for dismantling of systems to comply with health and safety requirements, including schedules of hazardous substances and methods of disposal
- vii) **Section 7** Equipment Schedules and Parts Lists. The schedules shall locate each item with details of the design and actual operating conditions, including replaceable assemblies. Sufficient information shall be provided to identify each item, with the source of supply, ratings, dimensions and appropriate standards. Equipment schedules shall be provided in an MS Excel or other agreed electronic format and also include as a minimum:
 - Unique asset or sub-asset reference linked to the Working Drawings including generic asset references for distribution systems
 - Where BIM is deployed, the Uniclass 2 classification
 - Asset/ sub asset description
 - System, where the asset forms part of a larger system e.g. chilled water
 - Location of plant, equipment and systems

- Quantity for multiple assets of the same type and duty e.g. light fittings
- Manufacturer, linked to a schedule of manufacturers' addresses and contact details
- Supplier, linked to a schedule of suppliers' addresses and contact details,
- Model number
- Duty, capacity, rating
- Order number
- Date of purchase (or installation for distribution systems)
- Duration of warranty
- Identification of any specialist companies required to undertake the future maintenance of the asset or sub asset linked to a schedule of relevant specialist company addresses and contact details
- A schedule of Parts and consumables associated with each asset or sub asset linked to a schedule of suppliers of those parts and consumables.
- Maintenance Tasks for the asset or sub asset by coded cross-reference to the relevant Maintenance Schedule in Section 5.

The Contractor shall ensure that Section 7 is available and issued in as complete a form as possible six (6) months prior to Practical Completion or as agreed with the Engineer, to enable the Employer to seek initial proposals and prices for the ongoing maintenance of the plant, equipment and systems post-Practical Completion.

- viii) **Section 8 A set of Record Drawings and Test Certificates.** If necessary, due to the number of drawings which have to be included in the manual, each drawing shall be reduced in size to suit the manual, whilst remaining completely legible. There should also be a Master Record Index provided electronically in MS Word or MS Excel, listing drawing numbers, descriptions, category and all related drawings.
- ix) **Section 9 Emergency Measures.** This shall include telephone numbers of Electrical Services Installer's emergency staff and name, address and telephone number of all manufacturers.
- x) **Section 10 Testing and Commissioning Certification.** Copies of all test certificates and commissioning data for each service and item of plant and equipment, cross referenced to the asset unique reference. They shall be final copies of the data produced as required by the Inspection, Testing and Commissioning Section of this Specification. Where such data is not available for inclusion in the draft copy of the manual required by paragraph b of this Clause, the draft shall be forwarded without them. Inability to include these items will not be accepted as a reason for non-production of the rest of the draft manual.
- (f) Where printed manuals are to be provided, covers shall be substantial, of adequate size, distinctive and of sufficient strength to protect the contents for the life of the

installation. The binding shall give a permanent anchorage along the left hand side whilst allowing the text to be flat without damage to the spine.

- (g) The contents shall be prepared with an agreed typeface on top quality A4 paper suitable for direct insertion into the manuals.
- (h) The front cover and where appropriate the spine shall have the name or logotype of the Employer, the name of the building and details of the services included in the manual clearly displayed in permanent lettering. Where the manual is contained in more than one volume, a volume number shall be added.
- (i) The title page shall identify the building, describe the Services referred to in the manual and give the full name and address of the Employer. It shall also contain, date of completion and date of handover of the services to the Employer. The date of issue of the manual with the name and address of the manual author and the Author's reference number
- (j) The preliminary pages shall contain the full name, address and telephone number of the Engineer, the Electrical Services Installer and specialists. A description of how to use the manual with any limitations on its use shall be included. The preliminary pages shall include a contents list, list of supplementary documents and a record of amendments to the manual.
- (k) Each section of the manual shall be divided by a stiff divider of the same size as the holder. The divider shall be labelled to identify the section of the manual which is following.
- (l) All pages comprising the manual shall be sequentially numbered within each Section.

E951600 ELECTROMAGNETIC COMPATIBILITY TECHNICAL JUSTIFICATION FILE

- (a) The Services Installer shall maintain a Technical Justification File in respect of Electromagnetic Compatibility.
- (b) The file shall incorporate all necessary EMC test certificates for equipment and or components.
- (c) The Services Installer shall provide a Declaration of Conformity on completion and this together with the Technical Justification File and supporting documentation shall be forwarded to the Clients Responsible Person as part of the Operation and Maintenance Manuals.

E951900 RECORD DRAWINGS

- (a) Record Drawings shall be provided by the Electrical Services Installer for comment 28 days prior to Practical Completion.
- (b) The Record Drawings, as described, shall be drawn using the current version of AutoCAD. Where record drawings are generated from a 3D Model, each drawing shall be annotated in sufficient detail to fully describe the engineering installations without the need to refer to the 3D Model. Printed copies shall be reproduced on quality paper using international A series sizes. Lettering shall be not less than 5 mm in height.

- (c) Each Record Drawing shall show the name of the Contract and, where appropriate, the zone or floor designation. They shall include a description of the drawing, drawing number and scale. The name and address of the Electrical Services Installer and the Engineer shall be included. Each Drawing shall include the words 'Record Drawing' in 18mm upper case lettering in the bottom right hand corner adjacent to the title block.
- (d) Failure to issue the Record Drawings in time to form part of the Health and Safety File will result in failure to achieve Practical Completion.
- (e) The Engineer will review and comment upon the draft Record Drawings and other relevant contributions to the Health and Safety File. This review will not relieve the Electrical Services Installer of this responsibility to ensure the information included is accurate and complete.
- (f) When agreement with the contents of the Drawings is received, digital and paper copies, in quantities to match the Manuals, shall be issued by the Electrical Services Installer. The Drawings shall comply with the requirements of the Construction (Design and Management) Regulations for incorporation into the Health and Safety File for the Contract.
- (g) Record Drawings shall show the work as completed and shall record the following:
 - i) Details and locations of any residual risks as defined under the CDM Regulations which the Building Owner, Operator or Maintenance Personnel should be aware of in the future management of the engineering services installations. These residual risks shall also be resident within the 3D Asset Information Model.
 - ii) The location, including levels if buried, of public service connections provided within the Contract, whether installed as part of the Contract or the appropriate authority, together with the points of origin and termination, size and materials of pipes, line pressure, flow and other relevant information
 - iii) The layout, location and extent of all piped services showing pipe sizes, together with all valves for regulation, isolation and other purposes, drain cocks, test pockets, gauges, flow or pressure switches and other instruments
 - iv) Location, identification size and details of all apparatus and controls equipment served by, or associated with, each of the various services
 - v) The layout, location, extent of air ducts, including those formed in builders work or otherwise, plant, equipment, dampers, acoustic silencers, grilles, diffusers, other air terminals, balancing dampers, access panels, fire dampers, turning vanes, hand holes, test holes, gauges and instruments. Each duct and terminal shall be marked with its size and air quantity flowing. Each terminal unit or grille shall have its duty clearly shown
 - vi) The location and identity of each room including spaces housing plant, machinery or apparatus
 - vii) Detailed general arrangements of boiler houses, machinery spaces, air handling plant rooms, tank rooms, electrical switchrooms and other plant or apparatus, including the location, identity, manufacturer, size and rating of each apparatus

- viii) Sections, elevations, isometrics and schematics of the plant spaces required to clearly indicate the plant arrangement
- ix) Control and wiring diagrams, incorporating details of each instrument and equipment item with a written description of the sequence of operation of each system. Diagrams shall include full details of internal panel wiring and connections to field mounted items
- x) Layout, location and extent of electrical switchgear distribution boards, cables and termination points
- xi) Unique asset and sub-asset references

E952200 INSTRUCTION OF EMPLOYER

- (a) The Employer's Representatives shall be fully instructed by experienced personnel in the operation, servicing and maintenance of the Works. Instruction shall include the provision of such specialist instruction as is required from any suppliers or specialists.
- (b) Such instruction shall be given for a minimum period of one week, or period as required to fully convey the complexity of the installed plant, equipment and systems to the parties receiving the training. On completion a signed receipt shall be obtained from the Employer stating that such instruction has been received and was sufficient for the future operation and maintenance of the asset.
- (c) A refresher course shall be provided three months after Practical Completion or such other duration during the first 12 months following practical completion, as required by the Employer. On completion a signed receipt shall be obtained from the Employer stating that such instruction has been received.

E952500 WORK IN EXISTING BUILDINGS

- (a) Where works are to be undertaken in an existing building, it shall be the Electrical Services Installer's responsibility to locate the existing Health & Safety File, (or Operating and Maintenance Manuals and Record Drawings where no Health and Safety File exists), at an early stage during the contract. The existing documentation shall be updated by cross referencing it to the new record documentation provided as part of the new contract works.
- (b) Where the final installations incorporate elements retained from the original installation, they shall be clearly identified within the record manuals and on the record drawings so as to clarify the demarcation between the existing and new contract works.
- (c) Where no Health and Safety File or original record documentation exists, or is incomplete, the Electrical Services Installer shall allow to provide the record documentation for the new contract works and take further instruction from the Engineer with regard to the existing works.

E97 TECHNICAL SCHEDULES FOR THE ELECTRICAL SERVICES

E970000 GENERAL SCHEDULES

INDEX TO SCHEDULES	
E970001	SCHEDULE OF DRAWINGS
E970004	SCHEDULE OF RECOGNISED SUPPLIERS
E970007	SCHEDULE OF RECOGNISED SPECIALIST SUPPLIERS
E970009	SCHEDULE OF FINISHES
E970010	SCHEDULE OF TECHNICAL SUBMITTALS
E970011	SCHEDULE OF SAMPLES
E970012	SCHEDULE OF SPARES
E970013	SCHEDULE OF REQUIRED DOCUMENTATION FOR PRACTICAL COMPLETION

E970001 SCHEDULE OF DRAWINGS

DRAWING NO.	TITLE	REVISION
27618-HM-ZZ-ZZ-DR-ES-1100	Electrical Services Schematic	P02
27618-HM-ZZ-ZZ-DR-ES-2100	Lighting Control Schematic	P02
27618-HM-ZZ-ZZ-DR-ES-6100	Fire Alarm Schematic	P02
27618-HM-ZZ-B1-DR-ES-2200	Basement Level Lighting, Emergency Lighting & Lighting Controls Layout	P02
27618-HM-ZZ-GF-DR-ES-2201	Ground Floor Level Lighting, Emergency Lighting & Lighting Controls Layout	P02
27618-HM-ZZ-01-DR-ES-2202	1 st Floor Lighting, Emergency Lighting & Lighting Controls Layout	P02
27618-HM-ZZ-02-DR-ES-2203	2 nd Floor Lighting, Emergency Lighting & Lighting Controls Layout	P02
27618-HM-ZZ-03-DR-ES-2204	3 rd Floor Lighting, Emergency Lighting & Lighting Controls Layout	P02
27618-HM-ZZ-RF-DR-ES-2205	Roof Level Lighting, Emergency Lighting & Lighting Controls Layout	P02
27618-HM-ZZ-B1-DR-ES-3200	Basement Level General Small Power & Ancillary Services Layout	P02
27618-HM-ZZ-GF-DR-ES-3201	Ground Floor General Small Power & Ancillary Services Layout	P02
27618-HM-ZZ-01-DR-ES-3202	1 st Floor General Small Power & Ancillary Services Layout	P02
27618-HM-ZZ-02-DR-ES-3203	2 nd Floor General Small Power & Ancillary Services Layout	P02

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DRAWING NO.	TITLE	REVISION
27618-HM-ZZ-03-DR-ES-3204	3 rd Floor General Small Power & Ancillary Services Layout	P02
27618-HM-ZZ-RF-DR-ES-3205	Roof Level General Small Power & Ancillary Services Layout	P02
27618-HM-ZZ-B1-DR-ES-4200	Basement Level Containment Layout	P02
27618-HM-ZZ-GF-DR-ES-4201	Ground Floor Containment Layout	P02
27618-HM-ZZ-01-DR-ES-4202	1 st Floor Containment Layout	P02
27618-HM-ZZ-02-DR-ES-4203	2 nd Floor Containment Layout	P02
27618-HM-ZZ-03-DR-ES-4204	3 rd Floor Containment Layout	P02
27618-HM-ZZ-RF-DR-ES-4205	Roof Level Containment Layout	P02
27618-HM-ZZ-B1-DR-ES-6200	Basement Level Fire Alarm & Associated Services Layout	P02
27618-HM-ZZ-GF-DR-ES-6201	Ground Floor Fire Alarm & Associated Services Layout	P02
27618-HM-ZZ-01-DR-ES-6202	1 st Floor Fire Alarm & Associated Services Layout	P02
27618-HM-ZZ-02-DR-ES-6203	2 nd Floor Fire Alarm & Associated Services Layout	P02
27618-HM-ZZ-03-DR-ES-6204	3 rd Floor Fire Alarm & Associated Services Layout	P02
27618-HM-ZZ-RF-DR-ES-6205	Roof Level Fire Alarm & Associated Services Layout	P02

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E970004 SCHEDULE OF RECOGNISED SUPPLIERS

The following schedule details manufactures, and suppliers extracted from the Hilson Moran master list of recognised suppliers, whom are deemed suitable to submit equipment for this project. The Electrical Services Installer's attention is drawn to clause E012500 & E02500 in respect of alternative suppliers.

CODE	MANUFACTURER	COMMENTS
1027 - LOW VOLTAGE SWITCHGEAR (DEVICES, ACB'S AND MCCB'S)		
Product Code		
1027	SCHNEIDER	
1027	ABB	
1027A - LOW VOLTAGE SWITCHGEAR (DEVICES, SWITCHES AND FUSE SWITCHES)		
1027A	SOCOMEK	
1027A	ABB	
1027A	EATON	
1028 - DISTRIBUTION BOARDS		
Product Code		
1028	SCHNEIDER	
1028	EATON	
1029 - MINATURE CIRCUIT BREAKERS		
Product Code		
1029	SCHNEIDER	
1029	EATON	
1030 - ENERGY METERS (MID APPROVED & CERTIFIED)		
Product Code		
1030	HAGER LTD	
1030	SCHNIEDER	
1031 - MULTIFUNCTION METERS		
Product Code		
1031	SCHNEIDER	
1031	HAGER LTD	
0087 - AUTOMATIC TRANSFER SWITCHES		
Product Code		
0087	SOCOMEK SICON LTD	
0087	SCHNEIDER ASCO	
0087	ABB	

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CODE	MANUFACTURER	COMMENTS
0093 - LADDER RACKING		
Product Code		
0093	PHILIP GRAHAME	
0093	UNISTRUT	
0093	LEGRAND	
0093	CABLOFIL UK LTD (GREENINGS)	
0093	METSTRUT - METSEC	
0094 - CABLE TRAYS		
Product Code		
0094	UNISTRUT	
0094	CABLEDUCT LTD	
0094	METSTRUT - METSEC	
0094	CABLOFIL UK LTD (GREENINGS)	
0095 - CABLE BASKETS		
Product Code		
0095	LEGRAND	
0095	UNISTRUT	
0095	CABLOFIL UK LTD (GREENINGS)	
-	-	
0096 - CHANNEL		
Product Code		
0096	UNISTRUT	
0096	METSTRUT - METSEC	
0096a - WIRE SUSPENSION SYSTEMS		
96A	GRIPPLE	
0098 - POWER CABLES		
Product Code		
0098	PRYSMIAN CABLES	
0098	DRAKA	
0098A - POWER CABLES FOR LIFE SAFETY		
Product Code		
0098A	PRYSMIAN CABLES	
0098A	DRAKA	
1033 - FIRE ALARM CABLES		
Product Code		
1033	PRYSMIAN CABLES	

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CODE	MANUFACTURER	COMMENTS
1033	DRAKA	
1072 - EARTHING/LIGHTNING PROTECTION COMPONENT MANUFACTURERS		
Product Code		
1072	DEHN (UK) LTD	
1072	WJ FURSE	
0104 - LUMINAIRES		
Product Code		
0105 - EMERGENCY LUMINAIRES		
Product Code		
0111 - ACCESSORIES		
Product Code		
0111	HONEYWELL MK	
0111	LEGRAND	

E970007 SCHEDULE OF RECOGNISED SPECIALIST SUPPLIERS

The following schedule details specialist suppliers extracted from the Hilson Moran master list of recognised suppliers, whom are deemed suitable to develop the designs and submit equipment for this project. The Electrical Services Installer's attention is drawn to clause E012500 & E02500 in respect of alternative suppliers.

CODE	MANUFACTURER	COMMENTS
0100 - EARTHING/LIGHTNING PROTECTION SPECIALIST INSTALLERS		
Product Code		
0100	OMEGA RED GROUP LTD	
0100	BEST SERVICES LTD	
0101 - FIRE DETECTION SYSTEMS		
Product Code		
0101		

E970009 SCHEDULE OF FINISHES

To be read in conjunction with Section E06 and the Scope of Services and Design Parameters Sections of the Electrical Services Specification

REF	ITEM	LOCATION	FINISH	COMMENTS

E970010 SCHEDULE OF TECHNICAL SUBMITTALS

The Electrical Services Installer shall submit the following technical submittals to the Engineer for comment and approval, and as detailed elsewhere in this Specification.

SPECIFICATION SECTION	ITEM OF PLANT / EQUIPMENT	COMMENTS
E015300	Standby life safety generator	
E015400	Automatic Transfer Switches & remote status indicators	
E015700	Feature luminaires including wall mounted luminaires and pendants	
E015800	Fire Alarm Control Panel	
E015800	Emergency voice communication system	
E016100	Disabled toilet alarm system	

E970011 SCHEDULE OF SAMPLES

The Electrical Services Installer shall submit the following samples to the Engineer for comment and approval, and as detailed elsewhere in this Specification.

SPECIFICATION SECTION	ITEM OF PLANT / EQUIPMENT	COMMENTS
E015700	Feature luminaires including wall mounted luminaires and pendants	

E970012 SCHEDULE OF SPARES

The Electrical Services Installer shall provide the following spares to the Client at the time of handover/ Practical Completion.

Specification Section	Item	Comments
E31	PANEL BOARDS, DISTRIBUTION BOARDS AND CONSUMER CONTROL UNITS	
E31	Miniature and Residual Current Circuit Breakers	10% of fitted with minimum of 5 of each type and size (Note that spare devices will not be provided of residential consumer units)
E31	HRC Fuses	10% of fitted with minimum of 5 of each type and size
E34	DEVICES	
E34	Specialist commissioning and or testing devices for protection relays	One per type required
E34	HRC Fuses	10% of fitted with minimum of 5 of each type and size
E50	Standby Generators	
E50	Lubrication Oil	11 Months Supply
E50	Exhaust After treatment Consumables	12 Months Supply
E50	Fuel Oil	Fuel Tank to be filled at PC following IST.
E50	General Consumables and Specialist Items	Spares in accordance with Manufactures recommendations
E57	LIGHTING	
E57	Lamps (Including BC/ES LED)	All Luminaires with the exception of those fitted with integral LED's to be new and unused at practical completion
E57	Lamps (Including BC/ES LED)	10% of all fitted with minimum of 2 of each type and size
E70	Fire Alarm and Detection Systems	
E70	Keys for Fire Alarm Power Supply Switches	All keys to be tagged with descriptors
E70	Panel Keys	All keys to be tagged with descriptors
E70	Fire Alarm Break Glasses	20% of fitted with Minimum of 20
E70	General Consumables and Specialist Items	Spares in accordance with Manufactures recommendations
E72	EVC Systems	
E72	Keys for Fire Alarm Power Supply Switches	All keys to be tagged with descriptors
E72	Panel Keys	All keys to be tagged with descriptors
E72	General Consumables and Specialist Items	Spares in accordance with Manufactures recommendations
E76	SMOKE CLEARANCE SYSTEMS	
E76	Keys for Fire Alarm Power Supply Switches	All keys to be tagged with descriptors
E76	Panel Keys	All keys to be tagged with descriptors

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Specification Section	Item	Comments
E76	General Consumables and Specialist Items	Spares in accordance with Manufactures recommendations
E80	ANCILLARY SERVICES	
E80	General Consumables and Specialist Items	Spares in accordance with Manufactures recommendations

E970013 SCHEDULE OF REQUIRED DOCUMENTATION FOR PRACTICAL COMPLETION

The following documentation must be provided to the Engineer for review and comment as a condition of being granted Practical Completion.

Item	Item	Comments
01	BS7671 Electrical Installation Test and Completion Certificate	Final copy
02	Emergency Lighting Test and Completion Certificate, including lux level measurement drawings	Final copy
03	Fire Alarm Test and Completion Certificate - Insulation resistance test results - Standby battery and power supply unit calculations - Commissioning records - Cause and effect diagram/matrix	Final copy
06	Operation and Maintenance Manuals	Draft copy will be accepted
07	Record Drawings	Draft copy will be accepted
09	Copies of all Test results from Site Acceptance Tests	Final copy
10	Contributions To Building Log book	Draft copy will be accepted
11	EMC Technical Justification File	Final copy
12	Confirmation from Building Control in Respect of satisfactory demonstration of all fire detection, emergency lighting and life safety systems	Final copy
13	Confirmation from Distribution Network Operator in respect of satisfactory demonstration of all G59 protection and/or interlocking systems	Final copy
14	Internal and External plant noise measurements	Final copy
15	Confirmation that all client training has been given	Final copy

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E990100 SUMMARY OF PRICES

REF	DESCRIPTION	COST
E01	Prelims, including liaison and coordination with others	£
E015030	Survey & Validation Works	£
E015060	Strip out of existing redundant electrical services	£
E015200	Mains low voltage distribution	£
E015250	Metering	£
E015300	Life safety generator set	£
E015400	Automatic transfer switches	£
E015500	General small power	£
E015700	Lighting, emergency lighting and lighting controls	£
E015800	Fire Alarm and EVC System	£
E016100	Disabled toilet alarm system	£
E015200	Earthing & bonding, including alterations to lightning protection	£
E015300	Containment	£
E015400	Builders' work in connection with the electrical services	£
E015500	Inspection, Testing and Commissioning	£
E015600	Operation and Maintenance Manuals & As Installed Drawings	£
	Provisional Sums	
	Mains failure relay to existing main switchboard	£5,000.00
	PV on roof (subject to space & other requirements)	£50,000.00
	General small power for unknown items, i.e. AV, security	£5,000.00
	Refurbishment of existing Banking Hall Lighting	£30,000.00
	Fire alarm interface for smoke extract system, including cause-and effect programming	£10,000.00
	Metering system	£5,000.00
	Lighting controls due to unknown luminaire types	£5,000.00
	Electrical Services Total	£