
Facilities, Residential and Commercial Services

Standard Specification for Electrical Installation Work

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REVISIONS

Any revisions to the Project Electrical Briefing Document will be numbered and the appropriate page(s) will be identified by the number of the revision and the year. A new revisions page will be produced to cover further revisions as indicated below.

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STANDARD INSTALLATION SPECIFICATION

1. Scope

- 1.1. This document should be read in conjunction with the University of Liverpool standards & current versions of the relevant Standards and Specifications detailed elsewhere in this document.
This Specification covers the type of materials, methods of use, fixing and location and is to be read in conjunction with the Conditions of Contract, the Specification of Work and the relevant drawings for each respective installation. The clauses contained therein are considered to be in addition to the 18th Edition of BS 7671, with amendments, and do not supersede the standard in any way.
- 1.2. The whole of the works shall be carried out in complete accordance with the 18th Edition of BS 7671 with amendments, the Supply Authority Regulations and the Electricity at Work Act 1989 and as currently amended.
- 1.3. Where deviation from the specification and drawing are required, the Electrical Contractor shall seek approval from the Nominated Principle Contractor / client via formal change of control procedure to ensure compliance with the Nominated Principle Contractors approvals & appraisals processes.

All deviations to the specification shall be pre-approved by the client /Nominated Principle Contractor.

All costs relating to deviations shall be pre-approved by the client/Nominated Principle Contractor
- 1.4. The term "Engineer" shall mean the Director of Facilities Management or his appointed representative.
- 1.5. The term "Contractor" shall mean the company or firm engaged to carry out the electrical installation works.
- 1.6. The term "Tenderer" shall mean the company or firm tendering for the electrical installation works.

2. Materials

- 2.1 Materials used in the works shall comply with the Specification, be new and unused and shall be manufactured, wherever possible, in Great Britain.
- 2.2 Materials shall comply with the latest British Standard Specification, where stated, and where materials are offered as alternatives for which there is no British Standard Specification, then the materials must comply with an equivalent known standard and samples shall be submitted for the approval of the Engineer before orders are placed.
- 2.3 When a trade name, firm or supplier is stated in the Specification, this shall be taken as being indicative of the required standard of design, quality, service and/or material. Alternatives will not be accepted.
- 2.4 Where materials and/or services are described as "approved", "equal and approved" or "selected" it shall mean that the Engineer's approval shall be obtained in writing before ordering the materials and/or services and before proceeding with the work.
- 2.5 At the time of obtaining quotations from a supplier named in the Contract Documents or when placing the order with a Nominated Supplier or Nominated Sub-Contractor (on the instruction of the Engineer) it shall be deemed that the Contractor has specifically stated that the firm concerned will be able to supply the goods or service at the required time to suite the general programme for the Contract. This clause shall not apply in cases when no alternative service is allowable.
- 2.6 Should a Supplier, Nominated Supplier or Nominated Sub Contractor not be able to comply with the general programme dates allocated for his goods or service, the Contractor must, before confirming any order, notify the Engineer immediately in writing and no claim for additional costs or extension of time will be allowed for the period of delay resulting from failure to check dates and notify the Engineer.

It is, therefore in the Contractor's interest to place orders as soon as it is practical, after the signing of the Contract for Suppliers and as soon as instructed by the engineer for Nominated Suppliers and Nominated Sub-Contractors.

- 2.7 Where any propriety brand of material is identified, it shall be used or supplied strictly in accordance with the manufacturer's specification or instructions.
- 2.8 The Tenderer shall include for taking down and removing from site all materials made redundant as a direct result of this Contract. The Engineer is to be offered the opportunity to retain, for further use, any serviceable items of redundant equipment.

3. Installations - General

- 3.1 Every installation shall be installed with the utmost care and attention given to neatness - in particular neatness of surface installations shall be of paramount importance. All installations and work shall be to the satisfaction of the Engineer, only the very best workmanship shall be accepted. **The Contractor shall include in his tender for providing such standards.**
- 3.2 The Contractor shall in all cases use figured dimensions on the working drawings in preference to small scale.
- 3.3 The Contractor will be responsible for taking and checking all site dimensions coordination with other services and for setting out prior to fixing.
- 3.4 Where the position of existing services is shown on the contract drawings, these are to be regarded as approximate only and the Contractor shall, before commencing any work, satisfy himself as to the positions of such cables, conduits, pipes or fittings, and as to whether their depths below the surface shall interfere with the works. In which case he shall provide such slings, struts and other supports as are adequate to support and protect the cables etc (see Excavation and Earthworks).
- 3.5 Care shall be taken not to disturb or damage any cables, conduits, pipes or fittings belonging to any Statutory Undertaking, Local Authority or private parties, which may be laid on the site either before the work commences or during the period of the contract or period of maintenance. Any damage to such cables etc, shall be made good at the Contractor's own expense.
- 3.6 The Tenderer shall include for supplying and installing all fixing brackets, standard or purpose made, necessary for the proper completion of the contract, including the supply and installation of any angle iron, framework, structures, or brackets necessary for fixing switchgear, bus bar chambers and tap off units etc. Brackets shall be steel - of dimensions to suit their purpose and loading, painted with a protective paint.
- 3.7 To avoid the possibility of inadvertently weakening load bearing structures, a schedule of holes through load bearing structures shall be prepared by the Contractor and approved by the engineer before commencement of work.
- 3.8 The drilling, welding to, or cutting of steel work (structural or otherwise) shall be avoided. If such drilling, welding or cutting appears essential the Electrical Contractor must first obtain the approval of the Engineer before any such work is undertaken. The electrical contractor shall be responsible for providing all support loading calculations for incorporation of the electrical designated works. The general support for conduit, trunking, cable tray etc, shall be fixed by an approved clip or welded to steel work in a manner approved by the Engineer.
- 3.9 Where cable or conduits, trunking etc, pass through walls, floors, partitions or ceilings, the hole provided shall, after installation be made good with cement or similar incombustible material to the full thickness of the wall, floor, partition or ceiling. Instructions on priming and painting areas made good as part of this contract shall be given in the Specification of Work -where appropriate.
- 3.10 A competent site based foreman/supervisor must be constantly in charge during the installation and have in his possession full copies of the specifications, schedule of requirements and drawings which must be over marked daily with any alterations.

- 3.11 The Contractor shall bring to the attention of the engineer any corrosive or other deleterious conditions revealed in the course of the work.

4. Switchgear and Distribution Equipment

- 4.1 Transformers shall be suitable for operation with the 11kv Voltage Supply provided by the University Of Liverpool HV Network and as described in the Specification.
They shall provide 415v 4-wire 50Hz 3-phase supplies for general distribution purposes vector group DYN 11 with an impedance of 4.75% (TBC).

Transformer Requirements

Phases	3 Phase (Double Wound)
Frequency Hz	50 Hertz
MV winding	11,000 volts
LV Winding	433 Volts (No Load)
MV Insulation Level	12kV
Power Frequency	28kV. r.m.s
Basic Impulse level	75kV Peak
Impedance - % at 75oC	4.75% subject to IEC Tolerances
MV Tapping's	+/- 2.5% and +/- 5.0%%

Tapping Selection By externally operated "off circuit" switch. The switch handle is to be provided with a padlock facility. Both switch and anti-vandal cover to be suitable for use with ENATS 35-1 defined padlock dimensions - minimum hole size 8mm

MV/LV Connections	Delta/Star N. pt.
B.S. Sector	DYN 11
Temperature Rise	Top Oil 60°C: Windings 65°C
Winding Type	Copper
Type: Outdoor/Indoor	Unit Substation (MV and LV flanges on same side of transformer Tank)
Insulation Liquid type	Midel 7131 transformer fluid

Transformers shall operate at any primary pressure between 10% above or below nominal voltage and with any frequency within 2.4% above or below nominal without exceeding the temperature rises specified in BS.171 (IEC.726), BS 2757/1986 (1994) for the class of insulation to be used with the ambient air temperature.

Transformers shall be provided with the following:-

- Bolted on tank cover (lipped and designed to shed water)
- 4 x lifting lugs
- 4 x jacking lugs
- Base skids drilled for roller axles
- Combined Rating and Connection Plate
- Earthing terminal
- Liquid level indicator showing normal oil level at 15oC
- Filling hole and cover
- Combined Drain/sampler valve (25mmoutlet with a 1" BSP internal thread)
- Plain breather pipe with 1/2 " BSP external thread
- Manual tap changing facilities
- Colour finish to manufactures standard colour Grey Ref 632 of BS 381C

- 4.2 All switchgear or distribution equipment used in main distribution systems or motive power installations shall be of the totally enclosed fully insulated interior metal clad (anti-rust finish) 500 volt pattern suitable for conduit or cable gland entry.
- 4.3 Switchgear shall have a fault rating compatible with the maximum prospective fault level attainable at each respective point of installation. The assembly shall be designed and constructed to withstand the

thermal and mechanical stresses set up by short-circuit conditions from a source fault level as stated elsewhere.

- 4.4 The numbers, sizes and ratings of units incorporated within the switch board or panel shall be as indicated on the drawings and schedules.
- 4.5 The assembly shall be a UK CE marked, ASTA certified, multi-cubicle, type-tested assembly (TTA) to BS EN 61439-1 with Form 4 segregation in accordance with BEAMA Installation recommendations. The type of Form 4 segregation is stated elsewhere. A copy of the specific certification shall be provided to the CA and included in the operational and maintenance manuals.
- 4.6 Switch panels shall be factory assembled Form 4 Type 6 and supplied complete with all necessary interconnection between bus bars and items of switchgear. The LV switchboard shall also include electronic transient voltage surge suppression to protect sensitive electronic equipment from voltage transient surges caused by lightning strikes absorbed by lightning protection systems and induced onto the electrical supply network. Surge protection shall be of the appropriate type, depending on its location within the electrical distribution system and the equipment served.
- 4.7 Before a switch panel is ordered, the Contractor shall submit a manufacturer's drawing fully dimensioned and detailed, and receive written approval from the engineer. Each section of the assembly shall be divided into compartments on a modular basis, to ensure that future alteration and/or additions of equipment can be accomplished without difficulty (i.e. bolted removable divisions, not welded).
- 4.8 Bus-bar chambers shall be constructed of heavy gauge sheet metal and steel angle with solid copper bars on porcelain, acetate or other approved rigid supports and be marked in accordance with BS EN 61439 with minimum current ratings in accordance with BS 159. The chamber shall be completely dust and vermin proof with gaskets between sections and the lids.
- 4.9 Bus bar chambers are to be constructed capable of being extended at both ends and the bars are to be ready to receive extension units.
- 4.10 Where specified, the bus bar system shall be arranged for the neutral earthing of the supply transformer to be made within the switchboard. Removable links shall be provided for testing purposes.
- 4.11 Bus Bars shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection.
- 4.12 A suitably rated copper earth bar in accordance with BS EN 61439-1 shall be provided throughout the length of the switchboard. It shall be pre-drilled to each end for future extension and removable end plates shall be provided.
- 4.13 The earth bar shall be drilled to accommodate all protective conductors and the incoming supply cable earth.
- All protective conductors shall be connected to the earth bar by brass nuts and bolts, with flat and spring washers. All connections shall be labelled at their termination point at the earth bar.
- A main earth termination point shall be provided inside each incomer compartment.
- 4.14 Certain sub-main cables may be oversized in terms of current rating, being governed by voltage considerations, and attention is drawn to the necessity for ensuring the switchgear glands, terminals, etc, are of adequate size for the cable specified.
- 4.15 The assembly shall include air circuit breakers, moulded case circuit breakers, fuse-switch-disconnectors, switch-fuse-disconnectors or disconnectors, as specified elsewhere. Unless otherwise stated, feeders shall be triple-pole with removable bolted link neutral. Cable boxes shall be manufactured to accept the incoming cable arrangement stated elsewhere.

- 4.16 Switchgear shall be interlocked such that switches will not open whilst the switch handle is in the “ON” position. The ON/OFF positions of operating handles shall be identical for all types of disconnector on the assembly
- 4.17 It must not be possible for switch indicators to show an “OFF” position whilst switch contacts are closed.
- 4.18 Fuse carriers and bases shall be of the flameproof, high impact, moulded plastic type, incorporating HRC fuses. Cartridge fuse-links shall comply with BS EN 60269-1 (BS 88). Cartridge fuse-links shall have an Utilisation Category of gG for general applications, including motor circuits. Category gM fuses shall only be used on motor circuits. Category ‘a’ breaking range fuses shall not be used.
- 4.19 Air circuit breakers shall be rated at not less than 600v, manufactured to BS EN60947-2 or BS 5311 as required, shall have a breaking capacity of not less than 25 MVA and be A.S.T.A. certified. Air Circuit breakers shall be complete with auxiliary contacts and terminals for the required controls and indications, together with all appropriate transformers and fuses.
Air Circuit breakers shall have mechanically operated ON/OFF and CHARGE/DISCHARGED indication. ACB’s of the same rating shall be interchangeable. ACB’s of a different rating, but of the same frame size shall not be interchangeable.
- The main air circuit breakers shall incorporate Castell interlocks as Necessary.
- 4.20 Protective relays shall be provided for each incoming ACB. Overcurrent protection shall be inverse definite minimum time (IDMT) relays. Restricted earth fault protection shall be by high-stability circulating current relays and Class X current transformers, of suitable characteristics. The installer shall allow for the full setting up and testing to the satisfaction of the CA of all protective relays
- 4.21 Particular attention is drawn to the method of any remote safety or interlocking control.
- 4.22 Each ACB shall be provided with an operating handle for racking the ACB in and out for isolation, etc. All ACB’s shall be clearly labelled.
- 4.23 Spare space on assembly tiers shall be arranged to allow the simple addition of a feeder device in the future. In the event that part of an assembly tier is empty, spare 100A fuse-switch-disconnectors shall be fitted to fill the spare space. All disconnectors, switched fuses and fused switches shall be clearly labelled.
- 4.24 Contactors are to be rated in accordance with “uninterrupted duty” and “utilisation category ACI” unless otherwise specified, manufactured to BS 5424, complete with D.C. or rectified A.C. operating coils wound for 230 volts protected by a cartridge fuse link, installed within contactors or externally in the form of a fused connection unit.
- 4.25 Residual current devices shall be current operated rated at 500 volts designed to trip at 30mA unless otherwise specifically directed, and supplied complete with a test button with suitable warning label.
- 4.26 For smaller installations and with the permission of the Engineer, switchgear may be mounted on a steel angle framework or timber backed of adequate strength and proportion. Cadmium plated or sheradised steel set bolts, nuts and washers shall be used. Frameworks shall be painted with a protective paint. Where a timber backboard is employed it shall be non-hygroscopic. Timber backboards shall be spaced off walls in an approved manner. Generally, switchgear and fuse gear shall be linked to other switch or fuse gear via couplings and male brass bushes and steel trunking of adequate dimension.
- 4.27 MCCB panels shall be manufactured to EN 60947 60947-2 and of the current limiting type. MCCB’s shall be of the quick-make and break, independent, trip-free type with mechanical ON/OFF/TRIPPED indication as appropriate. MCCB’s shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection.

The operating mechanism shall operate all poles simultaneously during opening, closing and tripping operations.

Each pole of the MCCB shall be provided with thermal element for inverse time delay protection and magnetic element for short-circuit protection. The thermal release shall be adjustable and fitted with a lock-off facility.

Ensure that full discrimination is achieved between the up and down stream devices.

4.28 The contractor shall undertake a full protection study based on the selected equipment to include HV/LV discrimination and all downstream LV discrimination. The study shall be verified and adjustments made if necessary at least 1 week before practical completion.

4.29 Each switch board or panel shall be provided with a circuit schedule identifying each individual circuit giving reference, description, rating of protective device and connected load.

The schedule shall be typed on an A4 sheet, framed and securely fixed to the switch board, panel and adjacent wall as appropriate.

5. Rising and Overhead Bus-Bars

5.1 Rising and overhead bus-bars shall be manufactured to BS 159 Bus Bar trunking systems shall be ASTA certified, conform to BS EN 60439-2 and be capable of withstanding the prospective short circuit currents specified elsewhere. of the appropriate size and rating as detailed in the specific Project Specification of Work and shall have each conductor enclosed in insulating material supported on high quality porcelain or other approved insulation, the whole being supported in a rigid rust-proofed steel framework with heavy gauge sheet steel covers. All junctions of steelwork shall be effectively bonded for earthing purposes. Bus-bars shall be best quality solid copper. Bus-bar trunking covers shall be removable only by the use of tools.

5.2 Plug in and/or clip on fuse boxes or enclosed fused tap off ways for conduit connection shall be arranged as detailed in the Specification of Work and shall be supplied complete with the necessary HRC fuses. The trunking shall be located such that the tap-off unit locations are within 500mm of the equipment they are to supply. A permanent label is to be pop-riveted or otherwise securely fixed to the lid of the tap off point.

5.3 Bus Bar trunking systems shall comprise a sheet metal enclosure, hard drawn, high conductivity copper Bus Bars and be complete with Bus Bar supports, expansion joints, thrust blocks, fire resisting barriers, and cable terminations.

5.4 Bus Bar trunking systems shall incorporate an integral earth conductor, be electrically continuous throughout their length and have a degree of protection to IP41 minimum. Supports for rising or overhead bus-bars shall be as detailed on the drawings and the system is to be complete with all purpose made accessories i.e. Tees, bends, expansion joints, etc., and fire barriers are to be installed where the bus-bar passes through a floor or wall. Power tap-off units shall have 'finger safe' automatic shutters operated by insertion or removal of a tap-off unit. The design of the units shall ensure that no live metalwork is exposed during insertion or removal and that the unit is connected to earth before contact is made with live Bus Bars. The unit shall remain earthed during removal until all live conductors are disconnected.

5.5 Tap-off units shall incorporate HRC fuses, MCB's, MCCB's, fuse-switch-disconnectors, or socket- outlets as specified elsewhere.

6. Section boards and Distribution Boards

6.1 All section boards and distribution boards shall be rated at 500V, type-tested and comply with BS EN 61439-1 and BS EN 60439-3. They shall be suitable for surface mounting, have lockable doors (supplied with two keys) and be controlled by an on-load integral disconnecter. Keys shall be labelled and handed to the CA at practical completion. BS EN 61439 to details in the project Specification of Work.

- 6.2 Enclosure shall be constructed of heavy gauge sheet steel and be fitted with an isolator switch.
- 6.3 Distribution boards are to be mounted at a height of 2 metres to the top edge, above finished floor level or as otherwise directed.
- 6.4 Miniature circuit breaker distribution boards may be used complying with BS EN61439 and having a category of duty M6 minimum or as detailed in the Specification of Work. MCB types i.e. A,B, C or D shall be as detailed in the Specification of Work.
- 6.5 Spare ways for MCB boards are to be blanked off with factory made blank units and insulating bus-bar boots, and for fuse boards they are to be complete with fuse carriers to the maximum size of the spare way but no fuse cartridges are to be fitted.
- 6.6 All neutral and earth bars fitted in distribution boards shall include a way for each circuit contained in the board. Where TP & N fuse boards are utilised as SP & N the neutral bar is to include for a neutral way for each fuse way of the board (i.e. an 8 way TP & N distribution board used as a SP & N board is to have a 24 way neutral block and 24 way earth block).
- 6.7 All distribution boards shall have provision for padlocking off the complete front cover to prevent unauthorised access to MCBs or fuses i.e. a pillar to take 6mm shank padlock.
- 6.8 Distribution boards shall be of the split multi service type allowing lighting circuits to be metered separately from other circuits. Distribution boards shall be provided with integrated pulsed output KWh metering, where multi service distribution boards are used they shall be provided with 2No pulsed output meters.
Distribution boards shall be provided with all CT.s, meters, terminals, connections and extension boxes necessary to form a complete installation.
All conductors terminating at distribution boards shall be appropriately marked with cable ring markers indicating the circuit number and where appropriate phase connection.

All covers, doors and access plates into the distribution boards shall incorporate a gasket to achieve a minimum protection as follows: -

- Internally IP32
- Externally IP65

Access for cabling shall be from the front only. Shrouding to IP2X shall be fitted to prevent accidental contact with live parts. Warning labels shall be provided.

Each distribution board shall be provided with a circuit schedule identifying each individual circuit giving reference, description, rating of protective device and connected load.

The schedule shall be typed on an A4 sheet, laminated and securely fixed to the inside face of the distribution board door.

An engraved designation label shall be fitted to the front of the board.

7. Metering

- 7.1 Sub-metering of electrical supplies shall be provided in accordance with the requirements of:
- Building Regulations Part L 'Conservation of Fuel and Power.
 - CIBSE Guidance Document TM39: 2009 'Building Energy Metering
- All meters shall be linked to the Building Energy Management System. It shall be possible to record energy usage of various services at many locations throughout the building, monitored through the BMS.
- The following services shall be individually metered;
- Lighting
 - Power
 - Mechanical control panels

- Cooling
- Ventilation

Metering shall be provided to all the equipment indicated on the electrical schematic diagram.

The metering unit on the main incomers to the switch boards shall display Volts, Amps, kWh, and KVA, frequency, power factor, total harmonic distortion and maximum demand as a minimum.

Where provided, metering units on outgoing ways shall display volts, amps, kWh and maximum demand.

A kWh metering shall be provided on final distribution boards where practicable. It is anticipated that the kWh metering within the facility shall be linked to the BMS using an RS485 cabling network.

Consideration shall be given to the requirements of meeting BREEAM obligations when installing electrical sub metering. The meter shall be installed at a convenient location in the switch board section or panel, suitable for easy reading and be complete with all CT's selector switches etc.

8. Fuses, MCB's and Residual current devices (RCD and RCBO)

- 8.1 All fuses in switchgear and distribution equipment are to be HRC manufactured in accordance with BS88 or BS1361. Cartridge fuses complying with BS88 shall have a category of duty A046 and a fusing factor as for Class Q1 fuses or as detailed in the project Specification of Work.
- 8.2 Miniature circuit-breakers (MCB) shall comply with BS EN 60898-1, and have a minimum rated short circuit capacity (I_{cn}) of 10kA unless otherwise specified.
- 8.3 MCB's shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection. Three-phase MCB shall trip all phases on any fault condition. Provision shall be made to enable the operating mechanism to be padlocked in the 'OFF' position.
- 8.4 Residual current devices (RCD) shall comply with BS EN 61008 (RCD) or BS EN 61009 (RCBO).
- 8.5 RCD's and RCBO's shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection. The units shall be double or triple-pole as required and mounted enclosed within the distribution board panels or purpose made enclosure.

RCD's (ie: devices with no overload or short circuit protection) shall only be used where appropriate overload and short circuit protection is provided by other means and then only with the agreement of the CA. The contractor shall not rely on overload or short circuit protection provided by others to justify the use of RCD's

The RCD/RCBO shall automatically open the protected circuit on an earth leakage fault between phase and earth equal to or greater than the fault current sensitivity rating of the device.

The operating mechanism shall be independent trip-free and shall not be able to be held closed against an earth fault. The units shall be complete with a test button and trip re-set device.

The RCD/RCBO shall have positive contact indication whereby the opening of the device is clearly indicated by a mechanical indicator. This indicator shall be linked to the device main contacts to show the positive opening of all poles.

9. Marking

- 9.1 The asset naming convention should be implemented from a design perspective, this following through to the installation then maintenance.
Example the typical numbering sequence utilised on the University of Liverpool campus would be:
The HV system incorporates unique designated numbers for all the substations,

Cables are identified as HV/ring number/ cable number
HV/R5/2 is the hv cable from substation 43 to substation 44 forming part of the HV ring 5

For the main LV switchboard
Building number/space reference/transformer number- SB/DB reference number
The reason for having the transformer number on it is so it identifies the source of the supply.
Some buildings are fed from transformers in other buildings.

Consider Arts and Humanities	building number is	811
and	Transformer number is	44 ,
	Lv switchboard	MSB01

The labelling will consist of - 811/space reference/44/MSB01

- 9.2 All switchgear and distribution equipment is to be complete with Traffolyte or similar approved labels, attached by small brass screw and nuts indicating in 10mm block lettering on white background, the duty, reference number, phase (1ph equipment), origin of supply, and also for isolators/fuse switches/switch fuses and fused tap-off boxes, their rating and fuse size installed.
- 9.3 All polyphase equipment is to be complete with Traffolyte or similar approved labels attached by small brass screws and nuts or otherwise securely fixed indicating in 12mm red lettering on white ground "DANGER 400 VOLTS"
- 9.4 All distribution boards and consumer service units are to be complete with a typed circuit schedule on thick white paper. The schedule shall clearly detail circuit designation, description, location, cable size, CPD rating and type and be enclosed in a heavy duty plastic envelope fixed to the inner face of the lid.

NOTE: It shall be possible to gain access to the "envelope" without removing fixing rivets, set screws, etc.

A further copy of the Schedule is to be issued to the Engineer.

10. Wiring

- 10.1 The Medium voltage cabling between the transformer and the RMU shall be installed utilising suitable sized multicore cross linked polyethylene insulated, steel wire armoured cables with low smoke and fume, zero halogen outer sheath, constructed in accordance with BS 6622:2007 and insulated to accept voltages equal to or greater than 11,000 volts. The cable shall be finished with a red sheath colour and fixed with appropriately sized Raychem heat shrunk termination kits complete with stress relief terminations.
- 10.2 The system of wiring shall be as indicated on the project Specification of Work or on the working drawings and may be any of the following:
- LSOH cable in conduit or trunking (6491B)
 - MICC cable (LSOH sheathed, unless otherwise specified)
 - Armoured, double PVC insulated cable
 - XLPE, SWA, PVCS or XLPE, SWA, LSOH cables
 - Double LSF insulated cable , with stranded conductors and equal sized CPC!
- 10.3 All cables are to conform to the type and BS Specification quoted in Chapter 52 of the I.E.T. Wiring Regulations and shall be of an approved manufacture, copper cored. Each cable reel shall bear the manufacturer's name and the date of manufacture. Cables shall not be more than 12 months old at the date of installation.
- 10.4 The "loop-in" system of wiring is to be used on final sub-circuits. No joints are to be made in the run of the cable and ringing of cable sheaths shall not be allowed. Generally, lighting feeds shall be taken to and from switches and not jointed through fitting etc.

- 10.5 The circuits are to be capable of carrying the connected load with a volt drop in accordance with The Wiring Regulations.
- 10.6 Identification of wiring shall be in accordance with Appendix 7 of BS7671, "Cable Harmonisation" as follows:

Colour codes

Single phase live conductors shall be	Brown
Live 1 of a 3 phase circuit shall be	Brown
Live 2 of a 3 phase circuit shall be	Black
Live 3 of a 3 phase circuit shall be	Grey
Neutral conductors shall be	Blue
Protective conductors shall be	Green / Yellow

Mixed circuits

Where old and new cables are present in the same circuit, i.e., an alteration or addition to a circuit, conductors shall be identified by proprietary cable markers at joint boxes and accessory joints;

Phase 1 (red or brown)	Identified as L1
Phase 2 (yellow or black)	Identified as L2
Phase 3 (blue or grey)	Identified as L3
Neutral (black or blue)	Identified as N

Protective conductors shall be green and yellow.

- 10.7 Duplicate supplies shall not be run within the same cable, conduit, trunking or duct. Category 3 cables shall not be run within the same cable, conduit, trunking or duct as category 1 or 2 cables. Category 2 cables shall not run within the same cable, conduit, trunking or duct as Category 1 cables. Category 3 cables forming fire alarm or emergency lighting systems shall be self-contained for each function in respect of cables, trunking, conduit and ducts.

Note: In dado trunking applications, segregation of categories must be strictly adhered to all necessary barriers etc., to be installed.

Volt Drop Allowance

Voltage drop allowance will be taken from BS7671:2018, table 4Ab for private installations whereby voltage allowances are:

Lighting -	6%
Other Uses -	8%

Specific requirements that should be followed for high voltage installations including substations are found in BS EN 61936-1:2010+A1:2014 and BS EN 50522:2011.

11. Underground Cabling and Handling

- 11.1 The Contractor shall provide all equipment required for supply, off-loading and setting to work of the cable including cable jacks, cable rollers, cable stockings, hauling tackle, and the like and shall be responsible for ensuring that these are used and maintained in a safe and serviceable condition.

- 11.2 Cable drums shall be handled, moved and stored in a manner so as to prevent any likelihood of damage to the cable. The Contractor shall take all necessary precautions to ensure that no loss or damage occurs to the cable supplied by the University.
- 11.3 Where mechanical means are approved to pull cables, the pull shall be applied using a cable stocking or pulling eye sweated to the conductors and sheath, and measures shall be taken to avoid excessive strain on the cable.
- 11.4 The cable shall only be laid when it is at a temperature of above 0°C and has been above this temperature for the previous 24 hours.
- 11.5 The Contractor shall bring to the immediate attention of the Director of Facilities Management any corrosive or other deleterious conditions revealed in the course of the work.

12. Excavation of Reinstatement

- 12.1 Underground cables shall be laid direct in trenches unless otherwise indicated. Before excavation is commenced, the area shall be scanned and marked out on site, the route identified for the area for excavation on site and shall be approved by the Engineer. Trenches shall be excavated to provide the minimum cover specified elsewhere. Turf and topsoil and any reusable paving/sets etc shall be removed carefully and preserved for reinstatement in their original positions.
- 12.2 When cable trenches are opened all cables shall be laid and the trenches shall be backfilled within 24 hours. At all times adequate safety precautions shall be taken around open trenches and arrangements made to prevent damage to cables and other users within the vicinity.
- 12.3 Trenches shall be kept as straight as possible, bottom of each trench shall be firm and of smooth contour.
- 12.4 In order to prevent damage to cables and accessories, the Contractor shall take adequate measures to ensure that water is not allowed to accumulate in cable trenches.
- 12.5 The depth of cable trenches shall in general be not less than 450mm (18") and the distance between cables shall be 150mm (6") between centres. Minimum cover for cables

Cables shall be covered to a minimum depth as given in the NJUG standard Volume 1.
- 12.6 When the course of excavation, obstructions are encountered which require deviation from the marked route, the new route shall be approved by the Engineer before further excavation commences.
- 12.7 Damage or suspected damage to other services found during or caused by the excavation and installation of cables, shall be reported by the Contractor to the Engineer.
- 12.8 Material excavated shall be so placed as to prevent unnecessary nuisance or damage. Top soil shall be placed separately and re-used to form the top layer when reinstatement is made. Large pieces of rock, concrete or metal etc. removed during excavation shall not be replaced when back filling, but shall be removed and disposed of by the Contractor. Before cables are laid, the bottom of the trench shall be evenly graded, cleared of loose stones and then covered with a 75mm layer of sand.
- 12.9 Back filling shall be made in even layers, the earth of each layer being well consolidated by light ramming and sufficient allowance made in the final layer to allow for settlement.
- 12.10 Where back filling is carried out by a Sub-Contractor, the Contractor shall provide supervision to prevent damage to cable.
- 12.11 Each and every cable shall be protected by cable tiles centred 75mm above the top of the cable. All cable tiles whether for straight runs or bends shall be of the apex interlocking pattern with the words – **DANGER ELECTRICITY**- impressed on every tile. Tiles shall conform to BS 2484 and shall be earthenware 225mm long by 150mm wide.

13. Cables in Ducts

- 13.1 Cables shall be drawn through ducts when crossing under roads, buildings, structures, paved areas and where shown on drawings.
- 13.2 Earthenware ducts shall be used unless otherwise stated, they shall be of the Stamford type, and conforming to BS 65 in all respects. During laying, care shall be taken to remove all extraneous material from the sockets, and the ducts shall be laid on a base of 75mm concrete also a launching of 75mm concrete shall be provided around the ducts. Effective measures shall be taken to prevent concrete entering the bores of ducts.
- 13.3 Prior to the installation of cables, all ducts are to be cleared by drawing through a mandrel of suitable dimensions, this shall be followed by a pull through to clear any accumulated dirt, after which the ducts will be plugged until cables are laid. After cables are laid, the void formed between the cable and the duct shall be sealed using bituminous compound hessian to prevent ingress of dirt and water.
- 13.4 Ducts shall extend for a minimum distance of 300mm beyond the limits of the features being crossed.
- 13.5 All ducts shall be minimum 100mm internal diameter unless otherwise stated. Ducts shall be laid in continuous lengths with integral joints and shall form a watertight system to prevent the entry of ground water into the duct system
- 13.6 Cable ducts shall only each contain one distribution cable (with any associated pilot or control cables) unless otherwise approved, but for systems such as street lighting etc, multiple cables may be drawn into a duct, so long as the cables do not take up more than 30% of the duct section, the cables can easily be withdrawn and the effect of grouping is allowed for in the current rating of the cables.
- 13.7 After all cables have been installed, both duct ends shall be sealed using mastic or expanding foam to form a vermin, gas, water and fire barrier. The fire rating of the seal shall be as necessary to match the fire rating of the local building structure.
Spare ducts shall be sealed with end caps and mastic to form a vermin, gas, water and fire barrier.
- 13.8 Cables shall be identified where they come into and out of ducts and all labels shall be legible and visible after duct sealing is complete.
- 13.9 Ducts shall be complete with vehicle loads, encasement, concrete and draw pits, fittings, etc to make a composite system. All duct routes shall be shown on the installers drawings and agreed on site with the CA prior to installation.
- 13.10 All duct and tape colours and identification shall comply with the proposals set out by the National Joint Utilities Group (NJUG). Table 1 in NJUG publication "Guidelines on the positioning and colour coding of underground utilities' apparatus" details the specific requirements

The NJUG code is not retrospective and older installations installed before the code was adopted may not conform to the current colour scheme.

Abandoned ducts are sometimes used for other purposes. Ensure systems are fully identified and traced out before any work is carried out.

14. Jointing and Terminations

- 14.1 The filling of cable boxes with compound shall proceed without break, the box having been preheated to the pouring temperature of the compound. Compound shall be poured at a steady rate at the correct temperature to ensure that voids are not formed. Joint compounds shall be in accordance with the cable manufacturer's recommendations.
- 14.2 The armouring of cables shall be securely terminated at glands by means of armour clamps in such a manner that the lay of the wires is undistorted and all wires are firmly gripped.

- 14.3 Through joints in cables will not be permitted in approved areas.
- 14.4 The cores of all power cables shall be phased out and the core ends identified in accordance with BS 7671

15. Markers

- 15.1 On all cables of 11KV and above, identification labels shall be securely fixed by non-corroding ties to the ends of all cables. The cable labels shall give the cable size and destination. All labels shall be of brass contraction.

16. Site Testing

- 16.1 All cables of 11KV and above shall be tested by an approved high voltage testing, specialist contractor. The specialist Contractor shall carry out the following tests on all new or modified cables before the cable is put into operation on cables rated 11KV and above
- 30,000V phase to phase
 - 17,500 phase to earth for a period of 15 min.
- The Contractor will return to the Engineer associated test sheets.

17. Cables

- 17.1 Where more than two circuits are run in one trunking the cables in each circuit are to be laced together with cable ties or cord and identified.
- 17.2 All cables shall be kept 150mm clear of steam and hot water pipes and other services.
- 17.3 Where unprotected cables are laid on the soffit of the ceiling, and only single battens are used for ceiling support, these battens are to be cut to allow the cables to pass through. The Electrical Contractor is to include in his tender for the supply and fixing and act as protection for the cables from ceiling fixing nails/screws.
- 17.4 LSOH cables shall not terminate in lamp holders or lighting fittings or pass through lighting fittings where temperatures significantly above the ambient are present.
- 17.5 Final connections to such lighting fittings shall be made in heat resistant silicone rubber insulated flexible cable. Connections between flexible cables and sub-circuit wiring shall be made via cable connectors housed in the conduit boxes supporting respective fittings. Where this is impractical, an approved conduit box shall be sited adjacent to each respective fitting. Where this is impractical, an approved conduit box shall be sited adjacent to each respective fitting and connector shall be housed within the conduit box.

18. Mineral Insulated Copper Clad Cables

- 18.1 Mineral insulated cables shall be sheathed with copper, incorporating high conducting copper conductors embedded in compressed magnetism oxide, heavy duty grade for all systems as manufactured to B.A.S.E.C approvals, and delivered to site bearing the manufacturer's identification labels.
- 18.2 Mineral insulated cables shall be fitted with screw-on pot scale, filled with plastic compound, and incorporating protective conductors on pots, or an approved heat shrink seal incorporating protective conductor with green/yellow sheath. Phase conductors shall be identified using coloured tapes.
- 18.3 Where possible, unless directed to the contrary, MICC cable shall terminate at equipment, fittings or accessories via a gland, conduit coupling and male brass bush.

- 18.4 MICC cable shall be LSOH sheathed installed using LSOH boots and shrouds (unless otherwise specified).
- 18.5 MICS cable shall be installed in accordance with the manufacturer's instructions by tradesmen who are expert in the handling and jointing of the cable. Bending, stripping and sealing tools shall be employed as recommended by the manufacturers.
- 18.6 MICC cable shall be installed in horizontal and vertical runs-diagonal runs will not be permitted. Minimum bending radii of MICC cable shall be in accordance with chapter 52 of the Wiring Regulations. Where MICC cables are surface routed, they shall be run in a neat and workmanlike manner to conform with the architectural features of a room-even if this entails longer routes of cables. Where MICS cables are buried in wall fabric or floor screeds, they are to be adequately protected from mechanical damage- particularly before floor screeding.
- 18.7 Where MICC cables pass through floors they shall be protected by steel conduit to a minimum height of 300mm. Protective conduits shall be fitted at each end with a female brass bush. Where MICC cables are routed through other areas where mechanical damage is likely to occur, they shall be protected by steel covering. Protective conduits or covering shall be sealed against the ingress of dust or litter using quick setting mastic after the installation of MICS cables.
- 18.8 Where it is proposed to use MICC wiring units on an installation, these will only be acceptable when obtained from the manufacturers direct.
- 18.9 Each circuit wired in MICC cable shall leave switchgear or distribution boards as separate.
- 18.10 Special scale (135°C) are to be used on mineral insulated cable for all boiler plant wiring, where run within heating ducts, final connections to electric fires, fan convectors, unit heaters, enclosed close to ceiling lighting fittings or where high ambient temperatures can be anticipated.
- 18.11 Where mineral insulated cables are used on fire alarm system, the cables are to be LSF sheathed and the sheathing is to be coloured red to identify its duty.
- 18.12 MICC cables shall be fixed by means of LSOH sheathed copper clips (one cable) and saddles (more than one cable) where cables are buried in the building fabric. Clips and saddles shall not be secured to the joints of surface brickwork or block work.
- 18.13 Where three or more MICC cables are run together in plant rooms, roof and floor spaces, ducts, etc., they shall be run on galvanised tray.
- 18.14 Fixings on galvanised tray shall be made with round head brass set screws, nuts and washers.
- 18.15 Fixings for MICC cables recessed into floor screeds or walls shall be made with galvanised nails secured into purpose made plugs.
- 18.16 Fixings for MICC cables surface routed shall be by roundhead brass wood screws into purpose made fire resisting wall plugs.
- 18.17 Plastic cable straps shall not be used.
- 18.18 MICS cables shall be tested as soon as possible after receipt on site, before and after installation within the building fabric (i.e. Walls and floor screeds) at handover and during the guarantee period. MICS cables shall be tested with a 500 volt Insulation Tester. Should any test not produce an infinity reading the Contractor shall investigate and make good the fault at his own expense.

19. Steel Conduit Work

- 19.1 All steel conduits and conduit accessories used in the execution of the Contract shall comply with the following requirements:
- 19.2 Solid conduits shall be of heavy gauge steel, welded, with screw threads for jointing length to length and for the attachment of accessories. Generally, conduits shall be galvanised inside and outside. They

shall be manufactured to the requirements of BS No. 4568 for Class B materials and none of size less than 20mm external diameter shall be used unless specially called for to the contrary elsewhere in this specification.

- 19.3 Flexible conduits shall be of heavy WATERTIGHT pattern finished galvanised and none of size less than 20mm external diameter shall be used unless specially called for to the contrary in this specification. Flexible conduits to be used for fixed wire installation work within building fabric shall be manufactured from low-smoke halogen free materials throughout.
- 19.4 Conduit accessories shall be of malleable grey cast iron BS 4568 and shall generally be galvanised inside and outside. They shall be of BESA pattern with long spouts threaded for the reception of conduits except in the case of such loop-in and adaptable type boxes. Covers for draw-in junction etc. boxes shall be of heavy malleable grey cast iron, generally without gaskets but, when definitely called for, in external situations or in damp atmospheres or locations, suitable approved gaskets shall be fitted. Special waterproof or watertight pattern accessories shall only be used if definitely so specified.
- 19.5 Bushes, glands, plugs, etc., used in conjunction with conduits and conduit accessories shall be of brass. All male bushes shall be of long thread pattern.
- 19.6 Saddles used for fixing conduits, which are to be buried in floor or roof screeds, shall be of clip type finished galvanised. Those used in fixing conduits to surface walls, ceilings, steelwork, etc., shall be of spacer bar type, galvanised. Crampets used for fixing conduits which are to be buried in wall plaster, shall be of steel, finished galvanised.
- 19.7 All conduits and conduit accessories used in the execution of the Contract shall be installed to comply with the following requirements.
- 19.8 Conduit and accessories damaged by weather or other hazards shall not be installed. Previously used conduit shall not be installed.
- 19.9 Cutting, screwing and setting shall be carefully carried out, and all ends shall be cut square. After cutting and screwing, ends shall be reamed to remove all sharp edges and burrs. Setting shall be effected without distortion of diameter and by means of an efficient setting machine. Screwing shall be by means of good quality dies in good condition and poor or damaged threads shall be rejected.
- 19.10 After jointing either length to length or to accessories, the exterior of the conduits, couplings or accessories spouts in the vicinity of the joint shall be particularly observed in the case of work to be buried or concealed and the Contractor shall take care to see that all joints are so painted before being buried or concealed.

20. Conduit Installations

- 20.1 Draw-in boxes or trough shall be inserted at intervals of not more than 10m in straight runs of conduit and, a draw-in box or trough shall be inserted after not more than two such bends or changes in direction.
- 20.2 Conduits shall be surface installed or buried in building structures in accordance with definite requirements of the other sections of this specification.
- 20.3 Surface installed conduits shall, in all cases, be run parallel to the building lines and shall be fixed in position at intervals of not more than 1.23m (4') by means of spacer bar type saddles and these saddles shall be fixed by the following methods as appropriate:
 - a) To brickwork, concrete or the like, by 25mm (1") x no. 8 brass woodscrews and fire resistant wall plugs.

- b) To steel structure by means of cadmium plated 2 B.A. mild steel machine screws and nuts or by means of similar mild steel self-tapping screws.

Conduits run in roof spaces, accessible trenches and such like shall be considered to be surface installed.

Draw-in inspection and junction boxes, and troughs, other than “adaptable” type boxes installed in conduit runs whether on the surface or buried, need not be separately fixed to building structures, but shall rely on the efficient saddling of conduits for their support. Saddles shall be fixed to the conduit runs immediately adjacent to the boxes or troughs. “Adaptable” type boxes of whatever size shall always be fixed separately to building structures by means of at least two fixings of nature similar to the fixings specified for saddles in sub-clause “1” above.

- 20.4 Conduit attachment to sheet steel cable trunking and fluorescent fittings channelling and such like and to all sheet steel or cast equipment boxes with untapped conduit entries, whether surface installed or concealed, with the exception only of loop-in type conduit boxes and other instances where space limitation prohibits shall be effected by means of flanged coupling, a long thread male brass bush and heavy pattern brass compression washer. The coupling shall be fitted outside the equipment and the male bush and compression washer inside the equipment with the flanged part of the washer bearing against the head of the bush.
- 20.5 Conduit attachment to loop-in type conduit boxes and to sheet steel or cast cases of other equipment where space installed or concealed, shall be effected by means of a standard conduit coupling, a long thread male brass bush and a heavy pattern brass compression washer. The coupling shall be fitted outside the equipment and the male bush and compression washer inside the equipment with the flanged part of the washer bearing against the box or case.
- 20.6 Attachments other than as detailed in the foregoing sub-clauses 10 and 11 will not be accepted unless the prior approval of the Engineer has been obtained.
- 20.7 Where attachment is to equipment such as cable trunking, florescent fittings, channelling, etc., which is painted or enamelled, the paint or enamel shall be carefully removed from the area of coupling, bush or washer contact and after attachment any exposed area from which paint or enamel has been removed shall be carefully touched up to match the original.
- 20.8 Attachment of flexible conduits to solid conduit, conduit accessories, equipment cases or motor terminal chambers shall be effected without exception by means of brass adapters to which the flexible conduit shall be effectively brazed or soldered. The brass adapters shall then be fixed to solid conduit, conduit accessories, equipment cases or motor terminal chambers in a sound manner, bearing in mind the need for the maintenance of efficient earth continuity. Earth continuity across all flexible conduits shall be affected by the installation within the conduit of a 2.5mm green/yellow sheathed earth wire, which shall be efficiently connected to the brass adapters by soldering or other approved method.
- 20.9 The Contractor shall ensure that conduits are free from dampness and moisture before any wiring is installed therein and shall swab them dry if there is any doubt or if such should prove necessary.
- 20.10 Throughout the course of the Contract, all conduits and accessories shall be effectively protected against the ingress of plaster and other building materials.
- 20.11 Wiring shall not be drawn into any conduit system until the system is complete.
- 20.12 In the case of buried or concealed conduit work, draw-in, inspection and similar boxes, the covers of which must be flush with the finished surface of walls or ceilings, shall have covers of a special overlapping type or shall have fitted between a standard cover, and the box a white bakelite break joint ring.
- 20.13 The use of running couplings shall not be allowed within the works carried out under this contract. Conduit union will be used instead.
- 20.14 All conduit systems shall be complete before the installation of cables.

- 20.15 All surface conduits shall be in vertical and horizontal routes. Conduits in loft areas and ceiling spaces shall be installed in vertical horizontal routes. Conduit routes shall be determined on site where not clearly defined on the contract drawings. All main or conduit routes shall be approved by the Engineer before installation.
- 20.16 Conduits recessed into or installed within walls shall be installed in vertical and horizontal routes. Horizontal routes shall be restricted to high level positions wherever possible.
- 20.17 Conduits cast into floors may be routed in diagonal routes.
- 20.18 All conduits must be installed in a neat and symmetrical pattern and should, where possible, follow the same route even if this entails using longer conduit runs and if during the course of construction it is found this is not being carried out in the manner specified, then the Contractor will be instructed to dismantle and re-install the conduits in the manner specified and the cost of any additional conduit and labour required will be borne by the Contractor.
- 20.19 All conduit routes shall incorporate an adequate number of draw-in boxes in agreed positions. Draw-in boxes shall be of correct type to suit purpose of use i.e. correct number and position of outlet points. Draw-in boxes shall be securely fixed in position using steel wood screws or toggle bolts, as appropriate, and shall be provided at each outlet position. All conduits to be "cast" into building fabrics shall be positioned clear of and above first reinforcement material. No more than two right angle bends shall be incorporated in any conduit run.
- 20.20 Generally, conduit fixings shall be installed at spacings within manufacturer's recommendations. Fixing saddles shall be positioned at a maximum of 1.2m apart or 0.3m from conduit outlet boxes or changes in direction.
- 20.21 Surface conduits including conduits routed through loft areas shall be secured using distance saddles to give not less than 2mm clearance between conduit and wall.
- 20.22 Flush conduits shall be secured using crampits or spring saddles as directed by the Engineer.
- 20.23 Where conduits are run adjacent to steam or hot water pipes, they are to be placed below these wherever possible and in any case are to be not less than 150mm there from.
- 20.24 The conduit and accessories are to be electrically and mechanically continuous throughout.
- 20.25 Conduits shall be protected by Denso tape wrapping where passing through floor slabs.
- 20.26 Where conduits are to be installed externally or in other potentially damp situations, spout outlet boxes or internally threaded cast boxes shall be used. Special measures to ensure water tightness shall be taken including provision of rubber gaskets.
- 20.27 The installation of cables in any conduit shall be in accordance with manufacturer's instructions and BS 7671. Cables shall be installed in conduit and trunking in accordance with IET guidance; however cables in conduit shall occupy no more than 65% of the available space and in trunking, no more than 55%. Cables shall be drawn in such a manner that it is possible to withdraw any number from the conduit without disturbing the remainder. Wire pulling lubricant shall not be used.

21. **Plastic Conduit and Conduit Fittings**

- 21.1 Plastic conduits shall be rigid PVC heavy gauge, white, black high impact, or LSF flexible conduit as specified.
- 21.2 Conduits shall generally be installed in accordance with manufacturer's instructions, with particular reference to expansion joints.
- 21.3 All changes in direction of conduit shall be carried out via purpose made accessories.

- 21.4 Conduits shall terminate at accessory boxes using a plastic flange coupling and plastic male bush. Conduits shall butt solidly into all conduit fittings.
- 21.5 All plastic “slip on” connections shall be cemented using manufacturer’s approved cement.
- 21.6 Plastic conduits **SHALL NOT** be installed in locations suffering temperatures (high or low) likely to cause damage to the same.
- 21.7 The use of plastic conduits are subject to compliance with 18th edition BS7671 regulations 521.10.201 and 521.10.202 and regulation 521.11.201 regarding the support of wiring systems in escape routes. These requirements outline the need for cabling to be supported by fire-resistant fastenings and fixings which are not liable to premature collapse in extreme heat. This means that plastic cable clips, non-metallic cable ties and plastic trunking and conduit to support wiring systems would **be unlikely** to comply with BS7671 for new installations without additional measures.
- Note: PVC conduit **shall not** be accepted under the above Regulation – “be mechanically protected against damage sufficient to prevent penetration of the cable by nails, screws as a suitable method of providing mechanical protection under this contract unless agreed with the client during the tender period.
- 21.8 All plastic conduits shall incorporate protective conductors.
- 21.9 Plastic conduits boxes shall be made of high impact material supplied complete with box lid and where installed at lighting point positions, shall be the type with external fixing feet.
- 21.10 Plastic conduits shall be fixed rigidly to the building fabric in accordance with Clause 2.21.2 above.

Plastic conduit boxes used to support light fittings shall be either reinforced pattern to carry 10KG load or be substituted with Galvanised boxes.

22. Polyethylene Conduits

- 22.1 Polyethylene shall not be used.

23. Cable Trunking – Steel

- 23.1 All cable trunking and accessories used in the execution of the Contract shall comply with the following requirements.
- 23.2 It shall be constructed of sheet steel of not less than 1.5mm for sizes up to 100mm x 100mm or equivalent and not less than 1.75mm for sizes above 100mm x 100mm or equivalent and standard sections shall not be less than 2m in length and shall be manufactured to BS EN10142.
- 23.3 It shall be free from all rough edges, burrs and rust, and shall be thoroughly rust-proofed and finished inside and out in a galvanised finish.
- 23.4 Sizes and types of trunking shall be as called for in the various sections of this Specification or on the drawings, or shall in any case be of sufficient size to accommodate the wiring required whilst still ensuring the appropriate space factor.
- 23.5 All standard rectangular section trunking shall be of the lipped type i.e. the sides shall be flanged over or lipped along the opening over which the cover or lid shall fit. Any skirting, trunking, multi-section trunking or trunking of special nature for installation in floors shall, if called for in any of the various sections of this Specification, be as definitely specified therein.
- 23.6 Lids or cover plates for standard rectangular section trunking shall be of similar gauge and finished as the trunking, shall have their edges flanged over to overlap the sides of the trunking and shall be provided with substantial means of attachment to the trunking. Fixing by means of self-tapping screws

will not be acceptable. Lids or cover plates for skirting or other special trunking, shall if such trunking is called for in any of the various sections of this Specification, be as definitely specified therein.

- 23.7 Bend, tees, jointing pieces and plates, flanges and other accessories shall, unless special permission is otherwise given by the Engineer, be ex-works by the manufacturers of the trunking and suitable in all respects for use in conjunction with the trunking. All shall be of gauge of steel not less than that of the trunking and preferably at least one gauge heavier. All shall be rust proofed and finished similar to the trunking.
- 23.8 Trunking of greater length than 3m, installed vertically, shall be fitted with stout metal pegs at 1000mm intervals so that cables can be laced in and out between them and thus be held firmly in position, and the trunking size shall be increased to maintain the same space factor present for the horizontal.
- 23.9 Where trunking is required to pass through walls or floors from one floor of the building to another, it shall be fitted with suitable and approved flame proof fire barriers.
- 23.10 Building Fire compartmentation must be maintained at all times and all associated builders work should be included for sealing of conduit, trunking and cable penetrations through walls to maintain the fire integrity of the wall/ floor.
- 23.11 All trunking and trunking accessories used in the execution of the Contract shall, unless called for otherwise in any of the various sections of this Specification, be installed to comply with the following requirements.
- 23.12 It shall be fitted with lid or cover plate facing outwards or uppermost.
- 23.13 Trunking may be fixed direct to brickwork, plasterwork, steelwork, etc., as may be necessary or indirectly to such structures by means of brackets. The Contractor, however, shall be guided in this matter by the requirements of any of the various sections of this Specification or where no definite requirements are given, by consultation with the engineer. Where steelwork etc., is permissible, the methods of fixing shall be as for surface installed conduit saddles, as specified in Clause 4.12, Paragraph 8 herein before. Where fixing shall be by means of brackets, the trunking shall be secured to brackets by means of cadmium plated mild steel bolts, nuts and lock washers. Bolts shall be round head pattern and heads shall be fitted within trunking.
- 23.14 Brackets for supporting trunking from roof or other steelwork shall preferably be arranged to hook or clip onto the steelwork in order that drilling of steelwork may be avoided. In such cases, use may be made of such patent fixings as "lindapter" or similar. In the event of hook or clip or similar type bracket proving unsuitable or unfeasible, the permission of the Engineer shall be sought to drill steelwork, but such drilling shall not be carried out prior to the engineer's approval being given in writing.
- 23.15 All containment fixings shall be all metal construction. All expanding plugs shall be fibre type and not plastic. Expanding metallic anchors, fibre plugs, concrete screws and other mechanical fixings shall be used.
- 23.16 All trunking shall be of standard finish and size, as called for on drawings.
- 23.17 Trunking systems shall be rewirable and shall be complete before the installation of cables.
- 23.18 Trunkings shall be run in vertical and horizontal routes, in a neat and symmetrical pattern. Routes shall be determined on site unless detailed on the contract drawings. All main routes of trunkings shall be approved by the engineer before installation.
- 23.19 Trunkings shall be sized to provide at least 50% spare capacity after the installation of all cables provided at original installation stage.
- 23.20 Trunkings shall be kept 300mm minimum clear of steam or hot water pipes.
- 23.21 Expansion couplings shall be provided where trunkings cross an expansion joint within the building fabric. Floor routed trunkings shall not be employed without prior approval of the Engineer.

- 23.22 No trunking apart from ceiling trunking shall be installed with the cover on the underside. Where trunking is secured to switchgear, fuse boards, etc., flanged type couplings shall be used. Particular attention is to be given to corners at tees and bends and to the fitting of screws to avoid possible damage to cables.
- 23.23 Trunkings shall be wrapped with "Denso" tape where passing through concrete floors.
- 23.24 Flush ceiling trunking shall not be less than 2.0mm gauge galvanised flo-coat after manufacture and free from distortion.
- Lids are to be flush with ceiling, secured to the body by means of mushroom headed steel screws at intervals not exceeding 400mm and suitably reinforced to prevent sagging.
- Fire barriers shall be fixed to the lid.
- 23.25 Where lighting fittings or pull cord switches are fixed to trunkings, trunking lids shall be cut and arranged to allow lids in the vicinity of fittings or switches to remain secured after the removal of other sections of lid.

24. Plastic Cable Trunking

- 24.1 Plastic trunking shall be rigid PVC heavy gauge, white, high impact complete with lid, full length back tray and manufactured fittings.
- 24.2 Plastic trunking shall be installed in accordance with manufacturer's recommendations.
- 24.3 Plastic trunkings shall be secured rigidly to building fabrics using round headed steel wood screws in manufactured plugs with oversize washers to prevent screw heads pulling through holes in trunking.
- 24.4 All plastic trunkings shall incorporate protective conductors.
- 24.5 All changes in direction of plastic trunking shall be carried out via purpose made accessories.
- 24.6 Plastic trunking shall be cut to length and access holes for conduit entry etc. shall be cut using only the manufacturer's special tools.
- 24.7 Surface fixed plastic trunking shall be routed as unobtrusively as possible following the architectural features of the room even if this entails longer runs of trunking. Trunking shall be run along full wall lengths and must not terminate part way along a wall, unless specified to the contrary.
- 24.8 Plastic trunking shall not be routed through areas suffering high or low temperatures.
- 24.9 The use of plastic trunking is subject to compliance with 18th edition BS7671 regulations 521.10.201 and 521.10.202 and regulation 521.11.201 regarding the support of wiring systems in escape routes. These requirements outline the need for cabling to be supported by fire-resistant fastenings and fixings which are not liable to premature collapse in extreme heat. This means that plastic cable clips, non-metallic cable ties and plastic trunking and conduit to support wiring systems would be **unlikely** to comply with BS7671 for new installations without additional measures.

25. Cables Tray and Basket

- 25.1 All cable tray and accessories used in the execution of the Contract shall comply with the following requirements.
- 25.2 It shall be constructed of perforated sheet steel as particularly called for in any section of the Specification, shall be of the particular widths and depths specified or, when not specified, of dimensions sufficient to accommodate all the cables to be routed on it without bunching, unless

specifically approved by the Engineer. It shall be provided in standard sections of not less than 2m in length.

- 25.3 All cable trays shall be heavily galvanised throughout and shall be free from all rough edges and burrs. The quality and type, unless otherwise specified, shall be heavy duty galvanised medium return flange.
- 25.4 All bends, sets, tees, jointing pieces and other accessories shall, unless special permission is otherwise given by the Engineer, be ex-works by the manufacturer of the cable tray and suitable in all respects for use in conjunction with the tray. All fittings shall be of gauge of steel not less than that of the tray and of the appropriate dimensions and shall be of galvanised finish. Fixings to tray sections shall be as specified for cable trunking.
- 25.5 All cable tray and accessories used in the execution of the contract shall, unless called for otherwise in any of the various sections of this Specification, be installed to comply with the following requirements.
- 25.6 Where intended to carry heavy power cables, it shall be installed, when horizontal, to enable the cables to be laid inside and not suspended below, unless particularly called for.
- 25.7 It shall always be installed whether horizontal or vertical, to allow space behind for securing cable straps.
- 25.8 All containment fixings shall be all metal construction. All expanding plugs shall be fibre type and not plastic. Expanding metallic anchors, fibre plugs, concrete screws and other mechanical fixings shall be used. Cable tray shall generally be carried on suitable steel brackets, securely fixed to the building structure work, as particularly called for in the various sections of this Specification and generally as specified.

26. Wires, Cables and Flexible Cords

- 26.1 All wires and cables installed under this contract shall conform with the relevant and applicable requirements appropriate up-to-date British Standards as follows:
- 26.2 PVC LSOH XLPE sheathed and armoured cables and insulated to BS 6346; BS 6724; BS 5467 and BS 7211 as appropriate, all holding BASEC approval.
- 26.3 Polyvinyl-chloride-insulated (PVC insulated) cables and flexible cords.
- 26.4 Mineral-insulated metal-sheathed cables BS 6207.
- 26.5 Mineral-insulated metal-sheathed cables must be the product of an approved manufacturer and compliant with the relevant B.S.
- 26.6 Polyvinyl-chloride-insulated (PVC insulated) cables and flexible cords, vulcanised-rubber-insulated cables and flexible cords, paper-insulated cables, butyl-rubber insulated cables and all others shall be the product of an approved manufacturer compliant with the relevant B.S. 6004.
- 26.7 In so far as identification of single core cables, wire and flexible cords and the cores of multi-core cables, wires and flexible cords is concerned, the requirements of I.E.T. Regulations must be rigidly adhered to.
- 26.8 All wires, cables and flexible cords shall be delivered to site with the maker's labels, seals and other proofs of origin, intact.
- 26.9 The sizes of all LSF and similar wiring, shall be strictly in accordance with the requirements of the various sections of the Specification and with the details shown on the drawings.
- 26.10 LSOH and similar wiring, shall only be installed within conduit or trunking systems within enclosed equipment or apparatus, unless specific direction is given otherwise.
- 26.11 Wiring shall not be installed within any conduit or trunking system until that system is complete.

- 26.12 Jointing of wiring shall not be permitted other than at equipment terminals or within suitable and approved joint boxes containing suitable terminals.
- 26.13 In so far as termination, bonding, protection against damage by heat, fire, explosion or by corrosion is concerned, special attention shall be paid to the applicable requirements of I.E.T. regulations.
- 26.14 The number of cables which shall be installed in any one conduit shall not exceed the number permitted by I.E.T. Regulations.
- 26.15 All wiring installed in cable trunking, ducting, channelling, and such like, shall be bound together in single or three phase circuit groups at 2m intervals and shall, at intervals by typed label marked in permanent fashion to indicate the circuit.
- 26.16 Where installed within switches, distribution boards, control panels and such like, wiring shall be neatly and carefully bunched, secured together by means of whipcord binding and adequately supported and held in position by means of supports or brackets of insulating material.
- 26.17 When fixing wiring and cables to cable tray etc., preference is for stainless steel cable ties that can provide essential support and are capable of withstanding temperatures of 300°C or greater, when used with suitable fire resistant mounts and fixings as described above, together with a suitable metal containment system, stainless steel cable ties will offer compliance with the regulations and can significantly reduce the risk of loose wiring and melting trunking.
- 26.18 Wiring of not more than one phase shall be installed in an outlet box, switch box etc., other than one designed for multi-phase use.
- 26.19 The sized of all M.I.C.C. wiring shall be strictly in accordance with the requirements of the various sections of this specification and with the details as shown on the drawings.
All accessories used in conjunction with the termination, sealing, jointing, etc., of the cable, shall be the product of the cable manufacturers and of the correct size of the product of the cable manufacturers and of the correct size and type for the purpose. Where SF sheathed cable is used, LSF shrouds shall be fitted over the final few inches of cable and over cable gland at all terminations. Also all jointing, sealing and termination work shall be carried out strictly in accordance with the manufacturer's recommendations and only by tradesmen qualified to do so.
- 26.20 In so far as termination, jointing, bending, protection against mechanical damage, damage by fire, explosion or corrosion is concerned, special attention shall be paid to the applicable requirements of the I.E.T. Regulations in addition to any requirements of this clause.
- 26.21 Except in cases of runs not exceeding 2m in length, M.I.C.C. wiring shall not be buried in building structure in such a way that it is accessible only by breaking in to the structure, unless prior permission is obtained from the Engineer in writing.
- 26.22 In the case of wiring or cabling by means of other than LSF or mineral insulated cables being called for in the Specification, methods of installation shall be as called for in the section of the Specification under which the work is to be carried out.
- 26.23 Where the use of flexible cords is called for, no cord of size less than 0.75mm² shall be used and, unless specified to the contrary, they shall be of PVC coloured white, to BS6500 and be rated at 850C
- 26.24 In all usage of flexible cords, arrangements must be made to ensure that cords are so clamped or fixed that weight of fittings or such like is not taken by terminals.
- 26.25 Where LSF, LSF double insulated cables are used within the building structure, the following conditions shall apply:
- 26.26 The cable shall be run at a minimum depth of 75mm below the underside of all floor boards, joists shall be drilled, not slotted, to accommodate transverse runs. Where cable is run parallel with the joists, it

shall be affixed to the joist at intervals not exceeding 300mm using moulded PVC clips of appropriate size to the cable.

- 26.27 Where LSF, LSF double insulated cable is run within walls, it shall be enclosed in steel conduit in accordance with the Specification, or be RCD protected. The foregoing conduit shall extend from the accessories being wired to 50mm beyond the point of entry of the cable into the floor or ceiling void.
- 26.28 Where new cabling is to be installed on existing cable tray, the cabling shall be independently fixed to the cable tray and not tie wrapped to existing cables.
- 26.29 Where traditional telephone wiring is installed, all telephone cabling from floor distribution points to line jack units shall be carried out in CW 1308 B white coloured sheathed cabling.
- 26.30 All data and structured cabling from data cabinets to data outlet positions shall be carried out in U.T.P. Cat 5E or Cat 6 sheathed cabling according to the specification and in accordance with the University of Liverpool CSD Network design guide. New data & telephone installation works shall be undertaken using CCA rated minimum. Cat 6A U/FTP to meet POE ++ to deal with increasing power demands of up to Type 4 (100W) Power over Ethernet.

27. Lighting Switches

- 27.1 Lighting switch assemblies shall comply with BS EN60669 either surface or flush and are to be 10A rated grids with rocker type in metal boxes and complete with cover plates detailed in the Specification.
- 27.2 Insulated plate switches may be used where detailed in the Specification. These are to comply with BS EN60669 rocker type screwed to a metal box where flush or to moulded PVC boxes where surface.
- 27.3 Where more than one phase of the supply is brought to a single switching position, purpose made switch units with fixed phase barriers shall be employed incorporating danger notices below the switch plate.
- 27.4 All grid type switches are to incorporate a protective conductor terminal on the grid plate into which the circuit protective conductor shall terminate. In the case of a steel conduit system a protective conductor shall be provided between each grid switch plate and its respective metal housing i.e. switch box.

28. Switched Socket Outlets

- 28.1 All socket outlets shall comply with BS 1363 either surface or flush and are to be 13A shockproof three pin shuttered and switched type complete with metal plates mounted in a metal box or as detailed in the Specification of Work.
- 28.2 Insulated plate socket outlets may be used where detailed in the Specification of Work. These are to comply with BS 1363 to match the insulated plate switches and screwed to metal boxes where flush or to moulded PVC boxes where surface.
- 28.3 Surface mounted metal socket boxes are to have no unused knockouts left when the installation is complete, all socket boxes must accept only the installed conduit.
- 28.4 A protective conductor shall be provided between the protective conductor terminal on each socket outlet and its respective metal housing i.e. Socket box. Where high protective conductor currents may exist, dual earth terminal socket outlets shall be installed.
- 28.5 Socket outlets for general use or for use by ordinary persons shall be protected by 30mA RCD or combined RCBO devices which operate within the stated requirements of BS 7671.

- 28.6 In addition to the above, sockets identified as USB sockets are to comply with IEC 61558-2-16:2009+A1:2013 USB sockets are to have 2 outlets capable of a minimum total charging load of 2A. If the total charging current exceeds the rated level of 2A then the device is to enter a current limiting safety mode. The USB outlets are to be electronically protected against an overload or short circuit. USB outlets are to provide optimum charging compatibility across a wide range of devices. All circuits containing USB sockets are to have reinforced earth as described in the Earthing Section of this Specification.
- 28.7 Filter socket are to incorporate a thermal overload device in the RFI filter section. Overload current cause's temperature rise, resulting in automatic 'trip out'. The overload device is to re-set as the temperature falls. Filter cassettes supplied with sockets are to have an LED which shows green under normal conditions but are to turn red or extinguish when a replacement cassette is required. An alarm is also to beep at 5 second intervals to indicate replacement necessity, the alarm is to have the facility to be de-activated if required.

29. Connection units

- 29.1 Connection units shall comply with BS 5733 and unless otherwise specified shall be double-pole switched and incorporate a BS 1362 fuse. They shall be mounted as required in the appropriate box.
- 29.2 All outlets shall incorporate red pilot lights. The pilot lights shall be recessed into the front plate of the outlets and shall comprise red lens, neon tubes and resistors in completely sealed units.
- 29.3 Connections for use with flexible cord shall have a cord outlet hole in the front or side of the front plate, with suitable flexi-grip enclosing for the cord.
- 29.4 Where the purpose of the connection unit is not clearly associated with the equipment it serves, a suitable label shall be fitted to indicate its function. Labels shall be durable such that they will not fade through exposure to sunlight or suffer due to abrasive wear. Where adhesive labels are used, the adhesive shall not degrade over time or exposure to sunlight, water or extremes of temperature.

30. Commando Equipment

- 30.1 All commando equipment is to conform to all current relevant regulations including BS EN 60309-1:1999+A2:2012, IEC 60309-1:1999
- 30.2 Commando industrial plugs, connectors, sockets and switches are to provide IP44 or IP67 ingress protection. All commando equipment is to have outstanding temperature performance and resistance to chemicals to ensure operation in arduous applications. All sockets are to have self-cleaning contacts and nickel plated pins to provide resistance to humidity and wear. Cable entry is to be secured via a cable clamp that applies pressure to the cable for the lifetime of the product. All commando equipment is to have prolonged earth pole connections to ensure that earth terminals are last to disconnect. Terminals are to be clearly identified and have terminal screws backed out.
- 30.3 Different colour commando equipment are to be used to distinguish between different voltages:
- 110v Yellow
 - 230v Blue
 - 415v Red

31. Room thermostats

- 31.1 Room thermostats shall comply with BS EN 60730 and BS EN 61058.
The rated voltage of thermostats shall be 230 volts unless otherwise indicated and the rated current shall be as required.
- 31.2 Room thermostats shall be of the adjustable pattern, having a nominal range of 7°C to 27°C unless otherwise required. Provision shall be made in the design of thermostats to prevent alteration of the indicated temperature by unauthorized persons.

- 31.3 Thermostats shall be suitable for controlling circuits comprising a resistive load only or a combined resistive and reactive load.

32. Cooker Switches

- 32.1 All cooker switches are to conform to all current relevant regulations including BS 4177:1992 and all cooker outlets to BS EN 60670-22:2006
- 32.2 Cooker switches are to be double pole and be capable of interrupting the supply on full load. The cooker switches are to provide a positive switch action and are to have a minimum rating of 45A unless otherwise stated.
- 32.3 The switch is to be readily accessible, is not be positioned behind or above a cooking appliance such that a person would have to reach over the appliance in order to access the switch/control unit. The horizontal distance between a cooker switch/control unit and the appliance it serves is to be sufficiently short for the switch to be under the control of persons relying on it for safety.
- 32.4 Installation of a cooker switch or control unit in a cupboard or cabinet is not permitted

33. Fire Alarm and Disabled Refuge supplies

- 33.1 All Fire Alarm and Disabled Refuge supplies are to conform to all current relevant regulations including BS EN 60669-2-4:2005 and BS 5839-1:2017.
- 33.2 A suitable double pole switch is to be provided to isolate the supply to the fire alarm and disabled refuge panels during routine maintenance. The double pole switch is to comply with the requirements set out above. In addition the double pole switch is to be lockable in both the 'open' and 'closed' positions and is to have a fuse (fast action, max 6A) within the unit

34. Timer switches

- 34.1 Time switches shall be of the self-starting, self-winding, synchronous-motor-driven, spring reserve, plug-in type, or fully digital with a battery standby of at least 30 hours.
- 34.2 The rated voltage shall be 230 volts and the rated current shall be 20 amperes unless stated elsewhere or as directed by the CA.
- 34.3 Time switches shall, unless otherwise indicated or as directed by the CA, incorporate the following:
- A 30-hour spring or battery reserve to drive the mechanism during electricity supply interruptions.
 - An easily replaceable cartridge fuse link complying with BS 2950 inserted in the motor circuit.
 - A day-omitting device to render the switch in operative.
 - An ON/OFF manual switch to enable the circuit to be controlled at will without affecting normal dial operation.
 - A 24-hour dial with two ON and two OFF levers and a single pole, single throw, switch.

35. Shaver Outlets

- 35.1 All single voltage shaver outlets are to conform to all current relevant regulations including BS 4573:1970+A5:2016
- 35.2 All dual voltage shaver outlets are to conform to all current relevant regulations including BS EN 61558-2-5:2010
- 35.3 Shaver outlets are to have automatic primary supply switching on insertion of plug with a choice of 230V or 115V output socket positions. They are also to have safety interlocked shutters to prevent insertion of two plugs simultaneously. Shaver outlets are to have integral over current device to protect transformer and be suitable for use with electric toothbrushes.

- 35.4 The rated voltage shall be 230 volts and the rated current shall be 20 amperes unless stated elsewhere or as directed by the CA.

36. Lighting Fittings

- 36.1 All lighting fittings detailed in the Specification of Work or on the drawings are to be supplied complete with lamps of the detailed wattage and colour. Luminaires shall be suitable for their location.
- 36.2 Each type of luminaire other than decorative shall be supplied with a complete set of photometric data. Where luminaires are supplied with prismatic or opal diffusers or controllers, they shall be UV and Temperature stabilised to avoid degradation. Polypropylene luminaires or diffusers shall not be used. Switch start fluorescent luminaires shall not be used.
- 36.3 Where hook and chain suspension is specified a protective conductor terminal shall be fitted in the conduit box and three core flexible cable is to be cable tied to, not threaded, down the chain.
- 36.4 Where the conduit suspension is specified, a ball and socket type dome lid with flexible copper bend between the fixed and moving part is to be mounted on the conduit box with a conduit drop and oversize double lock nuts and bush are to be installed on the fitting. Luminaires should not be installed on PVC conduit boxes as primary support.
- 36.5 Unless directed to the contrary, where a lighting fitting is recessed into a ceiling, the wiring system is to terminate in a plug-in ceiling rose or three pin plug and socket sited on the soffit and a short length of 3 core white circular silicone rubber flexible cable is to be taken into the fitting via a suitable grommet opening. The weight of the lighting fitting is to be supported from the structure and not rely on the ceiling grid. All luminaires shall be supplied incorporating full provision for support, located in the appropriate places and allowing full adjustment of mounting, compressing, fusing holes, brackets as most suitable.
- 36.6 All diffusers shall be manufactured in light stabilised plastic such as polycarbonate. Luminaires shall be rigidly constructed in corrosion-proof materials and designed not to distort when suspended or installed.
- 36.7 Lamp holders shall be formed of insulated high temperature mouldings rigidly mounted on the luminaire body. The cable terminations shall be fixed in the lamp holder in such a way that the plunger contacts maintain free movement and no strain is placed on the cables.
- 36.8 Luminaires will predominantly be LED. All LED modules shall be tested in accordance with IEC 62717. Where practical, LED luminaires shall be fully serviceable where LED PCB's and electronic control gear are fully replaceable. All control gear for luminaries shall be either electronic ballast or high frequency unless otherwise specified.
- 36.9 All lamps including LED lamps shall have an efficacy of not less than 55 luminaire lumens per circuit watt for general lighting and not less than 22 luminaire lumens per circuit watt for display lighting.
- 36.10 Any existing luminaries to be re-utilised within an installation shall be cleaned, overhauled and re lamped.
- 36.11 Surface mounted luminaires shall be mounted direct on to flush conduit installations, where a terminal circular conduit box shall be provided. Where surface conduit has been provided the luminaire shall be fixed direct to the ceiling soffit and connected via a side or end entry conduit box.
- 36.12 Suspended luminaires (non-decorative) shall be supported by one of two methods. Either 20mm steel conduit attached to the ceiling outlet box with a ball socket pattern ceiling plate or via a hooked conduit plate and galvanized jack chain. A braided copper link shall be fitted inside the ceiling plate to ensure earth continuity where a ball and socket connection is used.

- 36.13 Recessed luminaires shall be attached directly to the suspended ceiling where permitted. Where the ceilings are plaster, the installer shall install suitable flanged trims to the openings prior to plastering. Recessed luminaires shall be connected via an LCM installed within 3m of the luminaire.
- 36.14 Where low voltage dichroic (or similar) luminaires are to be provided within timber ceilings, fireproof panels shall be fixed by the installer above the luminaire, whenever the space between the top of the lamp holder and the timber is 200mm or less.
- 36.15 External luminaires and vapour-proof luminaires shall be installed with suitable gaskets on all openings to ensure the integrity of the installation. All fixings and supports in these situations shall be zinc plated, brass, or stainless steel as stated on the drawings or elsewhere.
- 36.16 Reflectors and louvers shall only be installed when all dirty trades work is completed and the contractor shall take care not to get fingerprints, marks, etc on the reflective surface (gloves may be required).
- 36.17 At the time of practical completion, the installer shall clean all luminaires thoroughly to remove dust and fingerprints and ensure all lamps are in working order and of the correct wattage and type specified.

37. Lighting Connection Modules

- 37.1 All luminaires recessed into suspended ceilings shall be connected by means of a Lighting connection module (LCM).
- 37.2 Where the selected automatic lighting control system comprises multi-way lighting control modules (LCM), from which wiring to each luminaire is derived, the Contractor shall be responsible for the design, location and selection of the appropriately sized LCM unit to suit each areas application. The contractor shall ensure the maximum permitted number of units, groups and scenes are not exceeded as per manufacturer's requirements.
- 37.3 The Contractor shall allow for a proprietary bracketing support system for each LCM, to be supported directly from the building structure. Under No Circumstances shall it be permitted for the suspended ceiling grid to provide the only means of support.
- 37.4 The wiring from the LCM shall be supported along its entire length fixed directly to the soffit or contained upon the cable basket/tray system within the suspended ceiling void areas.
- 37.5 All mains and control cabling associated with the lighting control system shall be supported along its entire length. No more than 500mm of cabling unsupported shall be permitted. Under No Circumstances shall it be permitted to simply "lay" any cabling on the suspended ceiling grid.
- 37.6 The Contractor shall ensure that no flex between the LCM and the point of termination at the luminaire position exceeds 3 Metre in length. The Contractor shall allow for co-ordinating the installation of each LCM, so as to be accessible and maintainable from below. Access shall be required to each LCM, during the commissioning stages of the project when setting to work the system in line with the client's operational requirements.
- 37.7 Four core leads shall be utilised for luminaries' with integral emergency lighting facilities.
- 37.8 The Dali control cable is to be either a separate 2 core cable or part of a 5 core cable as agreed with the Consultant Electrical Engineer.
- 37.9 Where the provision and installation of PIR's is incorporated into the installation. The Electrical Contractor is to ensure that the detector has a clear unobstructed view within the monitored space.
- 37.10 Where applicable detectors are to be placed away from glass panels which have movement occurring behind them.
- 37.11 The detectors are extremely sensitive to movement and are to be mounted on a solid surface which has no movement whatsoever.

Where a PIR is to be wall mounted the Electrical Contractor is to allow for the specified manufacturers wall mounted kit where appropriate.

Where a number of detectors are connected to a separate control unit the Electrical Contractor is to allow for the manufacturers requirements for the interconnecting cables.

37.12 The contractor shall allow for all commissioning as necessary

38. Emergency and Standby Lighting

- 38.1 Emergency and standby lighting installations shall be as shown on the drawings and detailed in the Particular Specification and shall conform to BS 5266-1 and BS EN 1838 (also numbered BS 5266-7).
- 38.2 The preferred method of providing emergency or standby lighting shall be self-contained units, as indicated elsewhere in this specification.
- 38.3 Luminaires for use on emergency lighting systems shall comply with BS EN 60598-2-22. Self-contained luminaires shall be ICEL approved and suitable for 3-hour operation.
- 38.4 All luminaires shall be purpose made manufacturers equipment, properly tested and certified by the manufacturer. On-site conversion of mains luminaires with emergency battery kits by other manufacturers will not be acceptable.
- 38.5 Emergency lighting shall be provided in all areas necessary, including exits and external escape and assembly areas.
- 38.6 Where mains luminaires are converted to emergency operation using inverter and battery packs, they shall be fitted in accordance with ICEL recommendations and the manufacturer's requirements. In particular, attention shall be paid to the location of the batteries with regard to the effects of high temperatures from luminaire control gear, etc, and that charge indicator LED's are clearly visible with the luminaire in position.
- 38.7 If converted luminaires involve the use of remote mounted batteries or inverter packs; these shall preferably be mounted within 500mm of the luminaire within steel enclosures fixed to the soffit or walls, or on a suitable bracket. Cabling between inverter/battery packs and luminaires shall be the same as wiring for central battery systems. Inverter/battery packs shall not be laid unfixed on the back of ceilings. A readily removable access opening shall be provided for local access to battery packs mounted remotely in voids.
- 38.8 Wiring to self-contained luminaires shall be the same standard as the local normal lighting circuits. A local key test switch shall be provided in a convenient location for each emergency lighting circuit.
- 38.9 Where self test luminaires are specified, the fittings shall employ an indicator system based on LEDs. The LED colours used and sequencing of fault indication shall be common throughout the project so as to avoid confusion during maintenance.
- 38.10 Centralised, remote and TCP/IP based monitoring systems shall be compatible with, and capable of monitoring self-contained luminaires and central battery systems as a maintenance test and diagnosis tool. They shall be manufactured and installed to comply with the requirements of BS5266 and BS EN 62034.
- 38.11 The system shall be capable of monitoring fittings up to 1km away from the control panel or access point via WFI. Systems shall be modular to allow for the expansion of the system in future and shall be capable of monitoring at least 10,000 luminaires with information recorded per luminaire. The same luminaires are wirelessly linked into a Gateway which collects and transmits their energy performance data and complete operational information, for all standard and emergency luminaires, to the World Wide Web for viewing using tablets, smart-phones, laptops and computers.

- 38.12 The system shall be capable of running automatic testing procedures in accordance with current legislation.
- 38.13 Failure of any individual device within the system will not cause failure of any other part of the system to operate.
- 38.14 Systems shall be capable of raising alarm both audibly, visually and remotely for system faults, lamp fail, lamp removal, test fail and test fail to start.
- 38.15 System shall be capable of interfacing with Intelligent luminaires which are fitted with integral Smart sensor providing daylight harvesting, maintained illuminance, presence/absence detection and scene setting facilities
- 38.16 The system shall be capable of group presence communication ensuring luminaires can illuminate in groups and with individual scene setting control using wireless mesh connectivity with building wide link address capability. Groups are easily created and changed providing future flexibility and reliability without altering wiring with an operational frequency of 868MHz
- 38.17 System to include seamless integration of wireless emergency lighting luminaires.
- 38.18 All aspects are to be programmable from floor level using an infra-red remote control Programmer for commissioning and fine tuning.
- 38.19 Software to incorporate simple wait before transmit logic to ensure error free transmissions.
- 38.20 The system to provide daily maintenance status reports, energy performance data, occupancy profiling information and air quality data for viewing on remote website with the capability to store drawings and documentation.
- 38.21 System to offer Off-site Storage of Records and can be accessed remotely via a web server with a username and password.
- 38.22 System manufacturer supporting products to offer on site commissioning, monitoring support, 12 month on site maintenance and 5 year product extended warranty
- 38.23 The whole system shall be tested by a person deemed competent by the installer and by the enforcing authority or the CA.
- 38.24 A test certificate in accordance with BS 5266 Part 1 Appendix A, shall be issued to the CA for including in the operating and maintenance documentation.

39. External Lighting

- 39.1 In general the external building perimeter lighting shall achieve the requirements of CIBSE Lighting Guide LG6, ILE Guidelines, BSEN 12464-2:2014, BS5489 and provide a safe environment for people and the building, minimising any potential light pollution and glare. The design and install shall allow for installing external landscape and pathway lighting to suit required lux levels.
- 39.2 The electrical contractor shall allow for a separate independent MCB distribution board located in the local switch room to supply the external lighting.
- 39.3 Building mounted luminaires and Bollard lights are the preferred type for lighting adjacent pathways. Bulkhead luminaires are to be installed over each external doorway. Column mounted lights should be used in car parking and access road areas. Columns shall be limited to a maximum height of 4m.
- 39.4 Where columns are positioned near to neighbouring properties, or located on the perimeter of the site, they shall be complete with suitable back-shields to prevent light spill. The back-shields shall be fitted within the lamp reflector, such that the appearance of the lanterns remains unchanged.
- 39.5 Where deemed necessary, the Electrical Contractor shall submit calculations showing the light spill in and outside of the site.

- 39.6 All luminaires shall utilise lamps that produce a white light having an efficacy of:-
- a. Building, accessways and pathways - 65lm/W
 - b. Carparking, associated access road and floodlighting - 70lm/W
 - c. Signage and uplighters - 60lm/W
- 39.7 The external building perimeter lighting shall be vandal resistant and fitted with efficient light output, long life lamps. The external building perimeter lighting installation shall give colour rendering of 65Ra or above for the security cameras.
- 39.8 The external lighting scheme shall be provided in accordance with the Local Planning Authorities requirements/restrictions.
- 39.9 No illuminated advertisements will be present on the project.
- 39.10 External lighting shall be of the LED pattern with 5 year guarantee for complete fitting and driver.
- 39.11 Car park, footpath and, where applicable, cycleway lighting schemes shall be provided to achieve lighting levels in accordance with CIBSE LG6 and BS5489 Part 1.
Lighting to the cycle shelter shall meet the requirements of BS5489 Part 1.
- 39.12 The following lighting levels shall be achieved:-
Carpark Areas: 20lux
The external lighting strategy shall be designed in compliance with Table 1 (and its accompanying notes) of the ILE Guidance notes for the Reduction of Obtrusive Light 2005. and BS5489-1:2003 + A2:2008
- 39.13 Where possible all external lights should be from a single manufacturer and from a single matching range. Luminaires and columns to be as manufactured by Messrs. Holophane Lighting/Thorn Lighting/Phillips Lighting or other equal and approved
- 39.14 The exterior lighting shall be controlled via dedicated contactors /circuits on a zoned basis to allow a lower level of illumination for essential areas or non-essential illumination to be switched off, with each zone controlled via a time-clock. Designated as security and amenity lighting.
The contactors are switched via relay outputs from the University BMS and controlled by a combination of time programmes and a lux sensor in the BMS software.
- 39.15 For security lighting the programme will enable the lux sensor between 3.00pm and 9.00am 7 days per week 365 days per year.
For amenity lighting the programme will enable the lux sensor between 3.00pm and 11.00pm and between 5.30am and 9.00am 7 days per week 365 days per year.
The lux sensor will be set to operate both security & amenity lighting when the light level falls below 200 lux & switch off when lighting levels rise above 300 lux. The software will incorporate a time delay of 5 minutes for both on and off operations.
- 39.16 All lighting columns shall be fitted with the following BICC DP cut outs for 230v. The column tops shall be wired using 3 core 2.5mm flexible cable from the outgoing fused ways.

40. Mounting Heights of Equipment

- 40.1 Mounting heights of all equipment are important and the Contractor shall take considerable care in this respect and ensure compliance with DDA requirements is adhered to. The following schedule of heights shall normally apply, but where it is desired shall differ from these, special instructions will be as contained in the various sections of the specification or on the drawings.
- 40.2 In the following schedule, the heights given are from finished floor level to bottom of the equipment:-

Wall mounted switch and distribution equipment and the like – 1600mm to 1900mm.

Wall mounted control equipment – 1300mm to 1900mm.

Lighting switches, control switches, indicator switches and the like – 1100mm to 1400mm.

Socket outlets in labs and offices – 850mm or 200mm above bench height.

Socket outlets in corridors – 450mm.

Clock points at 2500mm. (subject to ceiling heights)

Pull cords for emergency alarm systems are coloured red, located as close to a wall as possible, and have two red 50mm diameter bangles, one set at 100mm and the other set between 800mm and 1000mm above the floor.

Generally, switchboards and distribution boards shall be installed so that any item to which easy access is required such as a fuse, circuit breaker, instrument, etc., is not more than 2000mm or less than 300mm above floor level.

All outlets, switches and controls, including two-way switching, should be positioned consistently in relation to doorways and corners within a building and in a logical sequence to suit passage through the building. Preferably, light switches should align horizontally unless otherwise indicated.

41. Circuit Protective Devices

- 41.1 Fusing shall be of the cartridge type of size called for in the various sections of the Specification and on the drawings. No departure from Specification or drawing requirements shall be made without the approval of the engineer.
- 41.2 All circuits of 32A or less shall be controlled by miniature circuit breakers and the Contractor attention is drawn to the necessity of maintaining correct discrimination with the fuse feeding the M.C.B.'s.
- 41.3 R.C.D.s and R.C.B.O.s shall be used in accordance to BS 7671 and in accordance with the specification.
- 41.4 All cartridge fuses shall be of H.B.C., A.S.T.A. tested indicating pattern of approved manufacture.
- 41.5 On completion of the works, spares for all switch and distribution equipment, including switchboards, shall be handed to the engineer.

42. Earthing

42.1 System Type Earthing Arrangement

The contractor shall identify the system type and main earthing arrangement for the installation, in general will be TN-C-S (PME) whereby the neutral from the main LV panel will be utilised as a combined neutral and earth conductor back to the star point.

The neutral will be connected to earth within the main LV panel. From the main LV panel the neutral and earths are then kept apart

- 42.2 Main earth electrodes shall be supplied in the form of copper, steel tipped earth rod (s) of Messrs Furse manufacture or equal and approved, where supply authority earthing points are not provided a series of earth rods to an earth resistance level of 10 ohms to act as a transformer earth network for the sub-station shall be installed.
This shall be connected to the main HV earth bar located within the sub-station.

- 42.3 Earth electrodes shall be copper clad steel, complete with all drive type heads and connectors, and cable clamps. Each earth rod shall be protected by a purpose made enclosure that is accessible for testing and maintenance purposes.

- 42.4 Initially this may consist up to 6 No 3000mm long x 13mm Dia earth rods spaced at 3600mm centres in the footway outside the Sub-station and each earth rod connected in series together and to the main HV earth bar with 1c 240mm² G/Y earth cable to form a suitable earth for the HV system.
- 42.5 Prior to finalising the number of earth rods required the Contractor shall carry out a soil resistivity test to verify the exact number and size of the earth rods required. The Contractor shall provide a test certificate of the soil resistivity as part of the works.
The Contractor shall agree with the Engineer the exact number and size of the rods once the soil resistivity has been verified.
- 42.6 The Contractor shall install an earth bar with removable links. The earth rod connections shall be taken directly to the link connections at each end of the earth bar.
The Earth bar shall be sized to accommodate the earth cables being installed.
- 42.7 The earth resistance shall not exceed 1 ohm before interconnection with the transformer core.
- 42.8 The Contractor shall install
a 1c 95mm² earth cable from the transformer case earth to the HV earth bar.
a 1c 95mm² earth cable from the transformer 11kV feeder cable armouring to the RMU earth Bar.
a 1c 95mm² earth cable from the RMU case earth to the HV earth bar.
a 1c 240mm² G/Y earth cable from the transformer star point to the main LV switchgear and main LV earth bar.
- 42.9 Where a point of distribution external to the main switch room is serviced by conduit and/or trunking, a protective conductor shall be supplied and installed within the conduit and/or trunking and shall serve as the main protective conductor for the said point of external distribution, and the conduit or trunking serving the point of external distribution shall not be relied upon as part of the conductive path.
- 42.10 The electrical contractor shall allow for installing all other earthing requirements from the main LV earth bar
- 42.11 Earth bars shall be installed to sub stations, switch rooms and external areas
- 42.12 Earth bars provided are to be manufactured from hard drawn copper and come complete with M10 brass connection bolts, glass reinforced polyester insulators and a black powder coated steel base.
- 42.13 Earth bars within sub stations are to be made from 10mm x 50mm copper bar, mounted on insulators, have a minimum size of 24 Ways or the maximum number of ways based on the number of earth cables present plus 25% spare capacity, whichever is the greater. The earth bar shall be rated in accordance with BS 7430
- 42.14 Earth bars within switch rooms are to be made from 6mm x 50mm copper bar, mounted on insulators, have a minimum size of 12 Ways or the maximum number of ways based on the number of earth cables present plus 25% spare capacity, whichever is the greater.
- 42.15 Earth bars are to come with either single or twin disconnecting links to allow periodic testing of a live installation. Earth bar locations are to be agreed on site before installation.
- 42.16 The earth bars within these substation switch rooms are to be cross bonded to ensure that the correct and shortest fault current path is taken back to source.
- 42.17 A suitable percentage of spare capacity is to be made on the main earth bars for any future clean earths that may be required.
- 42.18 An earthing single line diagram is to be produced to identify the extent of the earthing and bonding system throughout. All earthing connections from main earth bars are to be clearly identified with suitable labels.
- 42.19 The earth fault loop impedance should be sufficiently low for the protective device (fuse, circuit breaker, RCD) to operate in the required time in the event of a fault to earth.
- 42.20 The Electrical Design engineer - Contractor shall be responsible for ensuring that the earthing and bonding system installed complies with the 18th Edition of the IET Regulations for Electrical

Installations, particularly with regard to exposed and extraneous conductive parts and exposed metallic parts of the building structure etc.

- 42.21 An equipotential bonding cable shall be provided between the main earthing connection point and the incoming water supply pipe, generally at its point of entry into the building.
- 42.22 An equipotential bonding cable shall be provided between the main earthing connection point and the incoming gas supply pipe, generally at its point of entry into the building.
- 42.23 An equipotential bonding cable shall be provided between the earthing connection point and accessible structural steelwork and lightning conductor system in accordance with BS EN 62305-4.
- 42.24 In addition to supplementary earthing for sub main cabling, equipotential bonding will be required throughout to main steelwork, service pipes and primary containment systems. The contractor shall also cross bond all steel containment systems and local steelwork identified as being liable to introduce a potential difference.
- 42.25 The purpose of earthing the non-current carrying metalwork of plant and equipment of a low-voltage installation is to:
- a) provide for a low earth fault loop impedance to facilitate automatic disconnection of supply in the event of a fault to exposed-conductive-parts;
and
 - b) limit the rise of potential under earth-fault conditions of non-current carrying metalwork with respect to earth to increase the safety of persons and animals in proximity to such metalwork. Extending the earthing arrangement of an installation within a building by use of protective equipotential bonding of exposed-conductive-parts and extraneous-conductive-parts increases the safety of persons and animals by reducing touch potential
- 42.26 All earth bonding conductors shall be not less than the minimum sizes given in BS 7671:2018 (18th Edition of the IET Regulations). ensuring that all local cross bonding installed complies with the 18th Edition of the IET Regulations for Electrical Installations, particularly with regard to extraneous conductive parts with touch potential.
- 42.27 The Electrical Contractor shall provide all necessary earthing conductors to fully comply with the above plus the British Standard Code of Practice on Earthing, CP 1013 Latest Edition including all labelling and warning notices comply with BS 951: 2009.
- 42.28 Marker tiles and earth rod chambers shall be supplied and installed indicating the position of earth main electrode.
- 42.29 Supply authority earthing blocks fitted as part of this contract shall be bonded to main earthing connection points.
- 42.30 On all sites where Protective Multiple Earthing (PME) is provided by the supply authority, the earthing conductor shall be connected to the consumer's earthing terminal together with the neutral conductor of the consumer's installation.
- 42.31 All items of electrical distribution equipment within switch rooms shall be bonded to the main earthing connection point.
- 42.32 Where MICC cables are used as sub-mains i.e., feeding a point of distribution external to main switch rooms, the outer copper sheath may be employed as an earthing conductor but shall be bonded direct to the main earthing connection point (switch room) and the main earth connection on the distribution equipment and cable glands.
- 42.33 All cables shall be identified with a unique cable reference in a visible position that indicates the cable number at each end by means of a proprietary manufactured indelible cable marking system.

43. Lightning Protection:

- 43.1 Lightning protection systems shall be designed, installed and tested in accordance with the requirements of BS EN 62305 and BS 7430.
- 43.2 The system shall comprise of an air termination(s), down conductor(s), testing joint(s), earth termination(s) and earth electrode(s). Steel reinforcing in columns may be used subject to the main contractor confirming there are: Sufficient vertical paths to earth to allow compliance with BS EN 62305
- 43.3 Sufficient metalwork enclosed within the structure so that touch voltages during a lightning strike will be below the maximum level given in BS EN 62305.
- 43.4 Sufficient vertical paths to earth to allow compliance with BS EN 62305
- 43.5 Sufficient metalwork enclosed within the structure so that touch voltages during a lightning strike will be below the maximum level given in BS EN 62305.
- 43.6 The materials for the component parts of the lightning protective system shall be those detailed in BS EN 62305. Care shall be taken in the selection of bonding clamps to prevent corrosion from the action of dissimilar metals.
- 43.7 The installer shall take full account of the environmental conditions at the site and the materials used in the building construction to supply a lightning protection system that will provide trouble-free life of at least 25 years. All components shall be from one manufacturer.
- 43.8 The installer shall submit technical details of the system, including fixings, materials, etc to the CA for comment on the architectural and coordination issues associated with the installation.
- 43.9 Metallic roofing and cladding shall be verified as being electrically continuous and bonded to the lightning protection system.
- 43.10 Dependent on the type of system specified elsewhere, all metallic projections and plant or equipment on or above the main surface of the roof structure shall either be bonded to the lightning protection system or provided with a secondary metallic structure mounted either adjacent or above the equipment which will then be connected to the lightning protection system. All bonding connections shall be covered in grease to prevent corrosion.
- 43.11 Conductors shall be run parallel and perpendicular to the structure.
- 43.12 Any extended metal running vertically through the structure shall be bonded to the lightning conductor at the top and bottom, unless the clearances are in accordance with BS EN 62305.
- 43.13 Where the foundations or piles, etc. are being used as the earth termination network for the lightning protection scheme, reference electrodes shall be installed for periodic monitoring of the condition of the network.
- 43.14 All underground joints shall be carried out using an exothermic process and protected against corrosion. Above ground joints shall be made using gunmetal or phosphor bronze fittings and fixtures. All above ground joints shall be accessible for inspection.
- 43.15 Joints between dissimilar metals shall be protected by proprietary inhibitor paste and taped with bitumastic bandage to prevent corrosion as agreed with the CA.
- 43.16 Any building weather proofing shall not be impaired.
- 43.17 Testing joints shall be provided in a convenient position for testing, approximately 1 meter above ground level.
- 43.18 Earth electrodes shall consist of metal rods or tapes or a combination of both as directed by the CA. Earth impedance testing shall be carried out during the construction so as to ensure earthing Impedance for each earth complies with BS EN 62305 and BS 7430.
- 43.19 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.

- 43.20 The method of connections to structural steelwork shall be agreed with the structural engineer and CA prior to commencement of the works.
- 43.21 The installer shall test the continuity of the structural steel work throughout the building and provide additional bonding where necessary.
- 43.22 On completion of the installation, the whole system shall be tested in accordance with BS EN 62305. Copies of the test results shall be forwarded to the CA for approval.
- 43.23 The installer shall allow for a retest of the system prior to the expiry of the defects liability period and as agreed with the CA.
- 43.24 **Surge Protection**
Emphasis will be placed on surge protection and its design to meet BSEN 62305 Part 4. All surge devices will be manufactured by Furse (ABB).
- 43.25 Over voltage protection devices will be designed and installed based on the concept of Lightning Protection Zones (LPZ) and in accordance with BS7671 Section 443, Section 534 and Appendix 16 and with BS EN 62305 part 4.
- 43.26 All SPDs are to comply with BS EN 61643
Consideration is to be given to the risk of both direct and indirect lightning strikes.
Consideration is to be given to both power cabling and data/ELV cabling
All boards serving equipment at risk of either a direct or indirect lightning strike are to have Type 1 surge protection. Equally all cabling (including data, ELV cabling etc.) at risk of a direct or indirect strike are to have SPDs installed at the point of entry/exit into/from the building.
All boards with final circuits supplying sensitive equipment (such as IT equipment A/V equipment etc.) are to have Type 2+3 SPD installed.
- 43.27 SPD is to have an indicator light (in a visible location) to show when the device is close to or has failed.
- 43.28 Connecting cables are to have a maximum length of 500mm, be bound and have a minimum CSA of:
16mm² for Type 1 SPDs
4mm² or equivalent size to line conductors if smaller than 4mm² for Type 2, 3 SPDs

44. Atex Directive:

- 44.1 All equipment and protective systems used in potentially explosive atmospheres shall comply with the ATEX Directive 94/9/EC and 2014/34 EU of the European Parliament and the Council.
- 44.2 Equipment meeting the requirements of the Directive shall have the UKCE symbol clearly affixed to indicate compliance
- 44.3 All equipment, protective systems and components must bear the specific marking of explosion protection as required by the ATEX Directive 94/9/EC in addition to the UKCE marking.
- 44.4 The work should be assessed and parts identified which falls under 'The Dangerous Substances and Explosive Atmospheres Regulations 2002', (DSEAR) carry out appropriate risk assessments in order to reduce or eliminate the risk of explosion.
- 44.5 Equipment and protective systems for all places in which explosive atmospheres may occur must be selected on the basis of the requirements set out in the Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996(1) unless the risk assessment finds otherwise.
- 44.6 In particular, the following categories of equipment must be used in the zones indicated, provided they are suitable for gases, vapours, mists, dusts or mists and dusts, as appropriate:

in zone 0 or zone 20, category 1 equipment,

in zone 1 or zone 21, category 1 or 2 equipment,

in zone 2 or zone 22, category 1, 2 or 3 equipment.

45. Labels and Circuit Lists

- 45.1 Labels – All building services cabling ,accessories and equipment should be referenced and labelled clearly the following list is not exhaustive but includes :
Mechanical and electrical plant, control panels , switch boards , sub distribution ,accessories, switches, sockets, isolators , fire alarm devices. MAC, & IP addresses for all computer network devices and equipment, door access devices , CCTV camera's, external light fittings etc
- 45.2 Note fuse switch devices shall designate both its capacity rating and the actual fuse size which has been fitted.
- 45.3 Labels engraved to indicate the function or usage of equipment shall be supplied and fitted as called for in the various sections of the Specification.
- 45.4 Labels shall be polished brass, brass finished matt chromium plated, traffolyte or plastic as definitely specified. Lettering shall be coloured black unless specially called for the contrary, although all labels bearing wording of a warning or “**Beware of Danger**” nature, shall be coloured red.
- 45.5 Circuit charts shall be fitted in all distribution boards or equipment from which more than one circuit emanates.
- 45.6 Generally, circuit charts shall take the form of a sheet with circuit details typed or printed thereon in a clearly legible manner, the sheet enclosed within a cellophane envelope and the envelope attached to the inside of lid, door or cover of the distribution equipment. The size of each list shall be commensurate with the size of lid, door or cover and with the information which it must contain.
- 45.7 A further copy of the distribution board schedule is to be handed to the Engineer.
- 45.8 An “electric shock treatment” notice is to be supplied and installed in each switch room, along with a schematic diagram of the installation. Each notice shall be framed and mounted at locations to be agreed with the CA.

46. Painting

- 46.1 Generally, any necessary painting of work carried out under this Contract will be the responsibility of the building Contractor, but the following are exceptions where painting shall be carried out by the electrical Contractor.
- 46.2 Of any work or items where particularly called for in other sections of this Specification.
- 46.3 Of any manufacturer's paint finish of equipment which has been marked or damaged, in which case painting required shall be in the nature of touching up and shall match the original in every respect.
- 46.4 Of all brackets, fixings, supports etc., in which case anti-rust painting and undercoating is required by means of zinc chromate or other anti-corrosive paint and an undercoating of light grey colour and all to be carried out before erection.
- 46.5 Of any externally installed metal equipment, in which case treatment after installation, shall be aluminium primer or other anti-corrosive paint, one undercoat shall be agreed on site during the course of the Contract.

47. Tests on Site

- 47.1 During and on completion, the installation shall be tested by the Contractor. The complete record of all on going tests shall be documented and copies given to the University of Liverpool electrical

engineer. The Electrical Services Installer must ensure that the instruments used for the tests are to BS EN 61010 -1 and have been recently calibrated to ensure their accuracy.

- 47.2 Tests shall be carried out in accordance with BS 7671 : 2018 Requirements for Electrical Installations Wiring Regulations. In addition, the Engineer or his representative reserves the right to call upon the Electrical Services Installer at any time to carry out further tests which he may deem necessary to satisfy himself of any special aspect of the installation.. For the purpose of these tests, the Electrical Services Installer is to supply instruments, materials, labour and attendance that may be necessary in the presence of the Engineer, without extra cost, before the expiry of the period of guarantee.
- 47.3 If any part of the installation shall fail during or as a result of any test, or if the results obtained shall not, in the opinion of the Engineer be satisfactory, the Electrical Services Installer shall forthwith, without any charge, make good any defects so occasioned, and shall submit the installation to further tests in the presence of the Engineer.
- 47.4 Tests shall include resistance of earth electrodes to the general mass of earth, earth continuity of the complete installation, and insulation resistance of all circuits. In addition, tests of protective conductors shall be carried out on all enclosed work before being closed.
- 47.5 Tests shall be carried out in accordance with the I.E.E. Wiring Regulations. In addition, the Engineer or his representative may carry out or request to be carried out further tests to satisfy himself of any special aspect of the installation, tests should be carried out to all secondary LV incoming supplies to determine the new Zs with the main primary supply not being available.
- 47.6 The Contractor shall provide a sufficient type and quantity of all measuring equipment and labour for tests which may be required to be carried out concurrently at various points on the site. Contractor shall take every precaution to ensure the safety of his own, other contractor's personnel during periods of testing.
- 47.7 On the satisfactory completion of the tests, the Electrical Services Installer shall provide a Completion Certificate and Inspection Certificate as described in BS 7671:2018, Requirements for Electrical Installations Wiring Regulations eighteenth Edition.
- 47.8 All test results shall be uploaded to Amtech Fast Test software and be printed to NIC EIC test certificates and handed to the Engineer with two copies for the test results upon which the completion is based.
- 47.9 The Engineer may, at his discretion, instruct his representative to duplicate any tests and/or completion inspection with a reasonable period after the receipt of the Contractor's Inspection Certificate, in order to assess, independently, the results declared thereon.
- 47.10 All costs incurred because of the necessity to conduct a second test and/or inspection of incorporated or deficient work (and, if required, any and all further tests and/or inspections as may prove necessary in this respect) shall be carried by the contractor. The contractor shall produce a final marked up record drawings. O&M manuals etc

48. Stand By supplies – Generators

- 48.1 Where stand by generators have been installed ensure a facility exists to ensure the normal supply is not run in parallel with the generator supply . Special attention should be given to the changeover arrangements so that operation in parallel with the incoming supply is not possible. Line and neutral isolation from the incoming supply should be provided.
- 48.2 Generating sets should be protectively earthed by connecting the frame and the neutral point of the generating set, associated exposed-conductive-parts and extraneous-conductive-parts to a main earthing terminal. The earthing terminal or bar should be connected to an independent earth electrode. The earth loop impedance at any point of the installation should be low enough to ensure operation of the fault protection, and this should be taken into account if the earth electrode forms part of the earth fault loop,

- 48.3 A separate earth electrode network should be provided solely for the generator when running and the incoming normal supply earth is not available.

49. Fire Alarm System

- 49.1 In general the electrical contractor shall design, install, connect and test an addressable fire alarm system for each of the associated buildings for a complete installation in accordance with BS 5839 Part 1: 2017
- 49.2 The design shall be provided at scheme level and detail design along with supply, installation and commissioning shall be carried out by the contractor. This will allow the design to be optimized to the contractors preferred fire alarm manufacturer.
- 49.3 The Design engineer shall be responsible for and develop a 'cause and effect' schedule this shall demonstrate the interdependences and system operation in conjunction with the fire compartment and fire strategy for the building.

The schedule may include:

- Single and/or double knock items confirmed.
- Zonal operation of sounders.
- HVAC operations and Building Management System.
- Smoke dampers.
- Smoke extract.
- Automatic Opening Vent
- Gas shut off valves
- Fire curtain.
- Automated fire extinguishers.
- Lifts.
- Security.
- Access Control.
- Audio Visual.

- 49.4 Fire detection and alarm systems are divided into three categories, as described in BS 5839 – Part 1 These categories are: -

Category L: Automatically activated systems that are designed to protect life.

- L1 - Systems installed throughout the protected building.
- L2 - Systems installed only in defined parts of the protected building.
- L3 - Systems installed only for the protection of escape routes.
- L4 - Systems installed in circulation areas used for as escape routes.
- L5 - Systems installed to satisfy specific fire safety objectives.

Category M: Manually operated systems (no sub-categories)

Category P: Automatically activated systems designed to protect property

P1- Systems installed throughout the protected building.

P2 - Systems installed only in defined parts of the protected building.

- 49.5 A similar categorisation system for dwellings is described in BS 5839 – Part 6.

The category designation for the fire detection and alarm system to be installed will be stated elsewhere within this specification.

However, in principle the following is the Universities approach:

- 49.6 Non-Residential Property

For the level of protection provided will be L4-L5 in accordance with BS 5839 Part 1: 2017.

L4 to BS5839 is the use of Automatic Fire Detection (AFD) to protect escape routes. L5 to BS 5839 Part 1: 2017 provides for additional detection to cover higher risk areas such as electrical switch-rooms, mechanical plant rooms, server rooms, laboratories etc.

- 49.7 Automatic Fire Detection will be installed in voids in accordance with BS 5839, unless a specific project risk assessment undertaken by the University Safety Advisor deems that it is not required.
- 49.8 Residential Property.
L1 must be provided. Particular care will be taken on the choice of the automatic devices and the sensitivity adjustment of the system.
- 49.9 The fire alarm system shall consist of addressable break glass units, smoke detectors, heat detectors sounders and beacons.
- 49.10 The electrical contractor shall include for all necessary equipment, boxes, devices and cables configured in a series of loops using enhanced FP200 Cable (RED).
- 49.11 The electrical contractor is to allow for all primary and secondary containment for the fire alarm installation and all associated power supplies for a complete operational system.
- 49.12 Each system signals back to Security Control room in Bedford House, Oxford Street via a Emizon TCD dual-path device either mounted in the panel or adjacent to the panel.
- 49.13 A 5 pair 1.5mm² BS5308 Part 2 Type 2 O/SCR XLPE/SWA/LSZH cable link will be installed from the fire alarm panel to the remote I/O Panel device to alert the status of the fire alarm panel to the university site fire alarm system.
- 49.14 All devices shall be fully labelled. This generally follows the format Panel/Loop/Zone/Device.
Fire alarm mimic drawings of the building layout should be produced and installed adjacent to the main fire alarm panel showing the locations of the system installed complete with fire log book.
- 49.15 A 230v un switched dedicated supply shall be provided by the electrical contractor to the fire alarm panel from the 'essential' distribution board.
- 49.16 The electrical contractor shall allow for full test, and liaison with the clients site fire alarm engineer who will be responsible along with the contractor for the final commissioning and certification of each of the building fire alarm systems and demonstrate to the client its operation to meet BS5839.
- 49.17 Spare break glass and test keys shall be included as part of the handover documentation.
- 49.18 Manual call points shall comply with BS EN 54-11 for "Type A" operation i.e. Direct Operation.
Manual call points shall be coloured "Red" with a frangible element covering the push button. Manual call points shall be clearly labelled with the text "FIRE".
- 49.19 Manual call points shall be mounted no higher than 1200mm AFFL and in compliance with the Disability Discrimination Act. The contractor shall obtain final written approval from the Building Control Officer (BCO) prior to installation.
- 49.20 Manual call points shall be flush or surface mounted to suit adjacent accessories.
- 49.21 Where break-glass-units are provided in areas accessible to students they shall be provided with clear plastic hinged covers. When a cover is lifted it shall emit a local alarm to indicate to nearby staff that a break-glass-unit is about to be used. This is intended to deter malicious operation.
- 49.22 Heat detectors shall comply with BS EN 54-5.
- 49.23 Heat detectors may be point type or line type detectors
Point type smoke detectors shall comply with BS EN 54-7.
- 49.24 Smoke detectors shall be either ionization chamber type or optical beam type Optical beam types, being the most resilient to false alarm, shall be the preferred type unless a particular risk dictates the need for ionization detectors.
- 49.25 Beam type smoke detectors shall comply with BS EN 54-12.

- 49.26 Smoke detectors shall be infrared type using either a separate transmitter and receiver or a combined transmitter/receiver unit with optical reflector. Regardless of which type is used, the detectors shall be capable of operating distances up to 100 meters and shall incorporate the facility to accept building movement which misaligns the receiver/transmitter or receiver/transmitter and reflector by up to 100mm in any direction.
- 49.27 Multi-sensor detectors shall comply with BS EN 54-5, 54-7 and 54-17. The detector shall comprise a combination of the following sensors: -
 Optical Smoke.
 Heat (fixed temperature). Carbon Monoxide
- 49.28 Each sensor element shall be capable of being programmed with different enabled / disabled time periods enabling a reduction in false alarms.
- 49.29 Flame detectors shall comply with BS EN 54-10.
- 49.30 Detectors shall be either individual infra-red (IR) or ultraviolet (UV) types and if the risk dictates the need, combined UV/IR detectors and differentiated on the drawings.
- 49.31 Aspirating systems shall comply with BS EN 54-20.
- 49.32 Where specified, aspirating systems shall be used either in place of/or in addition to conventional or addressable fire alarm systems.
- 49.33 Video smoke detection is an emerging technology which utilises the CCTV system within a building to detect the presence of smoke. Where specified, the system(s) shall be used as part of a fire engineered (performance based) design and shall be in accordance with the fire engineer's strategy. The system shall be designed, supplied, installed and commissioned by the contractor.
- 49.34 Fire alarm sounders shall comply with BS EN 54-3.
- 49.35 The minimum sound pressure levels (dBA) shall be in accordance with BS 5839-1 and shall not fall below the figures given below

Location	Min dB(A)	Max dB(A)
General Areas	65	120
Stairways	60	120
Areas of limited extent	62	120
Bedhead	75	120

- 49.36 Visual alarms will be provided in accordance with BS5839-1 and BS EN 54-23 and shall be either xenon beacons or twin large area LED type. The visual alarms shall be supplemented with a low sound level buzzer or external sounder, if specified in the particular requirements of this specification. Visual alarms shall be installed within the following areas as required by Part M of the Approved Building Regulations: -
- Toilets (Staff / Public).
 - Changing Rooms.
 - Shower Rooms.
 - Plantrooms / Boiler Rooms.
- 49.37 Any additional area identified by risk assessment which may not be suitably covered by sounders alone. Where the background sound levels are particularly high and visual alarms cannot be relied upon, consideration shall be given to removing the source of noise on fire alarm. (eg remove power to audio equipment in a theatre/club on fire alarm activation)
- 49.38 Portable alarms shall be provided in accordance with BS5839-1. The portable alarm device shall be a radio pager complete with integrated vibrating function, tactile messaging and LCD text messaging.
- 49.39 Control and indicating equipment shall comply with BS 5839-1 and BS EN 54-2.
- 49.40 Fault Monitoring

The control and indicating equipment shall monitor the following faults as a minimum: -

- Short circuit in any circuit serving manual call points or detectors.
- Open circuit in any circuit serving manual call points or detectors.
- Removal of any manual call point or detector that is designed to be detachable.
- Short circuit of any circuits serving fire alarm devices.
- Open circuit of any circuits serving fire alarm devices.
- Short circuit / open circuit of any wiring between power supplies and fire alarm devices.
- Any earth fault condition.
- Any operation of circuit protective device serving any fire alarm device.

49.41 A fault indication should be given, within the times stated below.

Fault	Duration
Failure of the main power supply	Within 30 minutes
Failure of the standby power supply	Within 15 minutes
Failure of battery charger	Within 30 minutes
Failure of batteries	Within 30 minutes

49.42 A zone diagram shall be fitted adjacent to each control panel in accordance with BS 5839 Part 1. The diagram should be framed and constructed to a standard suitable for its environment.

49.43 Power supply units shall comply with BS EN 54-4.
The power supplies shall normally be 24 volts DC derived from the mains via bridge rectifier / transformer equipment, but in the event of a mains failure the system shall operate from a battery system for a minimum of 24 hours, after which there should be sufficient capacity to operate the sounders for 30 minutes.

49.44 Remote signalling to alarm monitoring centres shall be provided in accordance with BS 5979 if stated as a particular requirement elsewhere in this specification. Each system shall signal back to Security Control room in Bedford House, Oxford Street via a Emizon TCD dual-path device.

49.45 The fire alarm system shall be interfaced to the following equipment to ensure the operation as described: -

- Lift Control Panel – The lift car parks at Ground floor level (or as indicated in the fire strategy) and locks “out of service” during fire evacuation.
- Mechanical Control Panel – Ventilation plant shuts down during fire evacuation (or enters a pre determined mode as dictated by the fire strategy).
- Access Control Doors – Access control doors on escape routes at automatically unlocked (unless pre determined requirements indicate an alternative course of action).
- Door Détentes – Fire doors automatically close during fire evacuation.
- PA equipment including voice alarm control panels

49.46 The fire alarm system will be wired using enhanced grade fire resistant soft skin cable in accordance with BS 5839-1. Where there are particular requirements to use a specific cable type, this is identified elsewhere in this specification.

49.47 Mixture of cable types will not be permitted. Cables shall only be supplied from one manufacturer for the entire system to avoid known impedance problems caused by mixing different manufacturers cables. Where used, the enhanced fire resistant cable will meet the PH120 classification when tested in accordance with EN 50200.

49.48 The minimum cross sectional area of the fire alarm cables shall not be less than 1.5mm². The fire alarm cable shall have a LSZH outer sheath, preferably coloured red. Other colours may only be used if specified in the particular requirements of this specification.

49.49 Plastic cable ties shall not be used unless the cable is laid on the upper side of either cable basket or cable tray such that the cables weight is fully supported by the basket or tray and the cable ties are only used to secure the cable in place.

- 49.50 The fire alarm system shall be installed and tested in accordance with the requirements stated in BS5839-1.
- 49.51 The fire alarm system shall be commissioned in accordance with the requirements stated in BS5839-1. The commissioning engineer shall measure and record sound level readings.
- 49.52 Fire alarm 'as fitted drawing plans shall be produced showing:
- Location of all fire alarm devices, sounders detectors, interfaces etc
 - Associated address for each device
 - Route of loop taken by cable between devices for all floors
 - Allocated zones
 - Main and mimic panels
 - Disabled Refuge alarm points
- 49.53 In accordance with BS5839-1 the fire alarm installer shall provide the following documentation on completion of system commissioning: -
- Certificates for Design, Installation and Commissioning.
 - Operation and Maintenance Manual.
 - "As fitted" drawings. Including devices, addresses, zones and cable routes
 - Log Book.
 - Record of agreed variations from the original design specification.
 - BS7671 – Electrical Installation test certificates.
- 49.54 The fire alarm installer shall provide at handover a fire alarm system log book in accordance with Annex F of BS5839-1.

50. Disabled Refuge Alarm System

- 50.1 The Electrical Contractor (or Specialist Sub-contractor) shall design, supply, install and commission Disabled Refuge Alarm and Disabled WC Distress Alarm systems, in accordance with the Design Parameters. This system is to be part of the Panic Alarm system.
- 50.2 Disabled Refuge Alarm
- A red disabled refuge alarm call point shall be installed at each ground floor and landing area of the fire escape staircases. The units shall be mounted in the wheelchair space on the escape stairway. The units shall comprise a clearly labelled 'HELP' or 'CALL' push button, internal hands free speaker and microphone, reset switch and re-assurance indicator.
- The Disabled Refuge Alarm Call Point shall be connected to a Master Control Unit located within the main entrance foyer.
- The Master Control Unit shall clearly indicate the origin of activation by means of LED and/or LCD display and audible notification.
- Push button controls shall be located on the Master Control Unit to accept calls from the Disabled Refuge Alarm Call Points and a 'Push to Speak' button to return call to the call point.
- 50.3 Disabled distress call system
- The Electrical Contractor shall supply and install a disabled distress call system within each of the disabled toilets.
- The system shall generally comprise the following equipment:-
- a. High visibility red pull cord, complete with reassurance indicator and easy grab pull handles.
 - b. Flush audible and visual over-door indicator unit, fitted flush within the ceiling immediately outside of the room.
 - c. Flush reset unit, located within each disabled toilet.
 - d. Power supply unit.
 - e. The system shall provide remote indication to a remote flush audible and visual indicator panel located in reception. A framed mimic diagram, shall be located adjacent to the remote control panel.

The layout of the system shall be in accordance with the Building Regulations part M.

50.4 Panic Alarm system

The Electrical Contractor shall design, supply, install and commission a addressable panic alarm system, in accordance with the Design Parameters, Room Data Sheets.

General, the system shall comprise the following equipment:-

1. Flush control panel unit (located in the office behind reception) capable of displaying alphanumeric characters on a back-lit screen and complete with integral and remote auxiliary sounder, located in reception. The system shall be programmed to display locations of the point of alarm call.
2. A repeater display unit shall be provided behind the reception desk.
3. Dado mounted call points comprising panic call and reset buttons, complete with jack for accepting plug-in trailing lead call button. The 1.8m plug-in call button trailing leads shall also be provided for each call point.
4. Over-door audible and visual reassurance indicator units, fitted flush within the ceiling or wall immediately outside of the room.
5. Network splitter devices. The devices shall be located in the ceiling void or located in store rooms.
6. The system shall be set up so that upon activation of the reception desk panic button, it activates all other panic alarm indicators (consulting rooms etc).

The Electrical Contractor shall program the control panel to display the names and location of the devices, corresponding to the designated room names/numbers of the occupier.

The panic alarm shall be a Quantec system as manufactured by Channel Safety Systems or equal and approved.

A framed mimic diagram shall be located adjacent to the control panel.

The system and accessories shall be flush of the stainless steel finish.

The contractor shall allow for all power supplies as necessary.

50.5 INDUCTION LOOP

The Electrical Contractor (or Specialist Sub-contractor) shall design, supply and install induction loop system(s) to the reception desks

The system shall meet the requirements of BS 7594:1993 - Code of Practice for Audio Frequency Induction Loop Systems. The loops and equipment shall be arranged to suit the room and furniture layout and the building fabric.

Generally, the system(s) shall comprise the following equipment:-

- Power supply unit
- Induction loop amplifier unit
- Transmission Loop/pad
- Desk mounted microphone(s)

Self adhesive signs displaying the Induction Loop ear/T symbol shall be installed at suitable locations, as required.

51. Security-Access control-CCTV- Intruder.

51.1 The Computing Services Department (CSD) operate and maintain the IP CCTV and Access Control connected systems on the University network.
CSD are the University of Liverpool owner of a set of minimum standards for CCTV and Access Control. These documents will be obtained from the Project Manager.

51.2 In general Systems shall be designed and developed in close consultation with the Project Manager, Campus Security and Building Users. Procured, installed and commissioned by a UKAS accredited security organisation approved contractor in accordance with this specification and any associated drawings.

- 51.3 Systems shall be designed and installed in accordance with the Data Protection Act
- 51.4 CV's for all personnel working on the installation of security systems shall be presented to the CA for approval prior to the installation commencing. The CA retains the right to reject any of the proposed personnel without identifying the reason.
- 51.5 Appropriate warning signs complying with the requirements of BS EN 50132 shall be installed. Systems shall be wired in accordance with BS 7671 and the other sections of this specification.
- 51.6 It shall be the Electronic Security Contractors (ESC) responsibility to further develop this design criteria into a fully detailed and co-ordinate design complying with the requirements of this set of documents and will include, but not be limited to, the following:
- Location and mounting details of all equipment.
 - Locations of all the equipment has been agreed in principle with the CA.
 - The ESC shall provide to the CA for approval, prior to the commencement of the work, complete details showing clearly the position of each and every piece of equipment and device and the proposed mounting and fixing.
 - Detailed electrical power requirements.
 - The ESC shall provide to the CA prior to the commencement of the work and in a timely manner to allow the main contractor to accommodate the requirements, a plan showing all power requirements and circuits needed for control equipment and field devices.
 - Detailed IP Ports requirements.
 - The ESC shall provide to the CA prior to the commencement of the work and in a timely manner to allow the main contractor to accommodate the requirements, a plan showing all IP Port requirements needed for control equipment and field devices
 - Detailed lighting requirements.
 - The ESC shall provide to the CA prior to the commencement of the work and in a timely manner to allow the main contractor to accommodate the requirements, a plan showing all additional lighting requirements.
 - Cable runs and ducting, conduits and tray requirements.
 - The ESC shall provide to the CA for approval, prior to the commencement of the work and in a timely manner to allow the main contractor to accommodate the requirements, a complete plan showing clearly any intended cable containment and cable routes.
 - Detailed control and equipment room's layout.
 - The ESC shall provide to the CA for approval, prior to the commencement of the work and in a timely manner to allow the main contractor to accommodate the requirements, a complete plan showing clearly the layout of the equipment.
 - Camera fields of view for each camera location.
 - The ESC shall provide to the CA for approval, prior to the commencement of the work, a site drawing showing all camera finally agreed locations and camera footprints of all camera/lens/presets and to show the calculations of lens size.
 - Fully detailed wiring schedules.
 - The ESC shall provide to the CA for approval, prior to the commencement of the work, a detailed wiring schedule showing all connections at control equipment, field nodes/controllers, marshalling cabinets, etc.
 - All schedules will be referenced to the local cabinet and the overall schematic so that the scope of the entire project can be easily determined by viewing the schematic and schedules.
 - Full software configuration details
 - The ESC shall provide to the CA for approval, prior to the commencement of the work, a full schedule of the following to assist with the design of the Electronic Security Systems:
 - All major control equipment
 - All equipment controlled by the SMS
 - Schedule of Inputs/Outputs per building.
 - Schedule of controlled doors and gates
 - Special functional requirements
 - Graphical Maps of the site
 - Design Intent Methodology (DIM).

- The ESC shall provide to the CA for approval, prior to the commencement of the work, a Design Intent Methodology document that will clearly explain, in layman terminology, exactly how the security system will function and how, on a day-to-day basis the operators will use the system.
- 51.7 The University Computing Services Department (CSD) maintains the specification for the Access Control System and is available upon request from the Project Manager.
- 51.8 The Electrical Designer Engineer as part of the project scope shall ensure that all equipment on third party systems e.g. CCTV and access control are compatible for connection to the UoL networks (FM and CSD). The designers attention is drawn to the sizing of cabinets where servers are employed for CCTV. Comments shall be sought from CSD i.e. Access Control and CCTV.
- 51.9 Where the installation of intruder alarm systems are requested by insurers, they shall comply with all of the relevant insurers requirements.
- 51.10 The intruder alarm system shall be installed throughout the facility to provide alarm monitoring in compliance with verified signalling for remote monitoring and University security response where applicable.
- 51.11 Where external communication of alarm or fault is provided, confirmation alarms are required prior to remotely signalling to the alarm receiving centre (ARC). This should comprise of the activation of at least two different detection types devices in the same zone or area or two devices in different zones or areas. The system shall comply with BS 5979.
- 51.12 The system shall be zoned by the contractor to allow partial setting of the system. Zoning arrangements shall be agreed with the CA prior to installation commencing.
- 51.13 Passive infra red detectors (PIR)
- PIRs shall comply with BS EN 50131-2-2 and be either the latching or non latching type as indicated elsewhere in this specification.
- Each PIR shall only be used in the application for which it was intended.
- All PIRs used shall have generic connections (i.e. power, tamper and alarm contacts) for use on any standard control panel unless indicated otherwise elsewhere in this specification.
- Each PIR shall be complete with an internal tamper switch.
- 51.14 The contractor shall identify the most suitable location within rooms for mounting of PIRs to avoid false alarms.
- 51.15 Combined microwave/PIR detectors
- Combined microwave/PIR detectors shall comply with BS EN 50131-2-4 and should be used in situations where the likelihood of false alarms is greater than normal.
- 51.16 Door and window contacts
- Door and window contacts shall be magnetically operated with a minimum tolerance of 7mm and shall be normally closed operation.
- 51.17 Control panels
- Control panels shall comply with BS EN 50131-3 and situated in a convenient position out of public view. Control panels shall be open protocol and accept any standard detector connection.
- 51.18 Power supplies

Power supplies shall comply with BS EN 50131-6 Installation and wiring

- 51.19 The installation shall be carried out in accordance with BE EN 50131-1 and BS 7671. Cables shall be installed in locations where they are not readily accessible to the public. Cables shall not be installed in locations where they are likely to become submerged in water or in locations of extreme temperature, humidity or direct sunlight.
- 51.20 All cables shall be complete from device to device with no joints. Any cable damaged during installation shall be replaced throughout its entire length.
- 51.21 Video Surveillance systems (VSS) shall comply with BS EN 50132 and any particular requirements identified elsewhere in this is specification.
- 51.22 Where a VSS is used as part of a fire alarm system for video detection they shall comply with the relevant standard.
- 51.23 Where the installation of CCTV systems is requested by insurers, they shall comply with all of the relevant insurers requirements.
- 51.24 The contractor is to design, supply, install and put to work the CCTV system as shown on the drawings and to particulars identified elsewhere in this specification.
- 51.25 Access control systems shall comply with BS EN 50133 and any particular requirements identified elsewhere in this is specification.
- 51.26 The contractor is to design, supply, install and put to work, the access control system as shown on the drawings and to the particulars identified elsewhere in this specification.
- 51.27 Protocols

All security systems shall be open protocol unless the client has a specific requirement for integration with and existing bespoke system.

52. Data-Telephone

- 52.1 The Universities Computing Services Department (CSD) operate and maintain these systems. CSD are the University of Liverpool owner of a set of minimum standards for the design and installation for telephones and networks. These documents will be obtained from the Project Manager.

53. PV Installation

- 53.1 Where called for the Electrical Contractor (or Specialist Subcontractor) shall design, supply, install, test and commission a complete PV system. The PV system shall be installed by an accredited Micro-Generation Certification scheme member,
- 53.2 Generally, this shall comprise cabled connections to/from the Main LV Distribution Panel to the items of equipment, and shall be provided complete with suitable switches and isolation devices.
- 53.3 The PV arrays shall be sized and selected by the Electrical Contractors in order to achieve, as a minimum, the below requirements and anticipated yields. The PV arrays shall be located to be achieve optimum output, It is the responsibility of the contractor to determine the structural loads of the building /roof are adequate to suit the PV array and final locations to be agreed with the university of Liverpool engineer before works commence
- 53.4 The Electrical Contractor is entirely responsible for designing and selecting the appropriate provision of PV. The below parameters are provided for general guidance only, depending on the option chosen.

System Type: Grid Connected, for instances when there is spare energy not being utilized within the energy demand for the building. The primary use will be to utilise all of the energy generated from the PV system within the buildings.

Solar PV Type: Roof mounted modules.

System Size: To be determined by the Electrical Contractor but, for guidance, will require approximately 8.0kWp.

System Output: To be determined by the Electrical Contractor, but for guidance, the system will output approximately 10000kWh/year in accordance with the allowance made in the Indicative Part L2A 2010 Assessment.

Active Area: To be determined by the Electrical Contractor, but will be approximately 60-80m².

Cell Type: Monocrystalline

Integration Type: Mounted on A-frame systems or brackets/fixing to suit the roof structure, orientated south at an optimum angle for maximum yield.

Loadings: The Contractor shall ensure that all wind loading simulations be carried out on the building with the PV system included. The contractor shall refer to but not limited to the following documents for guidance, BRE Digest 489 'wind loads on roof-based photovoltaic systems' and BRE Digest 495 'Mechanical installation of roof-mounted photovoltaic systems'.

The system shall utilise high performance Monocrystalline modules. The modules will be orientated to the south and mounted at an optimal angle so as to maximise the output generated. The module angle will also take into account the available roof space. The modules will be connected in series and connected back to the inverters. The systems will then each be taken to the MDP.

Inverters shall meet the G83/1 and G59 recommendations for the connection of small scale embedded generators in parallel with the public low voltage distribution and public electricity suppliers' distribution systems. The inverters shall have a minimum 5 year warranty. All PV technologies specified are to be certified IEC 61215, Class II double-insulated and CE marked. The inverter(s) shall be located in the plant room.

The detailed design shall allow for the DC cable runs to be kept as short as possible to minimise volt drop in the DC wiring under peak power current conditions (IMPP). Double-insulated, UV stable Multicontact cable shall be used both on the modules and for the main DC feed to the inverters. All DC connections are to be made using double-insulated DC cabling and touch-proof connectors. All DC components are to be equipped with this plug system.

The PV technologies are to be connected together in strings in series. The strings shall be connected to the inverters via a double pole DC isolator. The double pole isolators shall allow the DC supply to the inverter from the strings to be safely disconnected, including under full load conditions. The DC isolators will be located adjacent to the inverters. The connections to the inverter AC outputs shall be made using a suitable isolator. Each inverter AC output is then fed, via an adjacent double pole lockable rotary isolator, to the DB. As well as individual isolators for each inverter, a 4-pole lockable isolator shall be provided in the DB's as the main point of switching for the whole PV array. Final connection to the grid is to be made via a dedicated TPN feeder within the DB's.

The Electrical contractor is responsible for liaising with the DNO/ University Engineer for the connection requirements associated with the G59 parallel connection agreement.

Each array shall be provided with total generation metering in addition to the import/export meter provided by the REC.

The system shall be provided with a total generation meter.

The Electrical Contractor shall complete all necessary applications and apply for the FIT scheme.

The inverter shall be connected to the BMS for remote monitoring of the system performance and output, by means of an RS485 connection.

Provide training to University of Liverpool facilities staff on the configuration and setup of the PV systems,
 Provide all testing and commissioning to comply with standards and this specification,
 Documentation and as-built documentation.

54. BMS-Building Management System

54.1 Reference for the requirements for the BMS shall be made to University Guide developed by the Senior Mechanical Engineer.

55. Other FRCS Electrical Information.

	<i>Design and Installation Guidance:</i>		
FM00088	Electrical Safety Policy	2.1	1st March 2021
FM00098	Project Electrical Briefing Document	V5.4	7 th January 2021
FM00153	Standard Specification for Electrical Installation Work	V3.2	7 th January 2021
FM00240	High Voltage Underground Cables	V2.0	31 ST January 2019
FM00241	High Voltage Switching & Earthing	V2.0	31 ST January 2019
	<i>Standard Operation Procedures:</i>		
FM00221	Low Voltage Safety Rules	V1.0	11 TH December 2017
FM00220	Management of the Access to Low Voltage Switch rooms	V2.0	22 ND January 2017
FM00223	High Voltage Safety Rules	V2.0	29 th November 2018
CSD doc			
	CCTV Camera design guide	V1.2	29 TH October 2019
	Network Design Guide	V7.3	23rd January 2019

56. Appendix:-As Built Documentation

56.1 Upon completion and final hand over of the project, the Electrical Contractor is required to submit a comprehensive Operation & Maintenance Manual.

56.2 The contents of the manual shall be set out in a logical sequence to standardise across the university campus. Each section shall be fully indexed for quick reference and the complete document shall be contained within an A4 sized ring binder and a CD 'folder layout'.

56.3 Initially, a draft 'paper copy' of the manual, including all drawings, shall be presented to the nominated University of Liverpool Electrical Engineer, to coincide with the date of handover. The electrical contractor shall arrange to pick up the commented Manual.

56.4 The final (amended version) of the manual, together with the electronic version on CD Rom shall be provided to the University of Liverpool Electrical Engineer within 30 days from the date of the draft manual being returned to the contractor.

56.5 The Manual shall include the following sections:

Index of Contents - A full index to indicate all the sections of the manual to include page numbers etc.

Introduction - To include a general overview, list of abbreviations, schedule of record drawings and schedule of certificates.

- General Description- A full description of all electrical services systems and associated equipment/ plant compiled in to logical sub- sections. This shall include comprehensive instructions for the switching on, operation, switching off and isolation of the circuits/systems and for dealing with the emergency conditions and instructions for a precautionary measures necessary.
- Technical Data - Technical details and performance information for each item of plant/ equipment installed within project. The information shall include manufacturer's literature and a schedule of all applicable part numbers.
- Measured Values - The Electrical Contractor shall provide the following values in written format at the completion of the project:-
- All Installation and commissioning certification.
 Details of the internal and external Emergency Lighting illuminance level checks, including calculations
 An annotated AutoCAD drawing shall be provided identifying Lux levels, positions of readings and time/ date of the reading.
 Details of the General internal Lighting illuminance Lighting level checks, including calculations
 An annotated AutoCAD drawing shall be provided identifying Lux levels, positions off readings and time/ date of the reading.
 As fitted floor plan drawing of All electrical services (one set per service) with circuit designations LV schematics with load calculations
- Controls- Full description of control systems complied in conjunction with the control specialist.
- Maintenance General- Section and sub-sections covering schedules, inspection, (Manufacturers Info) fault finding, adjustment, replacement, overhaul frequencies and cleanliness.
 The section shall include maintenance sheets for all systems.
 This section shall include FULL 'Planned Preventative Maintenance' (PPM's) documentation for incorporation into the University of Liverpool site wide maintenance procedures.
 Spares List of spares based on manufacturer's recommendations and subject to the special conditions of the Contract.
- Testing/Commissioning Certification - The Electrical Contractor shall include for providing the approved NICEIC/ECA testing/inspection certification for all the installed systems in both paper form (for inclusion within the operation /maintenance manual) together with an electronic copy (PDF files) for University of Liverpool records.
- Red Lined As Fitted Drawings - Once the Electrical Engineer has approved the red lined drawings, they shall be passed back to the contractor for completion and official hand back to University of Liverpool for inclusion in the operation and maintenance manuals.
- Cable Calculations - Any circuits that are changed or added from that detailed within the design documentation must be checked first by the Consultant/ contractor to ensure compliance with BS7671 and passed to the Engineer. Failure to comply with this requirement may result in the electrical contractor removing that which has been installed and re-installing correctly sized cabling without any cost to University of Liverpool.