

## **2.01 GENERAL.DOC**

### **Introduction**

This part of the specification clearly defines the class and quality of materials to be installed and standards of workmanship to be undertaken and shall be strictly observed in the absence of specific details defined in this or other parts of this Specification or shown on the drawings.

### **General**

All materials of construction shall conform with the appropriate British Standards Specification, and shall be consistent in pattern throughout, and shall be the product of a preferred standard manufacturer. In any case where a specified item is not available then the matter shall be referred to the Contract Administrator

### **General Electrical Installation Methods**

The Electrical Contractor shall ensure that the works are carried out expeditiously, efficiently, and unobtrusively, and shall observe good standards of workmanship throughout the works. Installation methods shall be not inferior to the Standards laid down by the National Inspection Council for Electrical Installation Contracting (NICEIC).

The detailed layout of the electrical installations detailed in the Contract Documents, shall be the responsibility of the Electrical Contractor. The approximate position of principal luminaires, accessories and other materials are indicated, subject to limitations of scale, on the contract drawings. The Electrical Contractor shall, at any early stage of the contract, and before installation is commenced, conform all door swings, etc. and agree in consultation with the Main Contractor, Mechanical Services Contractor and any other services contractor or Artisan Trade, that the actual position of all conduits, accessories and other materials are appropriate. Minor modification to point and equipment positions agreed before the commencement of that section of the works, shall be without charge to the contract.

All installations, of whatever nature, shall be run true to line or level, or parallel to existing installations or structural features so as to produce most unobtrusive arrangements, and outlet boxes and fittings shall be fitted central and true, and in conformity with structural finishes. Where necessary deep boxes and extension rings shall be provided, and all box lids on concealed work shall be finished flush.

Approved arrangements shall be made at all points liable to building or appliance movement, e.g. by termination loop in M.I.C.S. cable or pliable conduits.

### **Standard Categories for Electrical Accessories and Wiring Containment Systems**

The University of Reading recognises five categories of duty for electrical accessories and wiring containment.

#### **Category 1 –Domestic**

White Plastic accessories

PVC insulated PVC sheathed copper cables

Laid under floors or surface clipped in and ceiling spaces or accessible voids

Enclosed in white PVC mini trunking over walls and ceilings.

Lighting to be wired using the loop in principal. 3 Plate systems not allowed.

#### **Category 1A - Light Duty**

White Plastic accessories

P.V.C insulated copper cables in High Impact black, white or grey PVC trunking and conduit.

#### **Category II Standard Duty (General Applications)**

Surface metalclad accessories in Alum or flush metalclad accessories in matt chrome

M.I.C.C surface clipped in and ceiling spaces or accessible voids and enclosed in white PVC mini trunking over walls and ceilings. Earth tailed pots to be used for earth continuity

SWA surface clipped

Grey Steel Trunking and Black Enamel Screwed Conduit.

#### **Category III Heavy Duty (Plant Areas, Workshops, etc).**

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Surface metalclad accessories in Alum or flush metalclad accessories in matt chrome  
M.I.C.C surface clipped or multiple cable runs laid on galvanised heavy-duty return edged cable tray or ladder. Earth tailed pots to be used for earth continuity  
SWA surface clipped or multiple cable runs laid on heavy-duty return edged cable tray or ladder.  
Galvanised Steel Trunking and Screwed Conduit.

### **Category IV Watertight and External applications.**

Surface metalclad or plastic accessories with threaded entries to IP65  
M.I.C.C surface clipped or multiple cable runs laid on galvanised heavy-duty return edged cable tray or ladder. Threaded glands to be used and earth tail pots for earth continuity  
SWA surface clipped or multiple cable runs laid on heavy-duty return edged cable tray or ladder  
Galvanised Screwed Conduit

### **Category V Hazardous Areas (Flameproof).**

Surface metalclad accessories with flanged lids and threaded entries to BASEEFA Zone 2.  
M.I.C.C surface clipped or multiple cable runs laid on galvanised heavy-duty return edged cable tray or ladder. Glands to be extended threads as required by BASEEFA Zone 2

#### **NOTE:**

Where no system of wiring is particularly specified Option II Standard Duty shall be used

#### **Accessories General Note**

All socket outlets, switches and terminating accessories shall normally be contained within dust-proof zinc electroplate deep steel boxes, with earthing terminals, or shall be mounted on zinc electroplate mounting frames when used in conjunction with trunking. The use of plaster depth boxes will be permitted only in specially approved positions. B.S.4568, Parts 1 and 2 standard circular boxes with earthing terminals shall be used for the mounting of all ceiling roses and ceiling switches.

Cooker Control Units to B.S.4177 shall be fitted in deep steel boxes, with waist high flush connector boxes and hoods for the housing of cooker wiring.

Wiring Accessories shall conform with the requirement of Table 2.1.1 below, and shall be the product listed in the Schedule of Preferred Equipment and Manufacturers.

**Table 2.1.1**  
Standard of Wiring Accessories for University Installations

Type of Accessory	University Classification			
	Category I	Category II	Category III	Category IV
Switches 5A or 15/20A A.C.Duty One, Two Way or Intermediate <u>Note: 5 A Rating is for Category I only</u>	Rocker Operated White Finish	Rocker Operated Grid Switch M.C.O. Finish	Fixed Grid Metal-Clad With Protected Dolly Enamelled or Galvd. Finish	Watertight Fixed Grid Assembly With Rotary Action Galvd. Finish
Switch Socket Outlets 2A to BS 546 Gauge	Not Approved	Dolly Operated to BS 546 M.C.O. Finish	Not Approved	Not Approved
Switch Socket Outlets 13 A BS 1365 1,2,3 or 4 Gang	Dolly Operated White Finnish 1 and 2 Gang	Dolly Operated MCO Finish 1,2,3 or 4 Gang	Single SSO Metal-clad Assembly Protected Dolly Enamelled or Galvd.	Single SSO Watertight Galvd. Metal-clad Rotary Switch Plug with Retaining Ring
Fused Spurs (Switched or Un-switched or With Cord Outlet)	Dolly Operated with neon Indicator	Dolly Operated with neon Indicator	Not Approved	Not Approved
Ceiling Roses General Purpose to 16th Edition with Break Rings as Required	Fully Shrouded White Finnish Moulded Base For 51mm Fixings	Fully Shrouded White Finnish Moulded Base For 51mm Fixings with Mounting Block as Required	Fully Shrouded With Through Earth for Hard Wiring Insulated Cover With Through Rubber Gasket	Not Approved
Ceiling Roses Plug In Type to 16th Edition with Break Rings as Required	Not Approved	Mounted on BS4568 Circular Box	Not Approved	Not Approved
Cord Ceiling Switches 5 Amp x 5 Amp	Loop in Type Mounting Block with Riveted Earth Terminal (5 Amp without Pilot Lamp	As Category 1 But 15 Amp Rated	Not Approved	Not Approved
Lamp-holders	White Finish all Insulated Cord Grip Type with H.O. Skirt Shade Ring	Heat Resistant all Insulated Cord Grip Type with H.O. Skirt Shade Ring	Heat Resistant Circular Grommet Grip H.O. Ring	Not Approved

Accessories not listed above, but called for in any specific contract shall be consistent in pattern and category to the above

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### **Installation Methods - Clearances**

The contractor, in setting out shall preserve wherever practical a minimum clearance of 150mm between all cable or conduit installations and other metallic plumbing and pipe fitting installations, and shall ensure that electrical installations are installed above water, or water bearing pipework.

Separation of electrical conduit and trunking containing P.V.C. cables to B.S. 6004 above heating apparatus or hot water pipes shall be not less than 175mm. The standard clearance of 150mm may be adhered to in cases in which M.I. or heat resistant cables are used.

The contractor shall observe the minimum horizontal separation of 2000mm between the following:-

Between any points, i.e. lighting switches, luminaires or outlets on differing phases.

Between lighting switches, switch socket outlets, all other service outlets and sinks.

The Electrical Services Contractor shall bring to the notice of the Engineer any potential situations in which the minimum clearances specified cannot be maintained, and shall receive and adhere to such written instructions as may be issued by the Engineer in each specific case.

### Installation Methods - Mounting Heights

The contractor shall as far as is practicable in any installation, adhere to the undernoted standard mounting heights for electrical accessories.

**Table 2.1.2**  
Mounting Heights of Standard Accessories

TYPE OF EQUIPMENT	HEIGHT
Distribution Fuse-gear (to Lower Edge)	as detailed
Light Switches ( to Centre)	1.40m
Switch Socket Outlets Low Level (to Centre)	1.00m
Switch Socket Outlets Intermediate (to Centre)	1.00m
Switch Socket Outlets High Level (to Centre)	2.00m
Control Thermostats	1.50m
Bench Sockets (Above Bench Top)	0.175m minimum

### Definition of Voltage

The terminology used for defining voltage throughout this document is that stated in BS 7671.

### Rubber Mats & Treatment for Electric Shock Chart

A 900mm wide ribbed rubber safety insulation mat extending the full length of the Main and all Sub-Main switchboards or cupboards shall be provided and laid in all high and low voltage switchrooms. The mat thickness shall not be less than 13mm and conform to the relevant British Standard.

Copies of the "Electrical Review" instruction chart for the treatment of electric shock shall be supplied, the chart shall show the mouth to mouth, and mouth to nose method of resuscitation. This chart shall be printed direct on to plastic or aluminum sheet and shall be coated with weather resisting varnish. The chart shall be fixed to the wall in the main switchrooms, sub-switchrooms at Riser and Plant Room locations and in each distribution cupboard.

### Service Aperture Fire Stopping

All service apertures in fire partitions shall be fire stopped by the Contractor using a proprietary arrangement to reinstate the required fire rating at the point of penetration.

In the absence of specific information regarding the fire integrity of walls, floors etc. a two hour rating shall apply.

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Purpose designed compression type cable transits using preformed intumescent blocks shall be cast into concrete slabs or incorporated with in blockwork/masonry walls where power cables pass from one fire compartment to another.

Where piped or rectangular ducted services can be surrounded completely an intumescent collar shall be installed arranged to fill completely any interstices and to seal the masonry aperture against transmission of any gases.

All builderswork apertures shall be constructed large enough to accommodate the appropriate fire stopping methods.

### **Dissimilar Metals**

Where dissimilar metals and/or materials are used together precautions shall be taken to ensure there is no chemical or electrolytic action between them. This particularly refers to aluminum and aluminum alloys and the surface with which they are in contact.

### **Specialist Services**

Where specialised services are shown on the drawings and/or included in the scheme, the Contractor shall include for all the work necessary to fully incorporate these requirements.

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### **Fixing Brackets, Plugs & Bolts**

The Contractor shall allow in his tender for the supply and fixing of all necessary brackets, plugs and bolts on stanchions, walls, ceilings, etc., where required to securely fasten conduits, switch boxes, saddles, distribution boards and other fitments securely in position: such brackets must be of a type, make and pattern approved by the appropriate manufacturer who shall also approve the method of fixing.

The boring or notching of structural steelwork, reinforced concrete beams, wood joists, etc., for cable runs and/or fixings shall be kept to a minimum and must receive the prior written agreement of the Engineer/Contract Administrator.

Fixings for cable trays shall be at regular intervals in accordance with the Manufacturer's recommendations and not exceeding 1200mm. Fixings shall be at a maximum of 225mm from each side of any bend or intersection.

All holes for plugs shall be cut or drilled, include for such labour in the tender.

Ensure that all conduits, fixings, inserts, etc., to be cast insitu are plugged and securely fixed to prevent movement or the ingress of grout, thereby fouling fixings. Any such points that are fouled or moved shall be cut out, repositioned and/or cleaned without reimbursement. The agreement of the Engineer/Contract Administrator shall be obtained for any fixing involving the cutting away of structural concrete or masonry walls.

The fixing of conduit, cable etc. to ventilation ductwork will not be permitted.

## **2.2 HIGH VOLTAGE SWITCHGEAR**

### **General**

Unless stated to the contrary, the high voltage switchgear shall be rated at 250 MVA, 11,000 volts, 3-phase, 3-wire, 50Hz and be of the extensible, indoor/outdoor pattern as appropriate.

The switchgear shall be shot blasted, zinc sprayed, primed with zinc chromate and stove enamelled with an oil resistant grey gloss paint.

The extensible ring main units shall be rated at 400/630A having an integral bar chamber containing 630A 3-phase bus bars with provision for earth and test on the cable terminals.

The switches shall be equipped with an independent manual, spring loaded operating mechanism having ON/OFF and OFF/EARTH positions. Mechanical interlocks shall be provided to ensure correct operation of the ring ON/OFF switches and ring feeder cable earthing switches. Facilities shall be provided to padlock the switches in the CLOSED/OPEN and ring circuit earthing positions. They shall also be provided complete with a vertical mounted fabricated steel split cable box to receive the incoming and outgoing cables.

The Oil or SF6 fuse switches shall be rated at 200A unless stated otherwise in later sections of this specification or shown on the drawings and shall be complete with an oil immersed or SF6 bus bar chamber containing 630A 3-phase bus bars and in the case of oil fuse switches fitted with type EMP oil immersed HRC fuses. The units shall be equipped with an independent manual spring loaded operating mechanism having ON/OFF positions, an "open all phases" device, an integral interlocked cable earthing switch with provision for test on the terminals and incorporating a separate interlocked independent manual spring loaded operating mechanism having OFF/EARTH positions. The unit shall be fitted with a vertical mounted fabricated steel split cable box to receive the incoming and outgoing cables.

Where switchgear is assembled to form an integral multi-panel switchboard the switchboard shall be fitted with bus bar couplings and bus bar end caps, brass cylinder type padlocks with common keys on all switches for locking in either ON, OFF or EARTH positions and be left charged with Oil or SF6 as appropriate.

A tinned copper earth bar sized not less than 25mm x 6mm shall be securely fixed to and extend the full length of a high voltage switchboard and be connected to an earthing terminal at each end.

All metalwork other than current carrying parts, shall be bonded to the earthing bar and provision shall be made for bonding the armouring and or metal sheaths of the incoming and outgoing cables thereto.

All high voltage switchgear and switchgear assemblies shall comply with current British and European Standards.

A 3-phase injection test probe unit shall be provided suitable for use on either the switch or fuse switch units.

### **Ring Main Units**

Ring main units shall conform to BS 5227. The RMUs shall comprise 2 No. switched disconnectors controlling the ring supplies and a tee-off circuit breaker to control the supply to a transformer. The switched disconnectors shall be non-isolatable. The circuit breaker shall be withdrawable. Unless otherwise specified, switched disconnectors and their remote feeder circuit breakers shall be key interlocked to prevent closure of the ring. Neon type voltage indicators shall be connected on the cable side of the switched disconnectors.



## **2.2 HIGH VOLTAGE SWITCHGEAR**

### **Circuit Breakers**

The circuit breaker interrupting medium shall be either bulk oil or SF6, and comply with BS 5311 and the following:-

#### ***Bulk Oil Type***

Circuit breakers shall be vertical isolation horizontal withdrawal type. The breaker poles shall incorporate arc control features.

#### ***SF6 Type***

Circuit breakers shall be horizontal withdrawal type utilising the puffer technique for arc control. The contact mechanism shall be mounted in a cast resin housing. Means shall be provided to monitor gas seals and the gas pressure.

### **Switches/Isolators**

#### ***Switched Disconnectors***

High voltage switches shall comply with BS 6581. Switched disconnectors shall be rated for fault making load breaking duties and non-isolatable. The interrupting media shall be as that of the circuit breakers being supplied. The closing and opening mechanisms shall be independent manual spring assisted. A fully interlocked cable earthing switch shall be provided. Where a switched disconnector is used to control an incoming supply, neon type voltage indicators shall be connected on the incoming circuit side.

The indicators shall be visible to the operator. Mechanical indicators shall be provided to indicate the switch positions.

#### ***Fuse Switches***

High voltage fuse switches shall comply with BS 5227. The switch mechanism shall generally be as described for switched disconnectors. The fuses shall be the striker pin type arranged to initiate opening of the switched disconnector should a fuse operate. Fuses shall be in accordance with BS 88.

### **Auxiliaries**

The closing mechanism shall be trip free and shall be independent manual type, spring operated. Spring charging shall be either:-

Manual, where the spring is charged by a single stroke of the operating lever, and permits a second charge after closure.

### **OR**

Motor charged, where the spring is charged automatically after closure. Motor voltage derived from tripping battery unit. A means of manually charging the closing spring shall be provided. An AUTO/OFF motor supply switch shall be provided.

A shunt release coil and a shunt trip coil shall be provided.

Mechanical indicators which are visible to the operator in the normal mode shall be provided for:-

- Circuit breaker open.
- Circuit breaker closed.
- Circuit breaker in service position.
- Circuit breaker in isolated position.
- Spring charged.
- Spring discharged.

## 2.2 HIGH VOLTAGE SWITCHGEAR

Automatically operated safety shutters which shield the live connections when the circuit breaker is withdrawn to the isolated position shall be provided.

The shutters shall be padlockable when the circuit breaker is withdrawn.

Current transformers (CTs) shall be provided for the indication and protection circuits shown on the drawings. For protection which requires the use of a CT located in remote equipment (ie. at a generator star point) the loose CT(s) shall be provided.

Where the indication is limited to an unswitched ammeter, this shall be connected in a protection circuit, otherwise indication circuits shall be separate from protection circuits.

CTs shall be cast resin encapsulated. Circuit breaker auxiliary contacts (2 No. normally open, 2 No. normally closed) shall be provided for remote indication purposes. Auxiliary circuits shall be suitably fused. The isolating contacts for auxiliary circuits shall be so arranged that circuit breakers of the same ratings are interchangeable.

The circuit breaker controls shall be a minimum of:-

- Mechanical trip button.
- Trip/neutral/close switch.

Control switches shall be lockable.

A flush pattern ammeter shall be provided on all circuit breakers excepting those used for bus-sectionalising purposes. A flush pattern feeder connected voltmeter shall be provided on all circuit breakers used to control incoming supplies.

Integral safety/maintenance earthing shall be supplied on circuit breakers as follows:-

- |                   |   |                  |
|-------------------|---|------------------|
| On incoming units | - | Cable earthing.  |
|                   | - | Busbar earthing. |
| On feeder units   | - | Cable earthing.  |
| On bus-sections   | - | Busbar earthing. |

### ***Voltage Transformers***

Where voltage transformers (VTs) are required for protection or indication, they shall be the 3-phase 3 or 5 limb type according to the connected equipment requirements. The VA rating, secondary voltage and class shall be determined to suit the duty. VTs shall be cast resin encapsulated. The primary and secondary windings shall be protected by suitably rated fuses. VTs shall be removable and safety shutters shall be provided to protect live connections.

### ***Interlocks***

Circuit breakers and switches shall be fully interlocked to prevent mal-operation and to ensure the safety of the operator. The interlocks shall cover normal operation and routine maintenance activities. Circuit breakers shall be interlocked with earthing switches. Where the interlocking requires the use of key exchange boxes, the boxes shall be supplied with the switchgear.

### ***Controls & Alarms***

## 2.2 HIGH VOLTAGE SWITCHGEAR

Power for circuit breaker tripping, closing, protective relays and indication shall be derived from a tripping battery/charger unit. Each circuit breaker control circuit shall be separately fused. Tripping circuits shall be unfused. Where remote control or indication is indicated on the drawings, suitable provisions shall be made. Provision shall be made for the remote tripping of the main incoming supply from the building central control console/LV switchroom/firemans panel as indicated on the drawings.

### *Labelling*

The switchgear and each outgoing way shall be identified by means of engraved identification labels. All components within the switchgear shall be identified by means of engraved identification labels. Identification labels shall be of laminated white-black-white Traffolyte or equal. Warning labels shall be of laminated red-white-red Traffolyte or equal. All labels shall be screw fixed. All major components shall be provided with a non-destructible rating plate which shall be securely attached. A rating plate carrying details of protection current transformers shall be mounted externally on each circuit breaker panel.

### **Switchgear Battery & Charger Unit**

A switchgear battery/charger unit shall be housed in an indoor, ventilated sheet steel cubicle. The unit will supply the shunt trip coils of both the HV and LV circuit breakers and also supply all the protection relays. The battery shall be of the NIFE type having a nominal 30 Volt output voltage. The battery shall be of sufficient capacity to maintain the switchgear in an operational state for a minimum of 12 hours in the event of a power failure which shall include two operations of each breaker in this period. The battery shall retain full charge within 12 hours of power restoration. The charging equipment shall be housed within the battery cubicle.

The charging equipment shall include the following:-

- An automatic constant voltage float charge unit to supply and automatically balance the battery losses and maintain the battery at a fully charged condition.
- A boost charge unit which when switched on the automatic constant voltage float charge unit shall be disconnected and the load switched to a lower tapping on the battery to avoid over-voltage should there be a mains failure during boost charge, the load shall automatically revert to full battery tapping.
- Mains supply isolating switch, this switch shall be fully mechanically interlocked with the cubicle door, to prevent the door being opened with the isolator in the "ON" position.
- A "Charge Fail" alarm relay and indicator lamp. The relay to have additional voltage free contacts wired to terminals for the operation of a remote alarm.
- Battery voltmeter and switch.
- Boost charge ammeter.
- Charge/discharge float charge ammeter.
- "Mains Supply ON" neon indicator lamp.
- All connections between the battery/charge unit and the HV and LV switchboards.

## **2.2 HIGH VOLTAGE SWITCHGEAR**

### **Tools, Spares & Accessories**

#### ***Tools***

A complete set of tools, handles and any devices necessary for the erection, testing and maintenance of the switchgear shall be provided. The tools supplied shall include a live line tester kit complete with carrying case. The tools and equipment shall be housed in a lockable wall/floor mounted metal box(es).

#### ***Spares***

The operating and maintenance manual shall contain a list of all spares required for the switchgear and its components.

#### ***Accessories***

These shall include:-

- Tripping battery unit.
- Foundation bolts.
- A set of "ISO-LOK" padlocks.
- Any other necessary items.

### **Protective Circuits**

#### ***General***

The types of protective relays or circuits required shall generally be in accordance with this specification unless otherwise specified or indicated on the drawing. All relays shall be flush mounted, have flag indicators and be manually reset. All relays shall be supplied with test plugs. All IDMT relays shall be the selectable multi-characteristic electronic type.

#### ***Incoming Supply Circuit Protection***

2-pole overcurrent, 1-pole earth fault IDMT relay. Remote tripping from emergency push button.

#### ***Outgoing Feeder Circuit Protection***

2-pole overcurrent, 1-pole earth fault, IDMT with instantaneous element on all poles.

#### ***Transformer Feeder Circuit Protection***

2-pole overcurrent, 1-pole earth fault, IDMT with instantaneous element on all poles. Intertripping from transformers LV circuit breaker.

### **Earthing & Bonding**

A main earth bar shall be run the length of the switchboard. The earth bar shall be hard drawn electrolytic copper and be located at the rear of the switchgear adjacent to the cable entries. The main earth bar shall be sized to withstand a bolted earth fault for a duration equal to the longest short time rating of any interrupter in the switchgear, and be of minimum dimension 50mm x 6mm unless stated otherwise in later sections of this specification or shown on the drawings. Provision shall be made at the ends of the earth bar for cable lugs for the connections to earth. All metallic non-current carrying parts shall be effectively bonded together and connected to the earth bar. All hinged doors shall be bonded to the main framework by means of flexible bonding wires, properly terminated.

## **2.2 HIGH VOLTAGE SWITCHGEAR**

### **Wiring & Cabling**

#### ***Secondary Wiring***

This shall be carried out in stranded copper single core cable, PVC insulated and coloured black. Wire ends shall be terminated using crimped connectors. Secondary wiring terminals shall be Klippon SAK 2.5 or equal, one conductor per terminal. Terminals for different voltages shall be segregated. The cores shall be identified at both ends by means of numbered cable ferrules or sleeves.

#### ***Cable Terminations***

The incoming and outgoing power and control cabling will enter the switchgear from below, unless otherwise stated. Main power cables shall be stranded aluminium or copper, XLP, SCR, PVC, SW, PVC or equal, unless otherwise stated. The connection chambers for the main power cables shall be the dry type, unless otherwise required for the type of cable specified. The chambers shall be of adequate size to accommodate stress relieving dry type terminations.

### **Testing**

#### ***Work Tests***

Those defined in the British and European Standards.

#### ***Site Tests***

Voltage tests shall be taken on the completion of the erection of the high voltage switchgear in compliance with the British Standards.

Voltage tests shall be undertaken on a part or all of the high voltage cable systems following laying and jointing as required by Site Progress.

Test pressure shall be applied gradually and shall be of the value specified in the relevant British and European Standards between conductors and sheath.

Phasing out tests shall be carried out on the completion of the cabling installation and erection of high voltage switchgear.

Phase rotation tests shall be carried out on the completion of the cabling installation and erection of high voltage switchgear.

All protective devices shall be tested before commissioning by the introduction of a current generator and ammeter into the circuits in order to prove the setting and operation.

In order to ensure correct connections and phasing all primary and secondary circuits shall be tested with the supply live and circuit breakers open and isolated.

An injection test shall be applied to the secondary circuits of every instrument to prove that the calibration is correct and that the instruments are in good working order.

All instruments designed for working at low voltage shall be disconnected when the high voltage is applied.

Certificates of the Manufacturer's type tests together with these site tests shall be included in the operating and maintenance manuals.

## 2.3 POWER TRANSFORMERS

### General

The continuous output ratings shall be as indicated on the drawings for 3-phase 50Hz service, the windings being arranged for delta/star connection to give a no load voltage of 11,000/433 volts. The neutral point of the star connected secondary winding shall be brought out to a separate terminal in the LV terminal chamber on vector group reference DY11 unless otherwise advised. The transformer shall be low loss type.

The transformers shall be designed to withstand a high voltage impulse of 95kV peak.

The transformer shall be Oil or Midel filled (as stated in later sections of this specification or shown on the drawings) self-cooled core type and be fitted with off-load tap changing gear on the HV windings to enable voltage adjustments of  $\pm 2.5\%$  and  $\pm 5\%$  to be made. A brass cylinder type padlock with two keys shall be provided.

The transformers shall be manufactured in accordance with the requirements of the Electrical Supply Industry Standard ES 35-1 and be suitable for outdoor ground mounting service to BS.171.

The transformer exterior shall be shot blasted, zinc sprayed primed with zinc chromate and enamelled with two coats of grey gloss paint.

Power transformers shall be complete with the first Oil or Midel fill.

Power transformers shall be tested before leaving the manufacturers works for ratio, losses, impedance, polarity and insulation in accordance with BS.171 and a copy of the test certificate shall be included in the Operating and Maintenance Manual.

The following items shall be incorporated as a minimum on a transformer unless stated otherwise in later sections of this specification or shown on the drawings:-

- Coolant level sight glass.
- Silica-gel breather.
- Rating and diagram plate.
- Lifting lugs.
- Skid type under base with wheels suitable for barring round.
- HV cable termination box.
- LV cable termination box.
- Earthing terminal.
- Winding temperature indicator and alarm controls.

### Cable Terminal Boxes

Terminal boxes and terminal arrangements shall be suitable for the cable types and conductor cross-sectional areas or bus duct type and sizes as detailed. Terminals shall be properly marked in accordance with the connection diagram and rating plate, the phase identification shall be R, Y, B.

The transformers shall be supplied with air insulated cable boxes, for both the high and low voltage cable terminations. The terminal boxes shall be fabricated from sheet steel, the dimensions and creepage distance of which are suitable for air insulated conditions.

Where applicable, the terminal boxes shall be arranged so that they can be removed from the tank of the transformer, without the necessity of breaking down the associated cable termination, drawing insulating fluid from the transformer tank, or lifting the transformer. The arrangement of the cable terminal box shall allow easy termination of the cables. The direction of cable entry shall be as detailed. Suitable means to support the specified cables when entering from below shall be provided on the transformer frame.

When busbar duct is specified for the LV connections, the transition piece shall be provided to the transformer manufacturer for fitting prior to delivery.

### Cable Terminations

## **2.3 POWER TRANSFORMERS**

Within the HV terminal box, bushings shall be provided suitable for use with Elastimold (or equal) stress relieving connections. The cable shall be “glanded off” using a compression type brass cable gland. LV cables shall be “glanded off” as above, and terminated via compression type cable lugs. A non-ferrous gland plate shall be provided for single core cables.

### **Rating & Connection Plates**

Each transformer shall be provided with stainless steel rating and connection plates. The information on the rating plate shall be in accordance with BS 171, together with the additional information referred to therein, including a connection diagram.

### **Equipment Identification**

Each transformer shall be identified by an engraved white-black-white Traffolyte label. If the transformer enclosure has doors, warning notices shall be fixed to the doors. This is to be additional to locking devices. Auxiliary equipment shall be provided with engraved labels identifying their function. All labels shall be screw fixed.

### **Locking**

Where doors are provided for access to HV terminals, Castell key locking shall be provided electrically interlocked with the HV switch/breaker whichever is providing the means of isolation.

### **Finish**

All equipment shall be supplied with manufacturer’s standard finish, applicable to the intended location/environmental conditions.

## **2.4 LOW VOLTAGE SWITCHBOARDS**

### **Construction, Instrumentation and Wiring**

Low voltage switchboards unless otherwise indicated later in the specification or on the drawings shall be of the cubicle pattern, metal clad Factory Built Assembly (FBA) to BS EN 60439 Form 4 type 7, unless stated otherwise later in this specification or on the drawings, comprising fuse switches, circuit breakers, switchfuses, distribution boards, etc., as detailed on the drawings and schedules having a minimum short time withstand capability of 50kA for 3 secs.

Switchboards shall consist of sheet metal panels built up on a substantial framework of rolled steel or folded sheet steel sections of not less than 16 swg. All necessary stiffeners for the framework and panel shall be provided to ensure a rigid structure. The whole shall be to BS.EN 60529 - IP32 and where mounted in plantrooms IP44, unless stated otherwise later in this specification or on the drawings.

Switchboards shall be divided internally by sheet metal webs so as to separate low voltage equipment, where possible, from instruments and shall comply with Form 4b of the Electrical Installation Equipment Manufacturers Association "Guide to Forms of Separation" unless stated otherwise later in this specification or shown on the drawings.

All access doors shall have concealed hinges, rotating type door handles and dust excluding gaskets.

After manufacture, all steelwork shall be cleaned off and zinc sprayed before paint finish, or other approved protective finish.

All paint finishes shall be stove enamelled with one primer coat, two undercoats and one finishing coat, the surface being rubbed down between each coat to the standard BS colour noted later in this specification or shown on the drawings. In the absence of a specified colour, the manufacturer's standard colour shall apply .

Protective devices/isolating switches serving a fire alarm system shall be coloured RED.

All internal wiring shall be installed at the factory and shall be PVC insulated, neatly bunched and supported. All wiring shall be colour coded and extended to labelled terminal boards for the connection of external services.

Instrumentation and metering shall be provided as described later in this specification or shown on the drawings.

As a minimum a Voltmeter and Ammeter for each incomer which is selectable between phases and phase and neutral together with a kWhr energy meter with kVA maximum demand indicator shall be provided. These instruments shall be mounted between 1350mm and 1700mm above finished floor.

Internal wiring for auxiliary and control circuits shall be PVC insulated and wire-ends shall be identified by numbered ferrules or sleeves. Wiring subject to movement (eg. on hinged doors) shall be flexible and protected by PVC sleeving or helical binding.

PVC trunking shall be provided for a through wire-way in each FBA. Wiring shall be enclosed in PVC trunking.

Wiring requiring connection to external circuits shall be brought to a numbered Klippon terminal block type SAK 2.5, or equal, in a separate enclosure or terminal box.

Low voltage and extra low voltage terminals shall be physically separated.



## 2.4 LOW VOLTAGE SWITCHBOARDS

Each FBA shall be designed to allow outgoing circuit cables to be terminated in total SAFETY under the following conditions:-

- Incoming main circuit cable live.
- Incoming auxiliary and control circuit cables live.
- Incoming main switch in OFF position.

Gland plates shall be provided on the external top surface of each FBA section and shall be:-

- Removable.
- Brass or steel as appropriate.
- Bonded to the main earth bar.

Where single core aluminium wire armoured cables are indicated, gland plate and terminations provided shall be compatible to avoid chemical reaction between gland plate and armouring of cable.

Unrestricted access shall be provided to the cable route and termination within the FBA. Facilities shall be provided for firmly supporting the cables within the FBA.

Cable terminations shall be suitable for copper cables. The neutral terminals shall be fully rated, ie. as phase terminals. Termination shall be **RIGIDLY** fixed.

Main circuit terminations shall be of the flat-tag type suitable for bolting flat crimp-type cable sockets, and be adjacent to each other for each circuit provided with interphase insulating barriers and individual shroud for each terminal. Terminals shall be clearly numbered or identified. Terminals which may be live even after switching OFF the main incoming unit on a particular FBA shall be:-

- Provided with safety screens.
- Provided with warning labels.

Indicating instruments shall be flush mounted. Those for power, energy and power factor shall be suitable for 3-phase, 4-wire, unbalanced loads.

Terminals shall be shrouded. Circuits operated from current transformers shall be provided with short circuiting links. Circuits operated on voltage shall be provided with withdrawable cartridge fuses.

### **Power Factor Correction Equipment**

Power factor correction equipment shall comprise of fully automatic packaged capacitor cubicle, capable of being switched manually, depending upon load conditions and tariff considerations.

The control enclosure for each section shall be provided complete with overcurrent protection, control circuit fuses, indication lamps and HAND/OFF/AUTO selector switch for manual operation.

Each cubicle shall contain a current transformer complying to Class "C" or "D" accuracy for their particular duty. The current transformer should be located in one phase of each load to operate the master relay.

The master relay shall incorporate a facility for automatic rotation of capacitor priority to ensure even use of the capacitors.

The Contractor shall incorporate a digital display indicating Voltage, Amperes and power factor. The display unit shall be visible and controllable from the outside of the cubicle.

The capacitors shall be provided with an overcurrent protection relay with manual reset button. The overcurrent alarm shall be wired to accessible and labelled terminals to provide a facility for indicating an overcurrent trip through a BMS.

Capacitor banks shall be dry type, aluminium metalised, self-healing polypropylene windings in a thermo setting resin sealed container, naturally cooled, indoor type. The capacitors shall be designed to operate for prolonged periods up to a maximum of 10% above RMS value of the highest voltage to be expected.

## 2.4 LOW VOLTAGE SWITCHBOARDS

Be in accordance with the permissible overloads, ie. **voltage** - the maximum RMS voltage should not exceed 110% of the rated RMS voltage for prolonged periods, **current** - the increase in RMS current of a capacitor above the current that would flow at rated sinusoidal voltage and rated frequency should not exceed 30%, **reactive output** - should not exceed 130% of the nominal rating as a result of the combination of current and voltage overloads. Finally, the capacitor tolerance of actual reactive output of individual capacitor units does not differ from the rated value by more than -5% to +10%. For capacitor assemblies the tolerance is within 0% to 10% of the rated output.

Lifting lugs or eye bolts shall be provided on each unit to facilitate handling.

The capacitors and associated connection and control equipment shall be suitable for continuous operation at ambient temperatures up to 40°C.

Non-current carrying metalwork shall be bonded together and a suitable connection made to the main earthing system.

Where the capacitors are within a separate enclosure the cubicles shall comply with the construction details applicable to the Low Voltage Switchboard and be finishes to the same BS colour.

### **Low Voltage Coils - Various Applications**

Coils for switching relays, contactors and other applications shall be capable of withstanding a 15% drop in voltage without the armature or switching apparatus dropping out of position.

### **Low Voltage AC Contactors - Inductive Load Uninterrupted Duty**

The contactor shall comply with BS.EN 60947 and shall be of the air break type having an eight hour rated duty, a utilisation category AC 3, an electrical endurance of not less than 500 operating cycles, and a rated operational current as shown on the drawings.

The contactor shall be electro-magnetically operated, suitable for local and remote control via an in-built LOCAL/OFF/REMOTE control selector switch. The wiring arrangement shall be as indicated on the drawings.

The contactor operating coil shall be AC suitable for the phase to neutral voltage of the supply and shall be protected by means of a cartridge fuse.

The number of main poles and number and type of auxiliary contacts required shall be as shown on the drawings but one pair of auxiliary contacts shall be provided as a minimum.

Individually mounted contactors shall be fitted with integral isolating switches having a rated duty, a load rating and utilisation category compatible with the respective contactor.

Individually mounted contactors and their associated control operating components shall be housed in pressed steel or impact resistant moulded plastic enclosures.

The enclosures for contactors installed inside buildings in all locations except plantrooms shall provide a minimum degree of protection of IP44 and in plantrooms IP55, the enclosures for contactors installed externally shall provide a minimum degree of protection of IP65.

## **2.4 LOW VOLTAGE SWITCHBOARDS**

### **Low Voltage Circuit Breakers, Air Break (ACB) Metal Clad**

Circuit breakers shall comply with BS.EN 60947 and have the uninterrupted current rating noted on the drawings when enclosed and in its operating environment with a rated operational voltage as specified for the switchboard.

When incorporated into a switchboard the circuit breaker shall have the same withstand capability as that specified for the switchboard.

Circuit breakers shall be of the metal clad withdrawable isolating removable type having provision for safe maintenance and where forming part of a switchboard shall meet the degree of protection called for; where mounted separately, shall have the degree of protection of IP31.

The closing mechanism shall be independent manual spring operated.

Circuit breakers shall be type tested with a certificate indicating compliance with this specification and BS.EN 60947 issued by an approved Testing Authority.

Provision shall be made to padlock the circuit breaker in the isolated/withdrawn position and to padlock the automatic shutters covering the live contacts when the circuit breaker is removed from its housing.

Interlocks shall be provided to prevent movement of the circuit breaker within its housing when it is in the "closed" or "service" condition and automatic shutters shall be provided to cover all live contacts when the circuit breaker is isolated or withdrawn or is removed from its housing.

Unless stated otherwise, fully automatic circuit breakers comprising auxiliary switches, protective devices and auxiliary components shall be provided.

### **Low Voltage Air Break Switches - Fuse Switches & Isolating Switches**

Low voltage air break switches shall comply with BS.EN 60947, have an uninterrupted rated duty, a utilisation category AC 23, a mechanical endurance not less than the values stated in the Standard and an electrical endurance not less than one-twentieth of the number of no load operating cycles corresponding to the mechanical endurance.

Fuse switches shall be fitted with cartridge fuse links which comply with the clause headed "Cartridge Fuses".

Each switch shall be provided with facilities for padlocking in the "OFF" position.

To prevent accidental contact with live parts, switches of the withdrawable chassis isolating type, shall have either fully shrouded fixed contacts or insulated cover plates.

Switches in individual enclosures shall have an earth terminal, meet the degree of protection specified for the switchboard and have the operating mechanisms interlinked with the access door.

Switches shall be provided with the auxiliary contacts indicated on the drawings but as a minimum, switches used to isolate the final connections between a starter and its motor shall be fitted with one set of contacts connected to open the starter coil circuit when the switch is opened and one set of spare contacts for remote indication/signalling.

## **2.4 LOW VOLTAGE SWITCHBOARDS**

### **Low Voltage Switchgear - Changeover Contactors**

These shall comprise pairs of contactors mechanically and electrically interlocked. The individual contactors shall be of the heavy duty clapper shaft type mounted on horizontal channels. The contactors shall be suitable for direct mounting in vertical tier formation without further insulation within the switchboards or enclosures indicated. They shall be manufactured in accordance with the clauses indicated for contactors within this specification but shall be suitable for uninterrupted duty as defined in BS.EN 60947.

### **Distribution Units & Distribution Boards**

Provide wall mounted distribution units, comprised of the components, labels and inter-connections all as generally indicated on the tender drawings. The distribution units shall be sized and configured so as to fit into the space(s) shown.

Distribution boards shall be fabricated from sheet steel, formed and welded or riveted together to form a rigid enclosure to house the required bus bar assembly and specified number of fuses or circuit breakers and finished as specified for the main/sub-main LV switchboards.

All distribution boards shall be provided with fully opening doors fitted with cylindrical locks of an approved make, and all live parts shall be fully shrouded by an insulated mask fitted internally giving access to MCB toggles or fuse cartridges only.

Removable gland plates shall be provided on the top and bottom of all boards, suitable for conduit or cable entry.

Neutral and earth bars shall have the same number of terminals for outgoing cables as there are single pole ways on the board, and shall be numbered to relate to the outgoing ways.

The MCB's shall be arranged so that they may be removed with ease.

Where combined MCB/RCD's are specified later in this specification or shown on the drawings the combination unit shall be regarded as a single circuit way.

Include for the actual number of distribution board ways required to meet the circuit ways indicated on the drawings.

This will generally require two distribution board ways for a single circuit way where MCB/RCDs are indicated.

Unless stated otherwise later in this specification or shown on the drawings, distribution boards shall be provided with 25% spare ways.

### **Switchboards & Composite Panels Connections**

Include for checking and tightening, as necessary, all the internal connections of LV switchboards and panels, whether factory or site erected, using the appropriate torque wrench setting, prior to energisation.

The Contractor shall include for carrying out a final check/demonstration in the presence of the Engineer or Site Representative and the torque settings shall form part of the record information.

## 2.4 LOW VOLTAGE SWITCHBOARDS

### Marking Labels & Circuit Lists

Unless stated otherwise later in this specification or on the drawings include for all switches, switchfuses, distribution units, cable boxes, adaptable boxes, etc., to be clearly labelled with plastic laminate sandwich or '2plex' blended acrylic labels (reverse engraved with 6mm letters) fixed to the outer surface to indicate the function of the particular unit or circuit controlled. Standard colour phase buttons shall be similarly fitted.

The labels shall be of minimum size 75mm x 75mm and shall be fixed by means of pop rivets or self-tapping screws. Each label shall provide the following information:-

- Item Number (if any).
- Service: Lighting, Power, Sub-Main, etc.
- Area Served.
- Phase - Voltage - Rating.

In the case of distribution boards, circuit lists, stating the location of circuit points, the rating of the protective device, cable CSA and the load of each circuit, shall be securely fixed inside the covers of the boards. The circuit lists shall be typed, on stiff plastic encapsulated material, or enclosed in PVC envelopes fixed to the door. Sample lists shall be submitted for agreement before installation.

Labels with numbers shall be attached to the barriers of each fuseboard to indicate the number of each particular circuit shown on the index.

In addition each TP and TPN switch, switchfuse, bus bar chamber, etc., shall be fitted externally with a label having the words "Danger - 400 volts" engraved in 8mm red letters.

All fire service switches shall be painted Red for easy identification. In cases where complete isolation is not achieved by the fire service switch a notice plate shall indicate the whereabouts of any auxiliary switches which require to be opened for complete isolation.

A diagram shall be provided in the main and sub-main switchrooms, showing the details and function of each switch, size and number of cores of all outgoing cables, location, size and rating of all distribution boards fed from the switchboards and the phase of each outgoing circuit. The diagrams shall not be less than 700 x 500mm and shall be mounted in a glazed frame. The layout and mounting of these diagrams shall be agreed with the Engineer/Contract Administrator prior to erection.

Labels shall be fitted to all control equipment installed.

### Miniature Circuit Breakers

All MCB's incorporated in distribution units shall be capable, of withstanding a prospective short circuit current of 9kA unless stated otherwise later in this specification or on the drawings.

Miniature circuit breakers (MCBs) shall be of the ratings specified for enclosure continuous operation, and shall be manufactured in accordance with the current British Standard BS.EN 60898.

The MCBs shall be of the Thermal Magnetic or Magnetic-Hydraulic over current type with the mechanism factory sealed and temperature compensated for ambient temperature between 0°C and 35°C.

Current carrying contacts shall be of silver tungsten, or equivalent, and arc chutes of the de-ionisation principle shall be fitted.

## 2.4 LOW VOLTAGE SWITCHBOARDS

All MCBs shall be of the toggle operating type, with single operation mechanism to provide ON/OFF switching and restoration of the service after automatic tripping. All units shall be quick make quick break action and have trip free mechanism. Triple pole units shall have a tripping mechanism acting from any one phase such that a fault occurring on any one phase of a three or four pole MCB shall trip the breaker.

All MCBs shall be of the type which provides positive means of isolation.

### **Moulded Case Circuit Breakers**

Moulded case circuit breakers (MCCBs) shall be manufactured in accordance with the current British Standard BS-EN 60947.

The MCCBs shall have a thermal overload tripping mechanism with inverse time characteristics and with a magnetic trip for instantaneous tripping in heavy overload or short circuit conditions. The MCCBs shall be fitted with trip free arrangements to ensure that the MCCB cannot be held closed in fault conditions. MCCBs up to 250A shall have factory sealed and temperature compensated tripping mechanism and those over 250A shall have adjustable overloads within the range 80 x 150% of the normal rating of the unit.

MCCBs shall be of the toggle or rotary handle operating type, according to size, with single operating mechanism to provide ON/OFF switching and restoration of the service after automatic tripping. All MCCBs shall be quick make, quick break action and have trip free mechanism. Three phase MCCBs shall have a tripping mechanism acting from any one phase such that a fault occurring on any one phase of a three or four pole MCCB shall trip the breaker.

### **Residual Current Devices**

#### *General*

Residual current devices (RCDs) shall comply with BS 4293 and with the requirements of the IEE Wiring Regulations. A residual current-operated circuit breaker (RCCB) as described in BS 4293 falls within the scope of the term RCD as used in this Specification.

When incorporating overcurrent and short circuit trips and used as circuit breakers, RCDs shall comply also with BS EN 60898.

Residual current shall be measured by a transformer which may be zero-sequence-connected or core balance type.

RCDs shall operate when residual current exceeds 30mA unless stated otherwise. RCDs shall operate in 0.4 seconds or less.

RCDs shall have the same short circuit withstand capability as MCBs and shall be capable of making, carrying and breaking the full short circuit current. This requirement shall apply whether or not the RCD is the sole or main circuit breaker at any point in the system.

Unless used as circuit breakers, RCDs shall be connected in series with the overload and short circuit devices in the system. RCDs shall not be used as the sole means of protection against direct contact.

Every RCD shall be provided with a test button and an engraved, clearly legible label stating “**TEST FREQUENTLY**”.

### **Fuses**

Switchboard fuses shall be of the high rupturing capacity type complying with BS 88 having a fusing factor not exceeding 1.5 rated current, Class gG.

Motor back-up fuses shall comply with BS 88 - AC4 category of duty, Class gM.

## **2.4 LOW VOLTAGE SWITCHBOARDS**

100% spare fuses for each of the sizes provided in each switchboard shall be supplied and mounted in suitable spring clips inside the units.

Fuses for fused connection units and plug tops shall be to BS 1361, 13A or 3A to suit appliances protected.

## 2.05 DIESEL GENERATING SETS.DOC

### Generated Electricity Supply

The electricity supply to be delivered from the generators shall be 11000V for high voltage systems and for low voltage systems shall be three phase, four wire AC. having a rated voltage and frequency of 415V at 50Hz.

The steady state voltage and frequency shall be maintained within the following limits, for generators operating singly or in parallel between no load and 10% overload, cold to hot conditions of the machine, and at power factor of 0.8 lag to unity.

$$415 \text{ V} \pm 2\frac{1}{2}\%$$
$$50 \text{ Hz} \pm 1\%$$

The sets shall provide base load or standby duty as described later in this specification and/or shown on the drawings.

The rated voltage and frequency shall be controlled such that on the sudden imposition or removal of the loads noted below the limits given will not be exceeded and the output will return to the rated voltage and frequency within the time period stated.

Load %	Limits Voltage	Limits Frequency	Time (seconds)
25	± 5%	±2%	5
100	±10%	±5%	10

The wave form of the voltage output shall not contain more than 2½% harmonics.

Standby diesel generators shall be manufactured in accordance with BS 5514 - Class A1, requirements of governing accuracy.

### Plan Layouts

The layout of plant and equipment indicated on the drawings is based upon sizes and types of equipment available the equipment offered shall be accommodated within the spaces allowed.

### Delivery to Site/Protection

Any equipment delivered to site must be fully protected to the manufacturer's recommendations and where necessary broken down in sections of such size that can pass through the available entrances, stairs and access ways.

### Fuel System

The fuel for the generator set will be 35 sec. oil complying with British Standard BS EN 590 - Class A2.

### Fire Protection System

The installation shall include the supply and installation of a fire protection system, battery supported.

The system shall be electro-mechanically operated with fusible links positioned directly over the engine and alternator together with manually operated push buttons located adjacent to the entrances/exits. The operation of either a fusible link or push button shall operate (close) the solenoid operated fire valves in the fuel line to the sets, these valves shall be located adjacent to the point of entry of the fuel lines into the room. Full bore lockshield pattern isolating valves shall be fitted either side of each weight operated valve for maintenance purposes.

The operation of either a fusible link or push button shall also operate a changeover contact contained within a purpose made sheet steel box complete with a cover plate and a clearly marked terminal block. The contact shall be rated at 5 at 240-volts ac or 50-volts dc.



Wiring from these contacts shall be taken to clearly labelled terminal blocks in the Main Control Panel.

### **Alternator Output Circuit Breaker**

The circuit breaker fitted in the Generator control panel/cubicle, shall be of the 4-pole fully automatic type as described later in this specification or shown on the drawings.

### **Operational Requirements**

The Generator Set shall be able to operate as:-

- Fully automatic start-up and shut-down in the event of a mains failure.
- Manually via a key operated switch to start up and shut down and provide a standby supply with the normal mains supply available.
- Provision, via a key operated switch, to enable the set to be started up and shut down without the alternator output circuit breaker being closed all as described in later parts of this specification.

A selector switch on the control panel shall provide the following facilities:-

Position 1 - Fully automatic on mains failure and restoration.

Position 2 - Manual operation with mains available.

Position 3 - Manual run on no load.

Position 4 - OFF - with the switch in this position, it shall not be possible to start the generator set under any condition.

The above selector switch shall be fitted with a key system such that the following facilities are available:-

- "Position 1" shall be normal position.
- The key must be inserted to select positions 2, 3 or 4.
- It shall not be possible to remove the key from positions 2, 3 or 4.
- With the selector switch in positions 2, 3 or 4, an adjacent warning lamp shall be energised, the lamp shall be DC. operated.
- With the selector switch in positions 2 or 3, if a "Mains Failure" signal is initiated by any Phase Failure Relay, the control system associated with the normal mains failure system shall override the control systems required by positions 2 and 3 and the generator set shall provide an output via the alternator output circuit breaker.
- Switching from positions 1, 2 or 3, or from positions 3, 2 or 1 shall not affect the operation of the standby set if a mains failure signal is initiated, but switching to position 4 shall stop the set.

The generator set control system shall, also, under any condition requiring the engine to run, open any automatic air inlet and outlet dampers which may be described later in this Section or shown on the drawings.

The control panel(s) shall comprise a totally enclosed metal clad cabinet of adequate size to accommodate the required switchgear, contactors, relays and other equipment to form the complete automatic control unit for the generator set and be substantially constructed, with smoothly rounded corners and matt zinc or other corrosion resistant finish and unless stated otherwise later in this specification or shown on the drawings shall be floor mounted front access.

## 2.05 DIESEL GENERATING SETS.DOC

The panel shall have external access doors fitted with locking handles, provided with duplicate keys, the locks shall be of the same pattern throughout, so that one key will operate all locks.

The panel shall be provided with removable plates of adequate thickness for cable entries to the cabinet and be painted overall with two priming and two finishing coats of best quality air drying paint internally, finished internally in white, and externally to a BS colour to be agreed.

The panel shall be manufactured to provide satisfactory access to all parts for examination and maintenance and be provided with protection for all parts at mains potential to remove any risk of electric shock when work is carried out within the unit. All covers which allow access to components which operate at a voltage exceeding 250 volts shall be clearly inscribed with the word DANGER and the maximum working voltage shall be stated.

All control, sensing, interlocking and remote indication circuit wiring shall be wired out to clearly labelled terminals. Separate terminals blocks shall be provided for circuits associated directly with the generator sets internal control and monitoring system and for the connection of sensing, control and interlock circuits associated with any automatic change over systems the main LV switchboard and with the remote indications described later.

The following indication lamps shall be provided as a minimum refer to later parts of this specification and the drawing for any additional requirements (Red unless indicated):-

- Mains available (Green).
- Mains failed.
- Engine failed to "start" after 3 consecutive attempts.
- Low oil pressure.
- High cooling water temperature.
- Low coolant level.
- Cooling water heater ON (Green).
- Engine tripped on overspeed.
- Alternator output ACB tripped on over-current or earth leakage.
- Fire detection system operated.
- Battery Charger ON (Green).
- Battery voltage meter.
- Battery charger system failed.
- Generator 'ON LOAD' (Green).
- Generator earth fault.
- Air inlet or discharge damper motor failure.

A lamp test push button shall be included.

A common audible alarm shall be provided with a mute button.

Separate terminals for the remote indication of the following conditions shall be provided:-

- (i) Generator set locked out.
- (ii) Generator set ON LOAD.
- (iii) Generator set Output circuit breaker tripped on over-current or earth leakage.
- (iv) Fault on generator set - this signal shall include any alarm listed above that is not included under items (i), (ii), and (iii) above.

The above signals shall be derived from volt free changeover contacts within the control panel.

The control panel shall be equipped with the following instrumentation:-

- Frequency Meter.

## **2.05 DIESEL GENERATING SETS.DOC**

- Alternator Output Volt meter with selector switch to enable phase to phase and phase to neutral voltages to be checked.
- Alternator Output Ammeter with selector switch to enable phase and neutral currents to be checked.
- Alternator kWh meter.
- Alternator Maximum Demand Indicator.
- Engine shaft speed indicating tachometer reading revolutions per minute to BS 89 with 100mm dials.
- Service hours counter.
- Lubricating oil pressure gauge.
- Cooling water thermometer.
- Provision for linking the alarms/indication/loadings and other items above to a BMS as required under later parts of this specification.

The instruments may be mounted on a suitable panel fixed to the engine or may be incorporated in the main control panel.

Fuses shall be provided for all equipment and instruments. HBC cartridge type to BS 88 of suitable rating.

Include three replacement fuses as spares for each size of fuse used, mounted in plastic covered steel spring holders located at a convenient position within the panel enclosure.

### **Normal AC Supply to Control Panel**

The control panel shall be provided with an Isolating Switch for the incoming AC mains supply and an integral MCB type distribution board to provide circuit distribution and protection for the "normal"/"mains AC. supplies to maintain/energise battery chargers, AC control circuits, crank case, heater, etc.

An automatic, mechanically and electrically interlocked changeover contactor shall be provided in the supply side of the above distribution board such that when the machine is running, under any conditions, AC. supplies are maintained from the alternator to all services associated with the Control Systems.

### **Starter Batteries Charging Equipment**

Each Generator shall have its own dedicated battery set of the manufacturer's standard voltage and of adequate rating to meet the starting and running requirements of the set and all necessary controls.

The units are to be sealed lead acid of adequate size to give six starts each of 5 seconds duration, with battery 25% discharged at 0°C. The batteries shall be mounted in a hard wood box with removable top and be suitable for standing direct on the floor.

The batteries are to be supplied in a dry charged state, the manufacturer to fill and charge to coincide with commissioning.

The charging equipment shall be a constant current charger providing an output current 20% higher than the bench rate at commencement and 20% lower at completion of the charging period, and be incorporated within the engine control cabinet, with associated instruments and controls mounted on the front. As far as possible the instrument and controls are to match those of the main panel.

The charger to include all necessary relays, cut-outs, controls, switches and instruments, including an ammeter, voltmeter or voltmeter/load test facility to indicate the battery condition.

### **Cooling**

A water jacket circulating pump with a thermostatically controlled valve shall be fitted in the cooling system to assist rapid heating of the water in the engine jacket when starting from cold and to control its temperature when the engine is running. The valve shall be arranged to assume the "open" position should it fail.

A lubricating oil temperature stabiliser integral with the engine cooling system and a first fill of anti-freeze solution to the current British and European Standards shall be provided.

The engine driven cooling fan and radiator shall be adequately sized to allow for the additional resistance to air flow of any attenuators or ductwork described later in this specification or shown on the drawings.

Suitable flexible connections shall be used between the radiator and any ductwork/attenuators.

### **Engine Starting**

Engine starting to be by electric starter motor complete with automatic starting and sequencing control equipment, incorporating positive means of isolating the starter motor on satisfactory starting. Provision for protecting the mains battery charger during starting shall be included.

The starting equipment shall incorporate a suitable automatic timer, so arranged that, if the engine fails to start within a reasonable time (e.g. 8 seconds) the starter motor shall be disconnected. The starting attempt to be repeated after an adjustable interval not exceeding 15 seconds and, if necessary, repeated a third time. If the engine fails to start at the third attempt, the starter motor shall be automatically isolated from the battery.

On disconnection of the starter by the fail-to-start device, the visual warning indicator(s) and audible alarm(s) specified hereafter shall operate.

### **Engine Safeguards**

Engine safeguards shall be provided to stop the engine automatically by de-energising a solenoid coupled to the stop lever on the fuel inlet, at the same time giving individual warning of the failure by illuminating a visual indicator and sounding audible alarm(s) arranged to operate when any of the following conditions occur, irrespective of whether the set is on automatic or manual control:-

- Low Oil Pressure.
- High Cooling Water Temperature.
- Low Flow of Cooling Water.
- Low Coolant Level.
- Fire Detection System Operated.
- Air Damper Motor Failure (when specified later in this specification or shown on the drawings).

### **Ancillary Requirements**

#### ***Intake Air Filter***

To be suitable for operating in a "medium dust laden atmosphere".

#### ***Drain Plugs/Cocks***

Drain plugs and cocks are to be provided to drain the engine of lubricating oil, water and fuel. These are to be designed and constructed as to be free from leaks and so positioned at the lowest point to ensure complete evacuation of fluid and be readily accessible to allow draining to be undertaken without need for special receptacles.

#### ***Lubricating Oil System***

## **2.05 DIESEL GENERATING SETS.DOC**

Shall be totally enclosed with forced lubrication from an engine driven pump having on the suction side a coarse strainer and on the delivery side a full flow fine filter having a replaceable element and fitted with a by-pass relief valve so that oil flow to the engine is maintained if the filter should choke and be of sufficient capacity to enable the engine to run continuously for a minimum period of 12 hours at any load without replenishment.

### ***Cooling Water Heater(s)***

Shall be thermostatically controlled electric immersion type located in the cooling water circuit, with suitable ON/OFF control switch(s) mounted on the main panel. It shall be capable of maintaining the cooling water jacket at a minimum temperature of 10°C with an ambient temperature of 0°C and provided with visual indicator(s) on the main control panel which operate when the immersion heater control switch(s) are in the ON position.

### ***Coupling to Generator***

Shall be a monobloc arrangement or suitable shaft coupling and guarded to comply with BS 5304.

### **Main Engine - Generator Frame**

Shall comprise a base or frame upon which the engine and generator will both be mounted. They shall be coupled together by means of an adaptor flange, spigoted to ensure correct alignment.

### ***Balancing***

Shall be carried out during manufacture and comprise both static and dynamic balancing applied to the engine, generator and ancillaries to reduce out-of-balance forces to a minimum.

### ***Anti-Vibration Mountings***

Shall be provided and fitted between the main frame and the floor upon which the unit will stand. Any further/special requirements will be stated later in this specification or shown on the drawings. They shall have adjusting screws for optimum setting and levelling and be so designed and installed that no appreciable engine vibration will be transmitted to the floor or to any surroundings. The anti-vibration mountings to have special bases or pads to prevent movement across the surface of the floor when the engine is running.

### ***Flexible Connections***

Shall be provided for all external electrical and mechanical connections made to the unit, including the exhaust pipework and the water cooling system to permit free movement of the set on its resilient mountings.

### ***Guards***

These shall be provided for all exposed moving parts of the engine, generator and ancillaries so as to prevent accidental contact by personnel. The guarding to comply fully with the latest BS and HSE requirements will be stated later in this specification or shown on the drawings.

## 2.05 DIESEL GENERATING SETS.DOC

### *Warning Notice*

Shall be fixed in a conspicuous position on the engine-generator unit and bear the following warning in red letters not less than 13mm high for the heading and 6mm high for the remainder:-

### **DANGER**

**THIS MACHINE IS AUTOMATICALLY CONTROLLED. DO NOT WORK ON IT UNTIL STARTING EQUIPMENT IS ISOLATED OR DISCONNECTED.**

### *Drip Trays*

These shall be provided under every part of the set where drips of fluids are likely to occur. The trays shall be integral parts of the items they serve and provided with readily accessible drain cocks, or alternatively constructed from steel sheet, of minimum thickness 1.5mm with rounded corners and smooth reinforced edges and be easily removable for emptying and cleaning.

### *Spare Parts*

A list of recommended spares shall be provided with the tender, particular requirements are stated later in this specification or shown on the drawings. In addition provide sufficient consumable items to maintain the day-to-day needs of the set for a period of 350 running hours.

### *Tools & Accessories*

Shall be provided as recommended by the specialist/manufacturer to enable the set to be maintained on a day-by-day basis and shall include grease and oil guns, necessary for the normal maintenance of the set and its controls. They are to be of the best quality, the spanners being chrome-vanadium steel, contained in a suitable robust steel tool box with lid fitted with a lock with two keys provided.

### **Engine**

The prime mover shall be a four stroke, exhaust gas turbo-charged direct injection diesel engine with charge air cooler operating at nominally 1000 to 1500 rev./min. as noted later in this specification or as shown on the drawings. The estimated fuel consumption of the engine under varying load conditions shall be stated with the Tender.

The engine shall be designed to operate on fuel oil complying with British Standard 2869-1970 Class A2.

All belt driven auxiliaries shall be provided with at least two belts. The drive shall be capable of transmitting load with one belt removed.

The engine shall be provided with a governor to control the speed to meet the requirements of BS 5514 Class A1 governing as a minimum and in addition shall meet the requirements necessary to control the frequency within the limits specified in the clause headed "Generated Electrical Supply".

Manual speed adjustment from the control panel shall be provided over a range of  $\pm 5\%$  of the rated speed at any load.

### **Alternator**

Shall be in accordance with BS 4999, continuously rated, 3-phase 4-wire, star connected, alternating current machine of the screen protected, self-excited type, directly coupled to the diesel engine prime mover, the whole being designed and constructed to operate as an integral unit, and shall be complete with all necessary controls and instruments to BS.5000:Part 3. Shall be in accordance with BS.4999:Part 32 for the grade of insulation used and associated limit of temperature rise. The voltage regulation is to be with the engine governing within the limits specified in BS.5514, Class A1 and satisfy the Grade 2 requirements specified hereunder.

## **2.05 DIESEL GENERATING SETS.DOC**

Grade 2 (a) At any balanced load between zero and rated load and at any load power factor from 0.8 lagging to unity and at any normal service condition temperature, the output voltage to lie between the limits of plus or minus 2.5% of rated value.

Grade 2 (b) On suddenly increasing the load from zero to 60% rated value the initial voltage dip not to exceed 15% of rated value and recover to at least 97% of rated value within 0.5 seconds.

The voltage wave form is to be a sine wave shape within the permitted limits of BS.4999:Part 40 and BS.5000:Part 3.

The terminals are to be of robust construction, adequate in size for the current to be carried and the CSA of the cables indicated, properly and securely mounted and protected, and is to incorporate locking devices to ensure non-slackening due to vibration during service and to be marked in accordance with BS.5559.

### **Restricted Earth-Fault Protection**

When specified later in this specification or indicated on the drawings this shall consist of protection for the alternator against internal earth fault using the core-balance earth-leakage system.

When significant leakage current is detected, this shall instantly trip the generator set circuit-breaker, stop the engine and display the appropriate alarm(s).

In addition, it is to provide stability for through faults in the external installation (i.e. no tripping) by ensuring that:-

The neutral conductor, cable armouring and earth continuity conductor which are encircled by the core-balance transformer (together with the 3 Phase conductors) are those which return ALL neutral and earth-leakage currents from the external installation to the generator star-point

### **AND**

The generator metal work is insulated from its star-point and only connected to earth at a point down-stream of the core-balance transformer.

An earth bar nominally 50mm x 6mm shall be provided within the control panel to facilitate the connection of circuit protective conductors and equipotential bonding leads.

A nominally 300mm sq. Cu Single Core PVC protector conductor shall be provided for connection between the alternator and the earth bar.

A nominally 300mm sq. earth bonding lead shall be provided for connection between the main frame of the diesel set and the earth bar.

A nominally 300mm sq. Single Core PVC earthing lead shall be provided between the earth electrode and the earth bar.

Supplementary equipotential bonding conductors shall be installed from all exposed conductive parts to the earth bar in accordance with BS 7671.

### **Wiring on Engine/Generator Unit From Set to Panel**

This shall be carried out with PVC, XPLE or Butyl rubber cable suitably bushed and having stranded conductors of adequate mechanical strength and current carrying capacity.

It shall be adequately supported and protected from accidental damage, properly installed and terminated in suitable terminal boxes with flexible connections. Special arrangements shall be made where wiring is subject to movement and vibration.

### **Initial Supplies of Lubricating Oil, Grease, etc.**

## **2.05 DIESEL GENERATING SETS.DOC**

These shall be provided with additional lubricating oil, sufficient for re-charging the engine sump once, together with a supply of lubricating oils and greases to cover the normal use and servicing of the set during the 12 months maintenance period.

### **Noise Attenuation and Air Intake and Discharge Systems**

#### ***General***

Unless stated otherwise in later sections of this specification or shown on the drawings, supply and install the equipment described hereinafter to meet the external noise limits stated and the pressure/air flow characteristics of the proposed radiator cooling fan. The sizes of louvres, dampers and attenuators are indicated on the drawings.

#### ***Intake and Discharge Louvres***

The louvres shall comprise horizontal blades, profiled to facilitate weather resistance, and offering a free area of 50% minimum. The velocity pressure loss factor (as defined in the latest issue of the Chartered Institution of Building Services Engineers Guide) for the louvres shall be not greater than 4.5.

Incorporated into the louvre arrangement will be a wire mesh screen to prevent access to vermin and birds. The velocity pressure loss factor (to CIBSE) for this screen shall not be greater than 1.0.

#### ***Intake and Discharge Air Dampers***

Where stated later in this specification or indicated on the drawings, supply and install gravity and/or motorised air dampers to control natural air flow through the room when the generator(s) is not operating.

The dampers shall be parallel ganged multi-blade pattern with blades carried on mild steep spindles into bearings of sintered bronze with nylon inner brushes.

The frame and blades shall be constructed from galvanised steel sheet of 1.6mm minimum thickness. Weld points shall be adequately stiffened to prevent distortion and limited in length to ensure that there is no difference in travel from one end to the other.

The dampers shall offer minimum resistance to air flow and shall not exceed a maximum pressure loss of 20 Pascals in the fully open position. Multiple damper arrangements may be employed to obtain the required full cross sectional area of the air flow within the plenum chamber, providing all vertical frame members, or intermediate mullions are aligned with the acoustic splitters so as not to obstruct the free air path between the splitters. Air leakage through the full bank of dampers when fully closed shall not exceed 5% of the rated air volume when submitted to the differential air pressure which exists when the damper is fully open and the radiator cooling fan is operating.

Damper motors shall be suitable for a 240V single phase 50Hz electrical supply. The motors shall be driven into both the open and closed position, unless stated otherwise in later sections of this specification or shown on the drawings. The Control of the dampers shall be such that failure of the motor driving any single damper shall not prevent operation of any other section. The failure of any damper motor shall raise an alarm, both indicator lamp and audible, on the Main Control Panel and remotely when specified later in this specification or shown on the drawings.

#### ***Air Intake and Discharge Attenuators***

The attenuators shall be sized to prevent the external noise limits, as stated in later parts of this specification or indicated on the drawing from being exceeded when the set is operating at full load.

All attenuators shall comprise vertical banks of acoustic splitters housed within prefabricated enclosures.

Splitter casings and support members are to be fabricated from minimum 1.6mm thick pre-galvanised sheet metal with welded joints. Weld points shall be adequately treated to prevent corrosion.



## 2.05 DIESEL GENERATING SETS.DOC

All splitters shall be completely filled cavities. The absorbent material shall be cut from slabs, and loose infills or offcuts will not be permitted. The absorbent material shall be faced with a suitable scrim type material to prevent fibre erosion. The splitter shall then be protected by galvanised perforated metal, having a minimum free area of 30%. This perforated metal shall be fixed to the splitter casing to prevent sagging of the absorbent material.

The absorbent material within the splitter shall be of mineral wool or glass fibre, being inert, rot and vermin proof, non hygroscopic and not supporting bacteriological growth. The material shall meet the fire rating requirements of the Generator Room installation.

Air passage velocities shall not exceed 6m/s.

Provide within the Tender full details of the following:-

- Total air flow through attenuators.
- Static pressure loss through attenuators at the total air flow rate.
- Noise level within the Generator Room.
- The dynamic inertion loss of each attenuator, at the operating condition, at each octave band mid-frequency from 63Hz to 8000Hz.

### *Exhaust Attenuators*

The attenuators shall be sized to prevent an external noise limit as stated in later parts of this specification or indicated on the drawings from being exceeded when the set is in operating at full load.

The arrangement of attenuators shall be in multi stages, i.e. primary and a secondary/residential attenuator.

The construction of these attenuators shall be as necessary for the exhaust gas conditions.

Exhaust pipework within the engine room shall be thermally insulated with a 50mm Rocksil 144 HD rigid sections, plain, protected with rolled 22 gauge aluminium secured with 'pop' rivets.

The exhaust silencer(s) shall be insulated with 50mm Rocksil 128 WI wired mattress protected with rolled 22 gauge aluminium secured with 'pop' rivets.

Where any exhaust pipe extends through the slab, provide to the builder for locating in position the required sleeve. Include for necessary roof flashing plate, flashing band and weather skirt. Fit within the external section an air operated weatherproof shutter.

The whole of the exhaust system must be securely fixed with flexible bellows and anchor points as necessary to accommodate the expansion and contraction forces.

The exhaust system shall be supported from the roof using mild steel straps, purpose made hangers and suitable sub-frame. All supporting steelwork brackets etc., shall be painted.

Details of the fixing method shall be submitted for agreement.

### **Work Tests**

Unless stated to the contrary elsewhere in the specification, works tests shall be carried out on the complete equipment at the manufacturer's works for output and performance generally in accordance with the requirements of the latest BSS. If the tests are carried out elsewhere, the full testing procedure shall be complied with.

Note: If the tests are carried out on site, portable load banks and temporary connections shall be provided.

## 2.05 DIESEL GENERATING SETS.DOC

Copies of all relevant test certificates shall be provided and shall including the following:-

- Voltage regulation, governing and load test, at full load, 100% full load and 50% full load for a period of not less than four hours. Temperature, pressure and electrical readings to be recorded at intervals of approximately half an hour.
- Insulation resistance test.
- Demonstration of the correct functioning of the various protective circuits and devices.
- Demonstration of the correct functioning of the mains failure and restoration sequence of operation.

### **Pre-Commissioning Checks**

The Contractor/Sub-Contractor/Specialist shall carry out all pre-commissioning checks on site before the sets are run. These shall include, but not necessarily be limited to:-

#### ***Engine***

1. Bird guard fitted to air intake.
2. Adequate guards fitted.
3. All hot surfaces insulated.
4. No pipes or cables crossing the floor.
5. Anti-freeze in radiator.
6. Oil level correct.
7. Clear access around engine.
8. Lifting beam fitted and marked with safe working load.
9. Ducts clean and free of oil.
10. Battery stand adequate and batteries able to be serviced without hindrance.

#### ***Control Panel***

1. Earthed.
2. Clear and unhindered access.
3. Sealed from any ingress from other ducts.

#### ***Exhaust System***

1. Routed well clear of any combustible material.
2. Well insulated.
3. Weighted rain/bird flap fitted externally.
4. Drain fitted at base of any vertical bend(s).
5. Flexible connection to engine.
6. Sound attenuators fitted.
7. Adequately supported.

#### ***Fuel Line***

1. Fire shut-off valve fitted.
2. Well supported and sleeved through walls.
3. Packed with heat resisting sealer through bund wall.
4. Flexible connection to engine.

#### ***General***

1. "Engine Starts Automatically" sign displayed.

### **Commissioning on Site**

## 2.05 DIESEL GENERATING SETS.DOC

The Contractor/Sub-Contractor/Specialist is to include for full commissioning of the set and its control equipment and for the provision of all necessary instruments, tools, fuel and lubricating oil.

These shall comprise the following tests and checks:-

- Check that the main frame is level in all directions, engine and generator shafts are in proper alignment and the vibration absorbing devices are properly installed and located.
- Check that all radiator and engine block water drain points are free from sludge and other blockage.
- Check the voltage readings on the batteries.
- Examine the containers in which the lubricating oils were delivered and check that the types and grades of oils are as recommended for the unit.
- Ensure that there is sufficient fuel available for a two hour test run.
- Check water and sump oil levels and that the water jacket and radiator heaters (if fitted) are in working order.
- Check engine, bolts, main drive coupling, valve clearances, fuel pump settings, governor settings, pipeline connections, water hose, exhaust couplings, flexible pipework etc., and where a separate cooling water tank is fitted, that the water level is satisfactory and the ball valve and overflow work.
- Check all outgoing connections on the generator and at the control panel. All lugs for principal connections to have clean and bright contact surfaces, a suitable abrasive material being used where necessary.
- Check access panels and doors for proper opening and closing and for the functioning of any interlocks fitted.
- With the set isolated from the mains supply and the selector switch in the "Manual" position, start the engine by means of the "Start" push button and allow it to run up to normal speed. Check that during the time the engine starter motor is in operation, the mains battery charger is automatically switched off to avoid its being overloaded by the reduction in voltage across the battery.
- Check instruments and gauges for normal operation and response and that the generator voltage is being maintained within prescribed limits, making due allowances for no-load conditions.
- Stop engine by turning selector switch to "OFF" position and verify that generator contactor opens at between 95% and 85% of normal voltage. Re-check water and oil levels.
- Turn selector switch to "Auto" position, disconnect the sensing circuit supply and check that the set starts, the mains contactor opens, and that the generator contactor closes in correct order. Re-connect the sensing circuit to verify that the engine stops on restoration of the main supply and that the contactors operate correctly.

**Note:** Running the engine for any length of time under no-load conditions is undesirable and any no-load tests should be carried out in as short a time as possible consistent with thoroughness.

- Operate the necessary isolators and switches to put the set on standby for the essential services network. With the selector switch in the "Auto" position, and using the mains failure simulation push, verify that the set operates correctly with the appropriate time delay for taking up load and that the carrying of the load and its distribution over the Phases are satisfactory.
- Run the set at various loads for periods totalling at least 30 minutes. Check the voltage and current in each phase in turn and that the voltage and frequency are being maintained within the required limits with large step changes in load. Note the rate of charge on the battery charger ammeter with the engine stopped. Check against manufacturer's recommendation and adjust charging rates if necessary.

## **2.05 DIESEL GENERATING SETS.DOC**

- Check the operation of any turbo-charger unit and charge air cooler (if fitted), and the colour of the exhaust gas at various loads.
- Check that the various engine safeguards operate satisfactorily.
- Check the vibration absorbing devices for proper operation and that the performance of all flexible connections, both mechanical and electrical, is satisfactory.
- When all tests are satisfactory and agreed with the Engineer, the lubricating oil and water levels are to be checked, the fuel oil tank replenished and the set left in normal operating order.
- Demonstrate the stability of the generator restricted earth fault protection by clearing a final utilisation circuit earth-fault fed from a 13A BS 1363 plug fitted with a 13A BS 1362 fuse link, without tripping the generator protection.
- Check that the phase rotation accords with that of the site.

### **Examination & Servicing**

This shall be provided for a period of twelve calendar months from the date that the unit is commissioned and handed over unless stated to the contrary later in this specification or indicated on the drawings.

This is to include the complete set and associated equipment forming the unit and is to comprise:-

- Making good any defects in the unit and replacing any parts that fail or show signs of weakness or undue wear in consequence of faulty design, workmanship or materials.
- Visits to site and proper attention to any defects within 48 hours of receiving notification of such defect.
- Carrying out regular examination and servicing of the unit every three months, the service and examination to include all necessary adjustment, greasing, oiling, changing of lubricating oils (where necessary) to keep the unit in sound and efficient working order.
- Instructing the Employers personnel in the proper operation, care and maintenance of the set and its equipment.
- A comprehensive examination and test of the set and its auxiliaries including checking the operation of controls and safe-guards to ensure that the unit is in proper working order and in satisfactory condition for final acceptance by the Employer. This examination to be in addition to the normal quarterly servicing.

## **2.06 LOW VOLTAGE BUSBAR TRUNKING SYSTEM.DOC**

### **Construction**

Low voltage busbar trunking systems shall comprise factory built assemblies complying with the general requirements of BS 5486 Part 1 and the particular requirements of Part 2.

The total length of the system shall be determined from the drawings for tender purposes, but the measurements shall be checked on site prior to manufacture.

External fixing brackets for wall fixing shall be provided in accordance with the Manufacturer's recommendations (normally not less than 2m intervals).

End covers shall be fitted at the end of each run.

The busbar system shall comprise a sheet metal enclosure containing 4-pole copper busbars with a degree of protection of IP32, unless stated otherwise.

The busbar trunking system shall have a paint finish identical to that specified for the LV switchboard.

A minimum of one rust inhibiting primer coat, one undercoat and two finish coats are to be applied.

The finished colour will be selected from the standard range of colours detailed with BS.381C or BS.4800 by the Engineer/Contract Administrator, at the time of submission of the manufacturer's drawings.

All screws, bolts, nuts and washers shall be rustproof.

Busbars and connections shall be of high conductivity copper, of the minimum current carrying capacity indicated on the drawings and have a neutral of the same cross sectional area as a phase conductor.

Connection between adjacent lengths of busbars shall be by a mechanical means approved by the Manufacturer.

The bars shall be provided with the Manufacturer's recommended means of taking up the maximum expansion and contraction likely to occur to the bars under the installed conditions.

The busbars shall be supported and anchored by suitable high grade non-hygroscopic and non-tracking insulation material.

Phase colours shall be clearly marked and the sequence maintained throughout.

Connections to busbars for outgoing circuits shall be made by means of bolted type brass clamps screwed to the bars; drilling of busbars will not be permitted.

Where the rising busbar systems pass through floors or walls a barrier of fire resisting material shall be incorporated in the trunking at each point to prevent the spread of fire.

Insulated sleeves shall be fitted to the busbars as they pass through fire barriers to reduce the risk of flash-overs caused by dust and other deposits on top of the fire barrier.

A copper tape, nominally 25 x 6mm, shall be installed externally for the full length of the busbar trunking.

The tape shall be bonded to each section at intervals not exceeding 1200mm, by means of brass bolts, washers and lock nuts and connected to the main earthing conductor.

## **2.06 LOW VOLTAGE BUSBAR TRUNKING SYSTEM.DOC**

### **Protection Devices**

The busbar system shall unless stated otherwise in later sections of this specification or shown on the drawings have a rated short time withstand classification of Class 3 for a supply voltage of 415V AC. between phases at 50Hz.

Protection against shock in normal service shall be achieved by the provision of barriers or enclosures, or by complete insulation of all live parts.

Continuity of the protective circuits shall be ensured at all times.

Facilities shall be provided at the supply connection for the feeder unit which shall be provided with an integral switch complying with the appropriate section of this specification.

Labels shall be provided complying with the clause in this specification headed "Labelling".

## 2.07 EXTERNAL UNDERGROUND CABLES.DOC

### General

Unless otherwise indicated external cables shall be installed underground. Cable trenches shall be excavated to a depths indicated in the table below. The Contractor shall be responsible for the bedding and initial covering of the cable(s) and installing and supplying the warning tiles and marker posts, also for marking out the cable route and generally supervising all work in connection with the cable laying requirements. Back-filling and reinstatement of trenches will be carried out by the Contractor.

This specification must be read in conjunction with “Guidelines for Building Sites and the Landscaped Environment” appended to this specification in Part 2.

### Installation of Underground Cables External to Buildings

#### 1 Excavation and Re-instatement

The location, depth and marking of existing cables and services on the route of new cable routes shall be carried out by the Main Contractor in conjunction with the Architects’ drawing showing approximate positions, unless other methods are determined by the CA. The location and depths of existing cables and services shall be hand dug before any mechanical excavation work commences.

.2 The Main contractor shall be responsible for the excavation and re-instatement of cable tracks and in addition the undernoted works subject to relevant contract documents:-

- a) The provision of Heavy Duty Polythene sheeting on all lawns and mown areas to enable all excavated soil to be stacked thereon.
- b) The careful removal and preservation of all turf. the topsoil shall bekept separate from the sub-soil and all materials shall be maintained in good condition until reinstatement is complete.
- c) The reporting, and repair if broken, of any land drains, ducts and culverts located or disturbed by the works.
- d) Any shoring, pumping or de-watering necessitated by the works.
- e) The opening up of roads, existing clusters, as required by the works.
- f) The accurate “Bottoming Up” to correct line and level of all excavations and the removal of all ‘Hard Spots’, sharp stones and foreign material there from prior to sand carpeting.
- g) The provision of a 60mm. pit sand carpet, and laying thereof below all power cable tracks, and subsequent cable laying, the provision of a further 60mm. pit sand carpet overlay.
- h) The laying of cable tiles or tapes:-
  - (h1) Extra low voltage and low voltage single phase cables and Street Lighting cables up to a conductor size of 4mm<sup>2</sup> shall be covered with approved cable marking tape positioned 200mm. above the pit sand overlay.
  - (h2) All other low voltage single and three phase cables shall be covered with approved burnt clay tiles about the pit sand overlay throughout and each tile shall bear the legend ‘ELECTRICITY’ in 25mm high deeply indented characters.
  - (h3) All high voltage cables shall be covered with pre-cast concrete tiles above the pit sand overlay throughout, and each tile shall bear the legend “H.V.ELECTRICITY in 25mm high deeply indented characters.
  - (h4) Tiles may be of 150mm, 225mm or 300mm width, and shall be of width sufficient to overlap the cable (or the outermost cables in multiple runs) by 50mm at each side. See Clause 3 in respect to spacing of underground cables.
- (j) The subsequent reinstatement of ground in 200mm. Lifts each consolidated and rammed, evenly in layers, sub-soil first, with final reinstatement of top soil and re-laying of turf, or

## 2.07 EXTERNAL UNDERGROUND CABLES.DOC

hardcore under-based for footpaths and prompt removal of all surplus material. The turf shall be left slightly proud of the surrounding area to allow for settling.

- (k) The prompt repair and rectification of all subsequent settlement.

Particular attention shall be paid to the reinstatement of footpaths and roads. Duct crossings shall be laid on an under-bed of lean mix concrete not less than 150mm. deep, and shall be encased in lean mix to a total depth of 250mm after laying. Reinstatement of hardcore, blinding, or base material shall not be inferior to the original road or footpath construction. Ramming and consolidation must be thorough, and the surface shall be temporarily reinstated in Cold Asphalt or similar topping pending final reinstatement after consolidation under traffic.

### 3 Depth and Spacing of Underground Cables (i.e. Distances between surfaces)

The standard depth of cables below lowest points of eventual finished surface level shall be:-

3.1	High voltage cables in open ground	1.0m to top
3.2	Extra low voltage and low voltage cables in open ground	0.75m to top
3.3	Street lighting cables	0.45m to top
3.4	Duct clusters below roads, paths or car parks	0.7m to top of top row

All cables to be spaced as far as practical from other cables/services. Multiple runs of extra low voltage or low voltage cables which follow the same tract in open ground shall be not less than 200mm. or 4 diameters apart (whichever is greater). High voltage cables shall be run not less than 300mm. clear of each other, and of any other service.

#### 4.14 Laying Techniques - Distribution Cables

- 4.1 All cables shall be ordered from site measurements after cable tracks have been defined, and the position of any intermediate joints in long cables shall be agreed with the CA before such site dimensions are taken, all such intermediate joints being located in accessible positions. Intermediate joints will be permitted only when the route length of any cable exceeds the practicable reel length.
- 4.2 Cables shall be delivered direct to site from manufacturers works, with drum laggings intact, fully documented to b.S.6480/B.S.6346 and shall be ramped off or craned off delivery vehicles. P.I.L.C. cable ends as received shall be plumb capped and stamped "A" or "Z" to define core rotation, and shall be re-capped and stamped IMMEDIATELY ANY cut is made. P.V.C.S.W.A.P.V.C. cable ends shall be adequately protected.
- 4.3 All cables comprising a single circuit shall be laid in the same sense throughout, jointed "A" to "Z" to eliminate crosses at joints, and shall be jointed number to number at all intermediate joints. All cables shall be jointed colour true throughout, according to the standard University convention.
- 4.4 Cable scheduled for laying shall be maintained at an ambient temperature not less than 5° C for not less than 48 hours prior to commencement of laying, which shall be completed as a continuous operation. Laying shall not be commenced at any time when the ambient temperature is below 3° C. All cable clusters shall be de-watered, rodded and cleaned before cables are drawn in, care being taken to ensure that no gravel or stones are entrained in clusters when drawing. Trench profiles are to be adjusted at cluster entrances to ensure a compact bed for the cable without excessive bending or stressing.
- 4.5 The Electrical Contractor shall maintain on site during laying adequate manpower and equipment, including cable rollers reel jacks, fenders and packs to ensure that cables are laid in without kinking, abnormal bending, reverse bending or other abnormal stresses. The use of power winches will be



## 2.07 EXTERNAL UNDERGROUND CABLES.DOC

permitted, but no winch employed for the purpose shall be capable of a draw exceeding 1,500 kg. weight. The use of tracked or wheel vehicles will not be permitted for drawing in, and draw in tension shall be limited to 93 kgf/cm<sup>2</sup> of lead alloy sheath in all cases.

- 4.6 Rope attachments by close hitches or similar shall not be used, stockings will normally be insisted upon for drawing in. Where, exceptionally, permission is granted to use conductor cores for drawing in, all conductors shall be fitted with lugs, and all shall be utilised. Immediately on completion of drawing in by this means a minimum length of 30 diameters of complete cable shall be cut back to waste, and the cut end shall be plumb wiped and identified "A" or "Z". P.V.C.S.W.A.P.V.C. cable ends shall be adequately protected.
- 4.7 Cable drums shall be located as close to the excavation as possible whilst laying is proceeding, and the cable shall be laid off from the top of the drum which is to be restrained as necessary to keep the coils tight. The minimum permissible bending radius for all cables during laying, fixing and terminating expressed as a function of the overall diameter of the cable shall be as detailed on the following page:-
- |     |                    |                                     |
|-----|--------------------|-------------------------------------|
| (a) | During Laying      | - 3 diameters                       |
| (b) | Fixed in Track     | - 18 diameters                      |
| (c) | Final Terminations | - as Table 52C of I.E.E Regulations |

Cable unavoidably laid off in figure eight formation during laying shall be stowed with minimum bending radius of 60 diameters, with packers between flakes to prevent excessive stress or flexing where the rounds cross.

Substantial barriers and tapes with warning notices shall be provided to all open excavations, obstructions or as otherwise necessary to prevent danger. Excavations across paths and roads shall be plated to allow pedestrians and/or traffic to pass safely.

**NOTE** The Electrical Contractor shall inform the University Security Office whenever excavations or cable laying are to take place.

### 5 Cable Jointing

#### 5.1 P.I.L.C.S.W.A. Cable

Cable jointing shall be carried out by specialist sub-contractors. Each jointer shall be approved by name, and the utilisation of casual jointer labour will not be permitted.

#### 5.2 P.V.C.S.W.A.P.V.C. Cable

Cable jointing shall be carried out using approved cold junction jointing kits, appropriate to the size of cable.

All cable jointing shall be carried out in clean and weatherproof conditions, and the Electrical Contractor shall maintain on site at all times when jointing is scheduled to be carried out, regardless of weather conditions, a full range of tools, weatherproofing, and waterproof sheeting, artificial lighting and heating equipment and the usual range of hand tools and stores.

### 6 Distribution Cable Supports

Cables laid in trenches will be supported throughout by the sand underlay, and no further support is needed.

Cable laid in switchgear ducts may be laid on the floor of the duct.

Cables in service ducts, within duct risers, or elsewhere within, or attached to the surface of buildings shall be carried on galvanised steel perforated tray shelves continuously earthed, or rigidly supported by the fabric of the

## 2.07 EXTERNAL UNDERGROUND CABLES.DOC

building on purpose made silicon aluminium cable cleats. Tray support shall be spaced at no greater centres than 800mm and the total load imposed at any support shall not exceed 150 kg weight.

Cleated supports shall be provided at the undernoted maximum centres.

Vertical Runs	-	25 overall cable diameters
Horizontal Runs	-	15 overall cable diameters

Additional cleats or supports shall be provided close to all terminations and joints to relieve joints of extraneous stresses.

Unless otherwise specified twin or multiple cable groups within buildings shall be subject to a minimum spacing (i.e. distances between surfaces) of two cable diameters or 75mm (whichever is the greater) between cables and 25mm from building fabric. The effects of installation methods on cable ratings must be strictly observed as per Appendix 4 to the 16th Edition and Amendments of IEE Regulations. Clauses 2.7, 2.10.3 and 2.10.5 hereof also refer.

### 7 Distribution Cable Identification

At each cable termination and intermediate joint a soft copper identity label of 30mm x 3mm x length required, shall be bolted to an armour clamp and shall bear in 6mm stamped letters, the relative operating voltage, conductor size and material and circuit description (e.g. 415v, 150mm<sup>2</sup>, Cu., 2x2 S.S to 2Y2 Bldg.) or details as otherwise specified.

### 8 Cable Track Markers

8.1 Pre-cast reinforced concrete cable marker posts sized 750mm high x 150mm wide x 75mm thick, with club foot, marked with LV cable or HV cable as appropriate, shall be provided and erected under this contract at the undernoted positions:-

1. At each major change of direction in open ground (but not in paved areas)
2. At each cable joint
3. At intervals not exceeding 150m on long straight runs

### 9 Earthing of Cable Installations

The provisions of comprehensive earthing arrangements is implicit in the contract and shall conform to the whole of the requirements of the 16th Edition and Amendments of the IEE Regulations.

### 10 Duct Sealing after installation of Cables

The cable contractor shall take appropriate action to seal all duct entries to building against the ingress of ground water. The contractor may use approved seals for this purpose, or other approved method.

### 11 Distribution Cable Testing

Following completion of all cable jointing, testing and supply to the CA of test Certificates shall be carried out, all in accordance with BS6480/BS6346 and as otherwise specified or agreed by the CA. This testing shall precede testing under 5.2 hereof.

All necessary safety precautions shall be taken immediately prior to testing, by inspection, the erection of suitable barriers and warning notices (to be removed immediately on completion of testing), warning of all staff concerned, etc.

## 2.07 EXTERNAL UNDERGROUND CABLES.DOC

The testing shall be arranged with and witnessed by the CA to his entire discretion and satisfaction and shall include:-

1. Over-voltage pressure test to applicable sections of BS6480/BS6346.
2. Phasing out test at low voltage at all points of interconnection with existing installations to confirm colour truth, phase sequence, and ability to parallel with all relating circuits before the circuits are closed.

All high voltage cables shall be tested by specialist testing contractors, approved cable manufacturers, or the Electricity Boards, and their test certificate shall be handed over to the CA before the circuits are energised.

The Cable Contractor shall bear all expenses arising out of testing or subsequent testing consequent upon defective work.

### 12 Modification of Existing Cable Installations

The safety procedure to be followed in making modification to existing power cable installations is outlined as follows:-

- 12.1 All switching operations in connection with the modification or extension of existing University installations will be carried out under the supervision of the CA.

The Electrical Contractor will be permitted to carry out switching operations only in the undernoted circumstances:-

- 12.1 All switching operations in connection with the modification or extension of existing University installations will be carried out under the supervision of the CA.

The Electrical Contractor will be permitted to carry out switching operations only in the undernoted circumstances:-

- 12.1.1 To energise and de-energise temporary installations, i.e. site mains.

- 12.1.2 By arrangement with the CA, switching for the purpose of phasing out, testing, and proving installations or parts of installations prior to official test and official handover.

- 12.1.3 IN EMERGENCY switching to isolate supplies in order to limit damage or save life.

The energising of installations under 4.22.1.2 hereof shall be confined to the minimum period necessary for the work in question to be carried out, and a competent representative of the Electrical Contractor shall be present at all times when such phasing out, testing or proving is in progress.

The CA shall be advised immediately of any switching carried out under 12.1.3 hereof.

### 12.2 High Voltage Areas

Works of whatever nature carried out in high voltage areas shall be carried out under a rigid 'Permit to Work' procedure. Access by operatives of the Electrical Contractor to high voltage areas will not be permitted until the requisite Permits have been issued to, and countersigned by, the Authorised Representative of the Electrical Contractor, who will, therefore, be responsible, during the currency of the 'Permit to Work' for all supervision and safety of the works and areas covered thereby.

Operatives who are employed by the Electrical Contractor in high voltage areas, shall be specially experienced and fully briefed by the Electrical Contractor or his Authorised Representative on the scope and the safety aspects of the proposed works before operations are commenced.

## 2.07 EXTERNAL UNDERGROUND CABLES.DOC

The Authorised Representative of the Electrical Contractor employed in high voltage areas shall be of Technician Electrician or superior grade.

Works involving access to, extension, modification, or connection to components normally energised at high voltage shall not be commenced until the apparatus in question has been isolated from the supply, locked off, and earthed down in the presence of the Authorised Representative by the CA and a signed and countersigned Permit issued. The Authorised Representative shall not countersign or receive any 'Permit to Work' until such operations have been completed in his presence.

A copy of the 'Permit to Work' shall remain prominently displayed within the high voltage area throughout the currency of the works.

### 12.3 Cable Works on Open Sites

Cable Works involving existing installations on open sites shall be regarded as 'high voltage areas' for the purposes of the contract, and will be subject to the permit to work procedure outlined in 12.2 hereof.

The Electrical Contractor shall not attempt to disconnect or cut, any cable, irrespective of voltage rating until such cable has been positively identified by the CA and spiked or otherwise satisfactorily earthed in the presence of the Electrical Contractor's representative.

12.4 Immediately on hand-over of existing cable installations to the Electrical Contractor for modification, the Electrical Contractor shall carry out insulation, continuity, and phase identification tests to any part of the installation proposed to be re-used so as to verify the condition of the existing installation before modifications are made.

All such tests shall be carried out in the presence of the CA and written records of results in duplicate shall be made at site and submitted to the CA for record purposes.

The Electrical Contractor shall ensure that no deterioration shall occur to existing installation arising out of the progress of his works, and in the event of such deterioration or damage, this shall be made good at his own expense.

## 13 Liaison with the Grounds Section

Prior to commencement of any excavation works the Grounds Section must be contacted as follows:

Head of Grounds & Environment: M Nock tel 0118 931 8312  
Grounds Officer : P Brierley tel 0118 931 6740

Grounds staff shall be consulted at the commencement of buildings works, with reference to site stripping, top soil heaps, and tree protection and again when excavation is taking place in proximity to trees. Grounds staff may also wish to make periodic visits to inspect tree protection during the contract period.

## 14 Services Depths

Services shall be laid in accordance with the University's Standard Technical Specification (q.v). Generally minimum cover for new services will be as set out below, but reference MUST be made to the Estates and Buildings Department's Services CAs.

	<u>Minimum Cover</u>
Water Mains/Fire Mains	800mm
Electricity	
HV Cable in open ground	1100mm
ELV & LV in open ground	750mm
Street Lighting	450mm
Duct Cluster below roads, paths or car park	700mm

## 2.07 EXTERNAL UNDERGROUND CABLES.DOC

Gas Main	in open ground beneath roads	550mm
	beneath roads	700mm

### 15 Cables Laid Direct in the Ground

Where cables are laid direct in the ground, they shall be laid on not less than 75mm of soft sand, covered by a further 75mm of soft sand and protected by means of standard interlocking cable cover tiles. Each tile shall be marked "Electric" on the top side and the width of the tile shall overlap cable(s) by 50mm.

A heavy duty yellow plastic warning tape with continuous **BLACK** lettered legend "**CAUTION BURIED ELECTRIC CABLE**" shall be continuously installed above each cable route at 150mm below finished ground level.

Marker posts shall be of pre-cast reinforced concrete units, fitted with lead insert labels indicating the size of cable installed, distance, depth, reference number etc. These posts shall be positioned along the cable route and in all cases where there is a change in direction or joint. The proposed locations are to be shown on the Electrical Contractors installation drawings for prior agreement with the CA/Contract Administrator.

Where the cables pass under roadways etc., they are to be installed through cable ducts set in lean mix concrete provided and installed by the Electrical Contractor.

### 16 External Pipe Ducts for Electrical Services Generally.

Glazed earthenware ducts shall be used for all main cable routes.

Sizes to be used shall be 100, 150, 225mm all of standard crushing strength (20kN/m).

Bends, fittings and collars shall all be from the same manufacturer's range.

Socket or sleeve type joints are acceptable.

Entries to drawpits and buildings shall use bellmouths.

#### **PVC Pipe Ducts used for Secondary Electrical Services (Security, Communications & Small Power)**

Small bore electrical service ducts less than 100mm diameter may, where indicated on the drawings, be formed using PVC pipes.

These ducts shall not normally run deeper than 1500mm below finished ground level.

Pipes shall be unplasticised PVC or Class C (BS 3506; 1969).

#### **(a) Deep Level Penetration to Building Structure**

Deep level penetrations are defined as penetrations below the highest probable level of the water table in the vicinity of the penetration.

Duct entries shall be fully formed with proprietary puddle flanges.

Electrical services ducts shall be formed using heavy duty PVC pressure bearing pipework of appropriate diameter fully jointed/sealed as far as the first external drawpit to the penetration.

#### **(b) Drawpits & Covers**

Drawpits shall be arranged generally with the following features except where specifically shown on the drawings and schedules.

- Fully opening lids.

## 2.07 EXTERNAL UNDERGROUND CABLES.DOC

- Class M.
- Waterproof cover seal.
- Step irons to BS 1247 (hot dip galvanised).
- Cable hauling lug.
- Ducts with bellmouths.
- External waterproofing of walls.
- Construction in concrete (or CAing brickwork for specified small pits).
- Security detection for lifting of lids.
- Drawpit identification plaque.

Drawpit covers shall be of cast iron cellular construction with machined faces for fully waterproof service or of galvanised steel construction capable of accepting paving to match the surrounding area/landscape details.

The Electrical Contractor shall supply a complete set of lifting equipment suitable for the covers supplied.

All unused duct entries shall be fully sealed utilising solid or split hardwood plugs.

### 17 Trenching for Electrical Ducts

Pipe ducts shall be laid in the configuration specified in a clean sand bed not less than 100mm deep. After laying further sand shall be laid to a depth of 75mm over the pipes and consolidated, further layers, of earth backfill 250mm deep, shall be provided and consolidated.

Marker tape shall be laid over each duct across the full width of the excavation, 300mm below the finished surface.

Road crossings shall be carried out with the ducts being bedded and covered in lean mix concrete to a minimum covering of 100mm in all directions.

Filling of trenches, excavation and other works shall be carried out by one of the following methods at the discretion of, and to the satisfaction of, the CA.

Where the fill will be loaded at an early date (i.e. trenches under roads) or where consolidation is not permissible, concrete grade C10/20 shall be used. The extent of this work will be decided by the CA or his representative.

Where the fill will be loaded at a later stage in the work, hard core or broken stone, as instructed by the CA or his representative shall be used, well packed and rammed, or rolled if area permits, in 250mm layers after strutting and other temporary works have been removed.

All other filling of trenches and similar works not subject to loading shall consist of suitable excavated material, well rammed in 250mm layers after strutting and other temporary works have been removed.

Where backfilling is to be carried out over exposed or haunched underground pipes, only selected and approved material free of large lumps, bricks or the like shall be placed, by hand, over and/or round the pipe to a depth of 300mm (minimum) in layers of 150mm. It shall be carefully packed to fill all voids, and hand tampered. The remainder of the trench shall be filled in layers not exceeding 250mm and carefully consolidated.

### 18 Protection of Trees

The University Tree Team will inspect, dead wood and carry out a necessary tree work before building starts. Prior to any works starting on site, all retained trees will be securely fenced by the Grounds Department at the expense of the project. The fence shall extend at least to the tree's drip line using 1.2m chespile on posts at 2m centres. The enclosed area will remain in the ownership of the University and Electrical Contractors must gain the approval of the Grounds Department, through the Estates and Buildings Department, before gaining access for any reason. The fences must remain in place until removed by arrangement with the Grounds Department, and are to be maintained by the Main Contractor throughout the contract to the satisfaction of the Grounds Department, through the contract administrator.

## 2.07 EXTERNAL UNDERGROUND CABLES.DOC

No excavations of any sort may be carried out within the drip line of retained trees. Should the contractor be required to do so by the client any digging shall be carried out by hand with no root thicker than 25mm being cut. The Grounds Department will advise on the route of the excavation through the drip line and will be available to supervise the dig. At no time shall any tree roots be left uncovered or be allowed to dry out. Should excavations have to remain open for some time, they must be back filled with compost to retain moisture.

No materials may be stored under tree canopies or in such close proximity that they will cause harm to the root zone or canopy, e.g. diesel storage or wash out from cement mixers. Surplus soil must not be stock piled within the tree canopy.

No fires to be lit on site.

Retained trees must not be pruned or mechanically damaged by the contractor or his agents.

No machinery is to be operated within the canopy of any tree.

There must be no compaction by traffic on the root zone of trees.

There must be no lowering or raising of soil levels around the tree without consent from the Grounds Department.

The Grounds Department shall have reasonable access to the site at all times, by arrangement through the contract administrator.

### 19 Top Soil

*(This section is to be read in association with the particular requirements of the project specification, section D20 Excavating and Filling).*

Topsoil shall be stripped from the whole working site to an agreed depth and hauled to suitable agreed storage areas. Contracts shall allow for a provisional depth of 300mm.

Soil is to be stacked in heaps not exceeding 2m high with sides battered to 45°. away from the working area. Sides to be neatly battered at 45°.

The contractor shall keep top soil heaps free of all weed growth by spraying, using a Glyphosate based herbicide only.

### Sub soil preparation

Areas for topsoiling are to be cleared of all building materials, temporary paths and roadways or other debris.

Any contaminated sub-soil shall be removed from site and replaced with clean subsoil.

Subsoil shall be graded to accepted falls and contours leaving space for 450mm topsoil in planted areas and 150mm in grassed areas.

Prepared subsoil shall be ripped to a depth of 300mm at 500mm centres to relieve any compaction.

All subsoil preparation must be inspected and approved by a representative of the Grounds Department prior to any topsoil being placed.

### Topsoiling

A sample load of 10 tonne (minimum) topsoil shall be offered for approval and retained on site for comparison. Topsoil is to be placed graded to levels and lightly consolidated to a depth of 150mm for grass area and 450mm for planted areas.

All finished soil levels must stand at least 25mm proud of kerbs, inspection covers and other hard surfaces.

Soil levels shall be married to those around retained trees. Any such work must be carried out under the supervision of the Grounds Department.

All cables and other services must be laid to a minimum of 300mm below soil or grass levels, but reference must be made to the specific service requirements.

Soil contaminated by oil based products or any other materials toxic to plant life must be removed from site and disposed of correctly.

No tracking over placed topsoil will be allowed.

No materials are to be stored or placed on finished topsoil levels.

### 20 Excavations in Grassed an Landscaped areas

Before ANY excavation is authorised or ordered prior consultation with the Grounds Department must take place.

The line of excavation, location of trial pits etc., are to be agreed with Grounds Department, and advice sought in proximity to trees.

Excavated material shall be stored on polythene sheets, and not directly on to grass.

## **2.07 EXTERNAL UNDERGROUND CABLES.DOC**

All spoil shall be removed from site after backfilling.

The standard or reinstatement shall be to the satisfaction of Grounds Department.

Contractor's vehicles are generally NOT allowed on grass areas and then ONLY by prior agreement with the Grounds Department. All ruts and damage to grass shall be made good by the contractor, or reinstated by the Grounds Department (by arrangement), for which a charge will be made.

### **21 Paths**

Finished path level must be below adjacent grass level.

Turf must be reinstated back to path line, where path is cut through grassed area.

### **22 Road Crossings**

All reinstatement on University land shall be carried out in strict accordance with the "Specification for Reinstatement of Openings in Highways" issued by HM Stationery Office publication ISBN: 011551143.1.1992 encompassing the New Roads and Street Act 1991

The Contractor must fully comply with all aspects of safety regarding barriers and safety lighting during the hours of darkness associated with open trenches. Where necessary the Contractor must provide temporary traffic lights in areas where ducts cross road.

At Road Crossings ducts shall be installed on the halfway principle with adequate allowance made to allow the passage of the largest standard vehicle. The contractor shall liaise with the University Security Office before any roadway or footpath is partially closed. Under no condition must work commence on any road crossing until permission from the above has been obtained.

Due to the nature of the work it may not be possible to give a continuous run of duct, therefore the Contractor must allow in his tender to move ahead of certain works and make road crossings at off peak traffic flow times.



## 2.08 MAIN AND SUB-MAIN CABLING.DOC

### General

In the absence of specific details in subsequent clauses of this specification all cables shall have copper conductors.

The name of the cable manufacturer whose cables have been included for in the tender shall be stated either on the Form of Tender or in a covering letter, and the maker's test certificate shall be submitted to the Engineer before the cables are installed.

All cable runs shall be approved before installation is commenced and the cables shall be installed in strict accordance with the manufacturers instructions and the current British Standard.

Each size of cable shall be manufactured and supplied in one length on a suitable drum; no through joints will be allowed. At each and every cable end supply and fix a non ferrous label engraved with cable size, number of cores and termination point of opposite end. The preferred standard sizes of cable used within the University are as follows:

<u>High Voltage (Paper)</u>	<u>Aluminium Conductors</u>	<u>Copper Conductors</u>
(1) Transformer Connections	70 mm <sup>2</sup>	50 mm <sup>2</sup>
(2) Other H.V. Cables	185 mm <sup>2</sup>	120 mm <sup>2</sup>

Paper insulated power cables shall not be used on 415 volt systems except where specifically called for.

Where the cables enter/leave the buildings and/or cable trench a pipe duct shall be provided. Include for sealing the pipe ducts with purpose made plugs, suitable tape and compound, against the ingress of water. The general arrangement of pipe ducts and cable trenches are indicated on the drawings.

### High Voltage XLPE Insulated Armoured Cables

Cables shall be 8700/15000 Volt grade to IEC 502 with an external PVC sheath coloured RED.

Cables shall have a minimum cross section of 95mm<sup>2</sup> and copper conductors unless otherwise indicated in later sections of the specification or on the drawings.

No more than one cable shall be drawn into a pipe duct, and the minimum diameter for pipe ducts for HV cables shall be 150mm.

A minimum separation of 300mm shall be maintained from all other pipes or cable services.

### Low Voltage PVC and XLPE Insulated Armoured Cables (Copper Conductors)

All cables shall be of 600/1000 volt grade and manufactured to the current British Standard.

XLPE/SWA/PVC cables shall be XLPE insulated plain annealed copper conductors with extruded PVC bedding, single wire armour and extruded PVC sheath overall.

XLPE/SWA/LSF cables shall be XLPE insulated plain annealed copper conductors, with extruded LSF bedding, single wire armour and extruded LSF sheath overall.

XLPE/PVC and XLPE/LSF cables shall be as above without the armouring.

During installation, cables shall not be bent to a radius smaller than that recommended by the cable manufacturers and ambient temperatures shall be greater than 0°C and shall have been so for the previous twenty-four hours.

## **2.08 MAIN AND SUB-MAIN CABLING.DOC**

Where cables are pulled into pipe ducts, the entry to the duct shall be adequately protected (with a cloth or rag) to avoid damage to the cable sheath.

### **Paper Insulated and Armoured Cables**

Paper insulated copper conductor(s), lead covered, bedded, single wire armoured and served overall cables (abbreviated PILCSWA & S), shall be of the mass impregnated, non-draining type with full sized neutral, to BS 6480. The cable voltage grades required for the installation shall be as relevant clauses of this specification.

Where possible, all cores of paper insulated cables shall be taken direct to the bus-bar or terminals, and sweated solid, from below the surface of the compound, to the terminals. All cable tails shall be taped, with double lapped cambric bias cut Empire Tape, and after taping, all cores shall be treated with two coats of first grade insulating varnish.

Generally the cables shall be terminated and jointed by compression method using accessories and equipment (including compression tools and dies) recommended by the cable manufacturer. For all bi-metallic connections, the Sub-Contractor shall use "Densel" jointing compound between the interface contact surfaces.

During installation, cables shall not be bent to a radius smaller than eight times the overall diameter and ambient temperatures shall be greater than "0" degrees centigrade and shall have been so for the previous 24 hours.

Where cables are pulled into pipe ducts, the entry to the duct shall be adequately protected (with a cloth or rag) to avoid damage to the cable sheath.

Where installed in ducts, the cables shall be at least 25mm clear of walls on either galvanised mild steel tray or racks with claw type clamps at distances not greater than two metres. Where the cable emerges from a duct or trench vertically a length of suitable size high impact PVC conduit fitted with ring bushes at each end shall be threaded over the cable to protect the cable from below floor level to the base of the wiping gland, or be so positioned as to be protected from mechanical damage.

### **Cable Boxes**

#### **(a) PILC/SWA Cables**

In all cases where paper insulated cables are used, include for the installation of cable and boxes, complete with wiping glands, clamp and bituminous tropical sealing compound.

The boxes shall provide efficient means of sealing the paper insulation against the ingress of moisture, and shall be of the flanged pattern for direct attachment to the switchgear to which the cable runs or directly to the unit from which the cables originates. The lead sheath of the cable shall be well plumbed to the sealing box brass glands, with "plumbers" metal and the armouring shall be neatly splayed over the plumbing and held rigid by the armour clamps. Provide written confirmation that the jointer employed is fully competent to carry out the work.

Insulating sleeving is to be fitted over the conductor cores which shall be connected directly to the terminals of the equipment.

#### **(b) XLPE/SWA/PVC or LSF Cables**

Where XLPE armoured cables are to terminate at switchgear and apparatus they shall be made with compression type glands that conform to the current British Standard. The glands shall provide effective earth continuity from the steel wire armour to the gland body. The glands shall provide effective moisture seal and shall be complete with a shroud. All cable sockets shall suit the size of conductor and shall be hydraulically crimped to the conductor using a procedure approved by the Cable Manufacturer. Earth lugs shall be provided with all glands and an earthing lead fitted which shall be not less than 50% of the cross-sectional area of the phase conductor.

### **General - Terminations**

## **2.08 MAIN AND SUB-MAIN CABLING.DOC**

The Contractor shall include for all fittings and accessories required to complete the termination.

In certain circumstances the cable size shown on the drawings, may, to accommodate volt drop, starting current, fault levels and the like, be larger than that which will fit easily into the point of termination. Under these circumstances the Contractor shall include for, and provide suitable provisions to accept and connect the conductor, its sheath/armouring/gland and/or protection.

This is to include the use of any, or all, of the following - larger enclosure, larger terminals or components, special lugs or adaptors, extension boxes, final connections in reduced conductor size (but not below the protective rating value) from a fixed connector unit, oversized switchgear, etc.

In the event of the specific details of any adaption not being shown, confirm to the Engineer/Contract Administrator the intended method of carrying out the work.

### **Cable Cleats**

Cable cleats shall be of the hook and clamps type consisting of two dissimilar halves made of reinforced nylon. The support system shall comprise a support channel into which the hook and clamps section are secured, either by slotting into channel for horizontal mounting or by single bolt fixing for vertical mounting. The units shall be of the appropriate size for the cables.

Fixing centres shall be in accordance with the cable manufacturers recommendations and current codes of Practice.

### **Cable Sockets**

Where cable lug terminals or sweating sockets are employed, they must be of the correct bore to suit the cable which they are intended to connect. The cables must be a good fit in the sockets and the filling of surplus spaces with solder will not be permitted.

All soft-solder used in connection with the installation on site, is to be in accordance with the appropriate British Standard.

### **Cable Identification**

All main and sub-main cables shall be identified at their points of termination and along their routes at minimum of 5 metre centres.

Additionally where cables change direction or pass through walls, floors, ceilings, etc, an identification label shall be provided.

The label shall be fixed securely to the cable outer sheathing and shall contain the following information;-

- cable reference number
- origin of cable
- destination of cables
- cable type, number of cores and CSA in mm<sup>2</sup>.

### **Cable Tiles and Markers and Supports for Power Cables**

Cable tiles shall be of burnt clay or pre-cast concrete throughout, and each tile shall bear the legend "Electricity" in 25mm. high deeply indented characters.

Tiles may be of 150mm. 225mm., or 300mm, width, and shall be of width sufficient to oversail the cable (or the outermost cables in multiple runs) by 50mm, at each side.

Where cable tracks exceed 300mm. wide, tiles may be butted together to give overall protection.

## **2.08 MAIN AND SUB-MAIN CABLING.DOC**

Yellow P.V.C. marker tape may be used for marking street lighting cables and shall bear the words “CAUTION ELECTRIC CABLES”.

Track markers shall be of reinforced concrete 750mm. high 150mm. wide x 75mm. thick, with club foot, marked M.V. Cable or H.V. Cable as appropriate.

Cable supports shall be of die cast silicon aluminium alloy with backplates and Redhead fixing attachments. Cable laid on tray shall be located in position with insulated ties of proprietary pattern.

## 2.09 MINERAL INSULATED COPPER COVERED CABLES.DOC

### General

All MICC cables for general lighting and power wiring purposes cables shall be 600-volt grade (Light Duty). For all applications of sectional area exceeding 4mm<sup>2</sup> cables shall be 1000v. (Heavy Duty), and, unless otherwise specified, shall be LSF sheathed overall.

Light duty MI cable rated at 600 volt can be used for lighting circuits, small single phase power circuits and where specified.

MI cable shall not be used on discharge lighting circuits unless suitable precautions are taken to avoid excessive voltage surges.

Heavy duty MI cable rated at 1000V shall be used on all 415 volt circuits

The minimum internal bending radius of all MI cables shall be 6 diameters.

The Electrical Contractor shall ensure that at all times during which MI cable laying is proceeding, a full range of specialist tools are maintained and used on site. All stock coils of cable shall be kept neatly coiled pending use, and cables shall be run into position direct coils, straightened and clipped as a single operation.

In order to maintain consistency, MICC cable sheaths shall be coloured as below: -

RED	-	FIRE ALARM SYSTEMS
WHITE	-	EMERGENCY LTG SYSTEMS
BLACK	-	BMS SYSTEMS
ORANGE	-	ALL LV LIGHTING AND POWER APPLICATIONS
UNSERVED	-	RESERVED FOR SPECIAL USES (as detailed in the particular specification)

When MICC/LSF cables are used, LSF shrouds over glands shall be provided. Before applying a shroud all bare metal shall be wrapped with pressure sensitive adhesive tape.

Where connections are to be made to bus bars, etc., cone grip connecting lugs shall be used.

The recommendations of the manufacturer of the cable as described in their installation handbook shall be strictly observed.

The ends of all MICC cable shall be taken into earthed enclosures. No type of unfixed connector shall be used.

All MICC cable tails shall be clearly marked indicating the phase colour to which they are connected.

MICC cable routes exceeding the maximum manufacturing length obtainable may be through jointed, at locations agreed with the Engineer/Contract Administrator.

Such joints shall comprise:-

The manufacturers proprietary joint unit

### OR

A suitable sized adaptable box complete with the correct quantity of fixed base terminals.

### Fixings

## 2.09 MINERAL INSULATED COPPER COVERED CABLES.DOC

All MICC cables mounted direct to building surfaces shall be fixed by suitable clips approved by the cable manufacturer. Fixing centres shall be:-

- 400mm centres on vertical runs.
- 200mm centres on horizontal runs.
- 200mm from each side of any bend or set.

PVC covered copper 2 hole saddles shall be used for the fixing of all MI cables. Spacer bar PVC covered saddles may be used. Not more than 3 cables shall be supported by any one spacer bar saddle. Fixings for saddles shall be brass or other approved non-ferrous alloy..

All fixings for MICC cables shall be copper clips or saddles. All fixings for MICC/LSF cables shall be of the insulated pattern.

Where cable tray is specified for mounting unsheathed MICC cables, the tray shall be resin or PVC coated to prevent direct contact between the outer copper sheath and the tray metalwork.

The cable tray installation shall be as detailed in following clauses of this specification.

Cables installed on tray shall be laid in a single tier unless otherwise agreed with the Engineer/Contract Administrator, secured by copper, or PVC coated copper saddles, as appropriate, at a maximum of 600mm centres.

Plastic cable ties shall **not** be used.

### Terminations

Each length of cable shall be sealed at both ends with a screw-on pot type seal, cold plastic compound cap, anchor beads and neoprene sleeving, the pattern and application shall be as recommended by the manufacturers. Terminations shall be made immediately after cutting and stripping the sheath etc. Coloured insulating sleeves shall be used for identification of the conductor tails, complying with the current British Standard.

Entry of the cable into all boxes, isolators, fuseboards, etc., shall be made through a brass ring type universal gland, of appropriate size to suit the cable used.

Where joints are enclosed in boxes and are buried in the ground a non hygroscopic filling compound complying with the British Standard shall be used to completely fill the seal the joint box. Where joints are enclosed in brass sleeves and are buried in the ground, the ends of the sleeves shall be plugged with filling compound before the glands are screwed into the sleeve.

### Flameproof Accessories

Flameproof installations shall comply with the design criteria otherwise specified, and shall be run in M.I.C.C. P.V.C. (1000 volt Grade) throughout. Cable runs shall be laid out to ensure that only the minimum number of termination joints and accessories occur within the flameproof area.

Cable terminations shall comply with B.S.4683 & 229 with metric connections to suit metric M.I.C.C. P.V.C., certified for Group II gases and vapours, temperature classification T6 (85° C) with guard, and with key locked covers.

All fixing lugs shall be external to the fittings and accessories, screws shall be of approved non-ferrous metal.

All materials shall comply with code of Practice BS 7430.

### Testing

All MICC cables shall be tested at least twenty-four hours after the cable seals have been made tests shall be undertaken with an insulation tester at 1000 volts potential. An "infinity" reading must be obtained on each

## **2.09 MINERAL INSULATED COPPER COVERED CABLES.DOC**

individual cable both between cores and from each core to the cable sheath. Any faults showing at this time shall be corrected directly and the cable re-tested.

The Engineer/Contract Administrator will require a selection of cables to be tested in his presence during the installation of the works.

### **Method of Installation**

Cable Fixings on M.I.C.S. cables shall be of copper strip or spacer bar type. Cable fixings on M.I.C.S. P.V.C. cables shall be P.V.C. sheathed copper strip with brass or other approved non ferrous fixing screws. Multiple runs of M.I.C.S. cables in exposed locations shall be run on metal cable tray, as indicated in the Contract Drawings.

Cable in suspended ceilings shall be installed with the same consideration to neatness and fixing as would be expected for a surface installation.

A loop shall be introduced in a cable immediately before its entry into equipment subject to vibration or occasional movement. A clear space of at least 12mm shall be maintained at the point in the loop where the cable passes over itself.

A wood block or a wooden faced tool shall be used to finally dress the cables into position. Any corrugation of the copper sheath at bends will not be acceptable. The finished appearance of MI cable installations shall be of highest quality. Any kinked or distorted cable will be rejected, and shall be removed from site immediately. Repairs to a damaged cable sheath, regardless of the extent of the damage, will not be accepted. Subject to agreement with the Engineer/Contract Administrator a straight through joint only may be permitted.

Where practicable, MICC cables shall be kept clear of other metalwork, otherwise the copper sheath and the adjoining metal shall be bonded in at least two positions.

### **Protection of MICC Cables**

Concealed MICC cables shall rise from floors or drop from ceilings in vertical lines.

Where MICC cables rise from the floor to an island site they shall be protected by conduit to a minimum height of 300mm above floor level. The conduit shall be bushed and sealed with compound to prevent the ingress of water.

Where MICC cables pass through floor slabs or other structural work, they shall be protected by pieces of hard PVC conduit, or by a purpose made sheet steel cover up to a height of 1800 AFFL. The protection shall be plugged with bitumastic or similar compound after the MICC cables have been installed.

MICC cables **shall not** be cast in or built in, in a solid manner without the Engineer's/Contract Administrator's written agreement.

## **2.10 WIRES, CABLES AND FLEXIBLE CORDS.DOC**

### **General**

All cables, wires and flexible cords shall be copper and delivered to the site on their original coils with sealed labels intact, and labels shall be removed only as and when the cables are required for installation.

Where it is necessary to make direct connections between circuit cables and flexible cords, these shall be effected by means of fixed base connectors situated in the conduit outlet box.

No conductor used shall have a smaller cross-sectional area than 1.5mm<sup>2</sup> (7/0.50). No flexible cord smaller than 0.50mm<sup>2</sup> (16/0.20) shall be used.

### **Single Core Cables**

All single core wiring cables shall be 450/750 volt grade to the current British Standard with multi-strand copper conductors, PVC or LSF insulated as noted in later sections of this specification or shown on the drawings.

The cables shall be looped progressively from point to point and no joints will be permitted. Cables emanating from different distribution boards and/or switchfuses shall not be drawn into the same conduits or draw boxes.

All 3-phase sub-main and final-circuit cables shall have self-coloured insulation in accordance with the Current British Standard. Single phase lighting and power circuits connected to a 3-phase distribution board shall have self-coloured marking sleeves on the phase conductor within the distribution board to identify the phase to which it has been connected.

### **P.V.C./P.V.C. Wiring Accessories and Fixings**

P.V.C./P.V.C. Wiring systems are generally forbidden in University buildings and shall only be used where particularly specified in Part 3 The Supplementary Specification. Its use is limited principally to domestic installations. Where used wiring and accessories shall conform with appropriate B.S. and the use of "plaster depth" boxes will be permitted in conjunction with plate switches. In all other sections of these installations standard depth joint and/or accessory boxes shall be used.

All accessory and joint boxes shall be of steel, with screwed lids and approved earth posts, and gland clamps as required, and shall conform with I.E.E. Regulations.

PVC/PVC cables shall be installed according to a loop in system, and no jointing will be permitted other than at terminations (3 plate ceiling roses, switches, distribution boards and outlets).

All circuit wiring shall be arranged in locations which will afford maximum mechanical protection, particularly against flooring and roofing nails.

As far as is practicable cables shall be run on the side of wooden joists, at mid depth, and wooden joists may be holed 15mm diameter on or about vertical centre to accommodate transverse cable runs. Where more than one hole is needed, all shall be made on the same horizontal centre line.

Switch drops and outlet drops shall run vertically from floor or from ceiling to the outlet to be served. It will not normally be permissible to run cables behind skirtings, or horizontally in concealed locations. Cables shall be fixed with approved wiring clips, each cable being clipped independently.

All cables shall be fixed in strict accordance with Reg. 522.08.04 16th Edition and Amendments of the IEE Regulations.

Connections to box and distribution board "knock outs" shall be by insulated oval bushings, of the correct size designed to protect the cable, and maintain enclosures and boxes dust tight.

Circuit protective conductors shall be made off in special "loop in" earthing lugs at each accessory and outlet. The use of a continuity joint at any other point of the fixed wiring installation is prohibited. Bare CP conductors shall be twisted together and sleeved (green/yellow) before termination.



## **2.10 WIRES, CABLES AND FLEXIBLE CORDS.DOC**

Cable drops and risers concealed behind walls shall be protected throughout by oval or circular conduit or protective steel channelling pinned and installed 10mm behind the finished face. No part of the protective tube or channelling shall be accessible to touch on completion. The ends of mechanical protection shall be bushed or smoothed to prevent damage to the cable.

PVC/PVC cables shall not be run in conduits with mains or sub-mains.

### **Drawing-in of Cables**

All cables shall be drawn-in once erection of the respective conduit and trunking systems are complete with outlet boxes, etc. Draw wires or tapes shall not be drawn in concurrently with the erection of the conduits. All cables shall be run off from reels and any cable that is kinked, twisted or chafed shall not be used.

The lead and return conductor of each circuit shall be carried in the same conduit. Runs of cable between definite terminal points in the installation shall be installed without the use of intermediate joints, except in specific instances authorised by the Engineer/Contract Administrator. No single conduit shall carry more than one phase to any lighting point, socket outlet or other apparatus, where these serve a single phase load.

All wiring shall be carried out using a loop-in principle.

### **Heat Resisting Cables & Flexible Cords**

Cables used for final connections to motors, water heaters or heater fans, etc., shall be :-

- (a) Temperature range 35°C - 70°C. Where the ambient air or conductor temperature is likely to fall within this range the cables and flexible cords shall be insulated with a suitable butyl-rubber, and CSP sheath recommended by the Manufacturer and shall comply with the current British Standard.
- (b) Temperature range 70°C - 145°C. Where the ambient air or conductor temperature is likely to fall within this range, the cables and flexible cores shall be insulated with a suitable silicone-rubber insulation recommended by the Manufacturer and shall comply with the current British Standard.

Flexible cords for use with tungsten luminaires shall be a suitable silicone rubber insulated terylene braided recommended by the Manufacturer and complying with the current British Standard.

Flexible cords for use with fluorescent luminaires (operating at normal room temperatures) shall comply with the current British Standard and shall have conductors of plain copper.

## **Amenity Lighting - Standard Path & Road Lighting**

### **Wall Mounted Lanterns**

Wall mounted lanterns shall be weatherproof type as specified in Part 3 The Supplementary Specification and fully gasketed, with M.I.C.S. P.V.C. long waterproof glands, sheathed overall

### **Earth Rods**

Every 3rd column or end of the run to have sufficient 2.4m earth rods installed give a resistance of not more than 10 ohms.

### **Time Switches**

Sangamo Q553 Form 14 solar time switch with steel box

### **Traffic Bollards**

The cable termination arrangement on Traffic Bollards and Bollard lights shall be integral with the fitting, to suit P.V.C.S.W.A.P.V.C. cable.

### **Belisha Beacons**

Zebra Road Crossings will be provided with illuminated flashing Belisha Beacons (internally).

Crossing Flood Lights will only be installed under special circumstances, where the flow of traffic is high and pedestrians crossing are above the norm of the Campus, ie a hall of residence.

The columns to be manufactured to BS873 3.5m high. Similar to that manufactured by STREET FURNISHING SERVICES, WARGRAVE, BERKSHIRE.

## **2.12 EARTHING.DOC**

### **General**

The whole of the electrical installation and all equipment connected thereto shall be effectively earthed in accordance with BS.7671, and the requirements of the Regional Electricity Company (REC).

Where the REC does not provide an earth connection point the Contractor shall provide an efficient earthing system at the main incoming switchgear.

Unless indicated otherwise in later sections of this specification or shown on the drawings, this shall comprise a nominally 1200mm long 50mm x 6mm high conductivity copper earth bar mounted within the main switchroom.

All earthing/equipotential bonding connections and the earthing lead shall terminate at this bar through removable test links.

An earthing lead of nominally 300mm<sup>2</sup> csa and network of earth electrodes to achieve a resistance to earth of less than one ohm shall be provided.

Where the REC provides a separate earthing point this will be used as the main earth connection. Where this connection is in the form of a PME Service then the bonding/earthing arrangements must conform to the REC's requirements.

Where the installation is of a non-domestic type, then this connection may only be used as the main earth with the written consent of the REC which shall be obtained by the Contractor.

### **Method of Installation**

The earthing system shall comprise electrodes of 18mm diameter copper or copper coated/molecular bonded steel rods, and shall be installed as detailed hereunder.

Unless specified to the contrary earth rods shall be supplied in 1200mm lengths with internally tapped thread at one end and screwed stud at the other, complete with driving head, tape clamps and steel spike. Rods shall be driven to their full depth and connection between electrode and the earthing lead shall be accommodated in a small (approx. 300 x 300) concrete inspection pit with removable access cover, the whole to provide a water tight seal when installed within the building or in a concrete slab.

A label shall be affixed within the inspection pit indicating the driven length of the earth electrode and its measured resistance value at handover.

All PVC insulated copper tape when installed above ground or in floor trenches shall be secured at intervals not exceeding one metre by means of suitable saddles.

The tape shall be installed in square and symmetrical lines with links provided in the tape system so that periodic tests may be carried out.

All tape surfaces at joints, etc., shall be tinned and retained in metal to metal contact by means of sweating and riveting or by brass bolts, washers and nuts.

All joints in exposed sections shall be protected against moisture and corrosion by the application of two coats of anti-corrosion paint.

The entire earthing installation together with the metallic sheathing of cables shall be electrically continuous throughout forming a completely bonded system.

## 2.12 EARTHING.DOC

### Testing

Carry out soil resistivity tests to confirm the number, depth and spacing of rods and lengths of earthing lead required for the system earthing, based on 80,000 Amperes for one second per 25mm<sup>2</sup> of copper.

Include measured data in Operating and Maintenance Manual.

Take tests in accordance with BS.7671 with a Megger Earthometer or equivalent instrument before "Power ON" to ascertain the resistance of the earth electrode(s) and drive or bury further rods as necessary until the resistance of the electrode(s) is less than one ohm.

### Equipotential & Supplementary Bonding

Include for all equipotential and supplementary bonding in accordance with BS.7671.

Earthing terminals shall be provided in all outlet boxes including light switch, wall light and socket boxes. The circuit protective conductor shall be connected direct to the earth terminals on socket outlet plates and roses, and to the box terminal for light switches.

All metal work which may provide a path to earth such as components of hot and cold water systems, heating systems, ventilation systems, medical gases, compressed air and vacuum systems and exposed metallic parts of the building fabric, within two metres of any switch, switch socket or other electrical outlet less than 1500mm from the floor, shall have a resistance to earth of not more than 1.0 ohm provide the supplementary equipotential bonding wherever a reading greater than 1.0 ohm is recorded.

Include for the supplementary equipotential bonding of all metal pipes, wastes, sink units, baths and equipment to the electrical earthing system.

All protective conductors equipotential and supplementary equipotential bonding leads shall be of the minimum sizes given in BS.7671. and shall be PVC insulated self-coloured green/yellow.

## **2.13 LIGHTNING PROTECTION.DOC**

### **General**

The purpose of the lightning protection system is to minimize the effects of a lightning strike to the building, from above or from the side, and to safely conduct the discharge to earth without side flashing and without danger to personnel.

The lightning protection system shall comply with the requirements and recommendations of BS.6651 and with the relevant sections of the earthing code BS.7430:1991.

The system shall consist of an interconnected air termination network, down conductors, bonding conductors, earth electrodes and any other items required to make a complete system. Test joints shall be provided as required to make routine tests of the system.

The entire lightning protection system, apart from natural building elements used as part of the system, shall be the product of one manufacturer in accordance with the manufacturers recommendations, including fixings to the fabric of the building.

Natural conductive elements of the building such as metal roofs, columns and paving, reinforcement, foundations and piling may be used as part of the lightning protection system. Where building elements are to be used as part of the lightning protection system, they shall be tested during construction to ensure that the resistance is low enough for the purpose. A formal record shall be kept of the resistance readings taken.

The weather proofing of the building shall not be impaired in any way by fixing or by any part of the lightning protection system.

### **Products/Materials**

The type, grade and quality of materials and the dimensions of components shall be as detailed in BS.6651.

All fittings, fixings, supports etc. shall be purpose made and of the type and manufacture specified or as shown on the drawings.

Joints in conductors shall be kept to a minimum and shall be both electrically and mechanically sound and constructed to prevent the ingress of moisture.

All contact between dissimilar metals or between a metal and a material with which it might react shall be avoided, except as permitted in BS.6651 whereby all precautionary measures recommended shall be employed. Where necessary to prevent long-term corrosion, additional precautions shall be taken comprising separation, or the insertion of an intermediate material with which neither of the dissimilar metals/materials reacts.

### **Air Terminations**

Air terminations shall consist of a network of conductors on roofs and on the sides of buildings (where required), laid on a grid pattern so that no part of the roof or wall protected is more than 5 metres from a conductor.

Vertical air terminals shall be installed where shown on the drawings. Air terminals and associated fixtures and fittings shall all be of the same manufacture.

The conductors shall be PVC sheathed to a colour to be agreed with the Engineer/Contract Administrator unless shown otherwise on the drawings. PVC covered conductors shall be bared in order to make connections and the joints shall be subsequently weatherproofed and taped with PVC tape of the same colour as the covering.

Where roof conductors cross building expansion joints, a flexible link shall be inserted. The flexible link may take the form of a loop (in flat conductors of equivalent cross section to the fixed conductors) or a braided or stranded length of conductor. The circumference of circular conductors shall be not less than 8 times the length of gap to be bridged. The flexible link shall be firmly fixed on both sides of the expansion joint.

### **Down Conductors**

## **2.13 LIGHTNING PROTECTION.DOC**

Down conductors shall be disposed around the building(s), as required by the British Standard unless shown otherwise on the drawings.

Where building reinforcement or structural steel is to be used as the down conductor the procedures outlined in BS.6651 shall be followed during construction. If the resistance to earth of the completed building exceeds 10 Ohms then additional down conductors and, if necessary, additional earth electrodes, mats, plates or ring conductors, shall be installed.

Where reinforcing bars are insulated to prevent corrosion and where precast or prestressed members have no metal-to-metal contact with other members then additional bonding provisions shall be made to ensure electrical continuity.

Where connections are made to reinforcement bars or sections used as down conductors, the point where such connections emerge from the encasement or cladding shall be sealed, waterproofed and protected against corrosion by means of a suitable epoxy resin, cast into place and extending at least 100mm beyond the junction.

### **Earth Electrodes**

Earth electrodes shall be molecularly bonded copper clad steel rods driven vertically into the ground. Threads shall be properly rolled so that the copper cladding is unbroken throughout. Couplings shall be of silicon aluminum bronze and shall be fully threaded to allow metal-to-metal contact of the rods. Couplings shall be counter bored and of sufficient length to completely cover and protect the threaded portion of the rods to minimize corrosion.

Driving heads for the rods shall be high tensile steel and shall be fully threaded to ensure head-to-rod contact. Driving shall be accomplished by using a purpose made power hammer. Each rod shall be fitted, after driving, with a conductor clamp.

Where the ground is unsuitable for copper clad steel rods, other types of earth electrodes complying with BS.6651 may be used. Where building elements are to be used as the earth electrodes they shall be tested during construction to ensure that the resistance is low enough to make suitable electrodes. A formal record shall be kept of the resistance readings taken.

Appropriate sealing methods shall be used where rods or conductors pass through concrete into earth. Pre-cast concrete inspection pits and puddle flanges or, in tanked structures, more elaborate seals as described in BS.6651, shall be cast in at the time of construction. Permanent waterproofing and sealing shall be accomplished after installation and testing of the earth rods or conductors.

Earth pits shall be pre-cast concrete with reinforced covers. When fully embedded in concrete, earth pits may be of galvanized steel construction or moulded plastic bodies with galvanized steel frames and lids. Pits shall be installed so that they are flush with the finished floor or ground level.

Covers shall be removable for inspection and testing of the earth electrode and shall be inscribed 'Lightning Protection Earth'. A label shall be fitted in the pit inscribed with the length of driven rod and resistance measured at handover.

Drilled earth bars shall be fitted in pits where the number of connections exceeds one looped conductor (interconnecting electrodes) plus one external connection. The drilled earth bars shall be copper, not less than 50mm x 6mm and mounted on insulators.

Where natural earth electrodes are used, such as sheet steel piling, reinforced concrete raft or pile foundations or other suitable structures, provision shall be made during construction to ensure suitable electrical connection to such electrodes. If parts of the structure are also to be used as natural down conductors then electrical continuity between the elements used as down conductors and those used as earth electrodes shall be maintained.

### **Test Joints**

## **2.13 LIGHTNING PROTECTION.DOC**

All test joints shall be accessible for testing at the time of installation and for future routine tests.

Test joints shall be provided at the bottom of each down conductor so that the integrity of the earth electrodes can be tested separately. Where natural building elements are used as down conductors then test joints shall be provided at the top of the building to measure the resistance to earth.

### **Bonding**

All exposed metalwork on the roof and on the outside of the building shall be bonded to the lightning protection system. Interior metalwork shall be bonded if it is close enough to elements of the lightning protection system to risk the danger of flashover. The need for bonding shall be assessed by the calculation method given in BS.6651.

The Lightning Protection System shall be bonded to the main Electrical Earthing System at the main Earth Bar through an appropriately labelled removable test link.

In lift installations only, the continuous rigid metal structure shall be bonded to the lightning conductor and to adjacent structural steelwork and such bonding shall be confined to the top and bottom of the continuous rigid metal structure. The guide rails are not part of the structure for this purpose but shall be bonded as exposed conductive parts.

### **Test Certificates**

A test certificate shall be provided on completion of the installation to certify that Inspection and Testing have been carried out in accordance with the British Standard.

The test certificate shall contain the resistance measurement of each earth electrode and earth termination network, of each down conductor and of the building as a whole.

In addition to resistance measurements, the certificate shall contain the following information for each reading:

- (i) the date and time
- (ii) the weather conditions
- (iii) the type of soil
- (iv) the condition of the soil (e.g. wet, dry, average). Any measures taken to reduce soil resistance. Details of the reference earth used for testing.

## 2.14 CABLE TRAYS AND LADDER RACKS.DOC

### General

Cable trays and/or ladder racks shall be installed to carry multiple runs of cables, and shall be heavy duty quality unless stated otherwise in later sections of this specification or shown on the drawings.

Trays shall be perforated sheet steel and unless otherwise specified they shall be galvanised after manufacture. All trays shall be fixed at 600mm intervals and at a sufficient distance from walls, ceilings and obstructions as is necessary to permit free access for cable laying and fixing. In no circumstances shall this fixing clearance be less than 50mm. All fixing brackets shall be of sheet or flat steel bar hot dip galvanised, secured to walls, floors or ceilings by Redhead or other approved fastenings. Cable tray shall be constructed from plain sheet steel and shall be hot dip galvanised after perforation. The leading dimensions of cable tray shall be in accordance with Table below..

Preferred Standard Hot Dip Galvanised Tray

Nominal Dimensions		Minimum Sheet Thickness
mm	mm	mm
100	12	0.9
150	12	0.9
300	20	1.6

Ladder racks shall mild steel, galvanised after manufacture or aluminium. Wire basket trap trays shall be used for data/telecom cabling.

Wherever possible changes of direction in tray runs shall be by means of manufacturers specials, and radiused bends, or splayed bends shall be used where space permits. The overlap of all tray joints shall be not less than 50mm and all such joints shall be fastened by a minimum of 4 no. mushroom headed bolts with square nuts, of galvanised finish, with angle clips.

Where specified brackets shall be formed using either a minimum of 50mm x 6mm galvanised mild steel flat bar or patent steel channel as described in later sections of this specification or detailed on the drawings and shall be fixed at intervals recommended by the manufacturer for the full loading capability of the tray or rack. Where appropriate supply inserts and cast into reinforced concrete to support the cable tray or ladder rack. Set out and fasten the inserts to the shuttering.

All cable tray or rack bends shall be purpose made and shall have an inner radius of not less than 12 times the diameter of the largest cable to be fixed on to the tray.

On completion of erection all joints shall be dressed down and shall be painted with approved zinc rich protective paint (Glavafroid or equal to be approved).

All nuts and bolts used to assemble cable trays or racks and their supports shall be non-corrodible plated, ie. cadmium or similar.

The cable tray or rack installation shall be electrically bonded to form a continuous earth path.

Cable tray shall only be cut along a line of plain metal (not through perforations). All cut edges shall be prepared and treated according to original finish of metal. Where welding has been employed in fabrication and also on galvanised tray, a zinc rich paint shall be used.

Holes cut in cable tray for the passage of PVC/LSF covered cables shall be bushed to prevent damage to the PVC/LSF covering using a smooth bore brass bush.

Fixing brackets and fixings shall be uniform in finish with the tray. Spacers shall be provided on undulating surfaces to maintain tray true to line and level.

A minimum fixing of clearance of 60mm shall be maintained at both sides and back face to permit attachments to be secured.



## 2.14 CABLE TRAYS AND LADDER RACKS.DOC

The fixing of all bracket grounds, brackets and trays shall be the responsibility of the Electrical Contractor.

All cables on tray shall be securely fixed with approved 2 hole saddles spaced in accordance with 522-08-04 16th Edition and Amendments of the IEE Regulations Exception All cables (excluding MI cables) of 10mm OD or less may be fixed using proprietary PVC cable ties.

## 2. 15 CABLE TRUNKING AND CONDUIT.DOC

### General

Cable trunking fabricated in sheet steel shall be used where indicated on the layout drawings or as detailed in later sections of this specification.

Multi-compartment trunking shall have continuous separation barriers securely fixed; all accessories shall have matching, separation barriers.

Where trunkings pass through walls or floors, short lengths of fixed lid shall be provided to project 50mm either side of the wall or floor. Where these perforations are through a fire compartment, the trunking shall be provided with an internal fire barrier and the builders work aperture restored to provide a fire rating equivalent to the compartment.

Where finishes are damaged during or after installation, they shall be restored to their original condition at the Contractor's expense.

Where trunking is installed with the lid downwards, suitable cable retainers are to be fitted along the full length of the trunking at 300mm maximum centres. Trunking installed vertically shall have pin racks at 1000mm maximum centres.

Final connections between cable trunking and distribution/switchboards shall provide sufficient cable entry facilities to allow for the installation of all cables that can be terminated at the boards, whether they form part of these works or are reserved for future use.

Overall finishes to metal trunking shall be dependent upon the environment at the time of installation, as follows:-

- **Internal Constantly Dry**

General wiring works including surface and cast in situ installations -Black stove enamel, or air drying paint internal end external and shall be Heavy Gauge Seem Welded HGSW conduit complying with BS.EN Classification 442111402314

- **Plant Rooms, Industrial Areas or Damp Internal Areas**

Damp situations generally, wet laboratories, service ducts, external conduits, elsewhere where detailed in the Contract Documents - Galvanised, hot dip zinc coated inside and out, complete with cadmium/zintec plated accessories and fixings complying with BS.EN 50086-1 and shall be heavy gauge screwed welded steel (HGSW) conduit and malleable cast iron screwed type fittings, complying with BS.EN Classification 443111444314, shall be installed in environmental conditions as follows:-

- **External**

As (b) above, but with gasketed lids and external fixing lugs.

- **PVC conduit**

PVC conduit shall not be used unless it is particularly specified in Part 3 the Supplementary Specification

- **Flexible conduit used for final connections only.**

Flexible conduit shall not be used as the main method for containment through out the building.

Flexible conduits are only to be used for local connections to plant and equipment to prevent mechanical damage and the transmissions of vibrations through the building structure.

- **Concealed Conduit Systems**

All conduits in new buildings, apart from work in suspended ceilings, service ducts, voids, and in areas of fair faced brickwork or block-work. Shall be fully concealed.

## 2. 15 CABLE TRUNKING AND CONDUIT.DOC

Existing and reconstructed buildings shall be generally as above, but with exceptions which will be indicated on contract drawings.

- **Surface Conduit Systems**

All works in boiler rooms, plant areas, service ducts, within suspended ceilings and voids and within buildings and areas Constructed in brickwork or block-work fair faced on both sides shall be surface fixed.

### Segregation of Conduit & Trunking Systems

Trunking systems shall be segregated into independent compartments and conduits for the services listed below shall be independent of each other, and of any other conduit and trunking system.

1. Category 1 Segregation - Mains Voltage Systems.
  - Sub-mains between main switchboards, section boards, and final distribution boards.
  - 3 phase final sub-circuits.
  - Call bell Installations (parts above 230v nom).
  - Building Management Systems (parts above 230v nom).
2. Category 2 Segregation - Extra Low Voltage Wiring..
  - Intruder Alarm, Access Control and CCTV Systems
  - Public Address and A/V installations.
  - T.V./F.M. coaxial aerial installations.
  - Building Management Systems (parts below 25v nom).
  - Computer Network and Telephone installations (when permitted – see Supplementary Specification).
  - Specialist control wiring (when permitted – see Supplementary Specification)
3. Category 3 Segregation - Emergency Systems
  - Emergency lighting installations (when permitted in conduit and trunking)
  - Fire alarm installations (when permitted in conduit).
4. Category 4 Segregation - Communications
  - Computer Network and Telephone installations

Further segregation may be required for some systems to maintain immunity from interference from other systems. This will be either specified in the Supplementary Specification or must be brought to the attention of the CA by the specialist sub-contractor as soon as possible.

### Conduit Accessories and Fixings

The use of the following conduit fittings is normally prohibited in University Installations.

- Inspection Couplings
- Solid or Access Elbows, Bends or Tees
- Light or Heavy Gauge Clips, other than for location prior to floor screeding
- Light or Circular pattern locknuts
- Lambeth Saddles
- Light Gauge Box Covers

The standard fixing for surface conduits shall be the spacer bar saddle, used in conjunction with Circular Boxes.

Adaptable boxes for use in conjunction with conduit installations shall be not less than 50mm depth, finished uniformly with the conduit installation. The use of Sheet Steel Boxes will be permitted on all internal installations.

Adaptable boxes for use in damp situations shall be of zinc spray, galvanised finish, with external fixing lugs, and all boxes exposed to weather, or driving rain shall be of weatherproof type with machined lids and neoprene gaskets. Conduit connections to adaptable boxes shall be made with smooth bore entry bushes and machined couplings in all cases.

## 2. 15 CABLE TRUNKING AND CONDUIT.DOC

Earthing connections and terminals incorporated into conduit accessories shall be of brass 'stand post' type tapped into the accessory, with lock washer and cheese headed conductor clamping screw. Any accessory supplied with ready drilled and tapped hole for earthing purposes, and remaining unused shall be fitted with mushroom headed brass screw and lockwashers, to prevent ingress of moisture.

### Steel Trunking

General purpose cable trunking shall be zinc coated mild steel, with inturned flanges, and covers, galvanised sheet steel connectors and cadmium plated connector screws with locking washers. All lids shall be fastened by quick release countersunk headed clips unless otherwise specified. The number of joints in trunking systems shall be kept to a minimum and duplicate copper earth continuity links shall be provided at each joint. Trunking shall be manufactured from a minimum 1.2mm (18 swg.) thick sheet steel. The leading dimensions of cable trunking shall generally comply with the table below...

**General Purpose Standard Single Compartment Trunking**

Preferred Nominal Size		Minimum Thickness		
Width mm	Depth mm	Trunking mm	Cover mm	Connector mm
50	50	1	1	1.4
75	50	1.2	1	1.4
75	75	1.2	1	1.6
100	75	1.2	1.2	1.6
150	150	1.6	1.2	1.6

Trunking will normally be arranged on surface, or in special cases, incorporated into laboratory furnishings as indicated in the Contract Documents.

Where necessary to preserve alignment trunking laid on surface shall be spaced clear of the wall or ceiling faces with hardwood or steel spacers at each fixing point. Electrical trunking shall not be located below water pipes, or structural members which are prone to condensation.

Where necessary to preserve alignment lighting trunking shall be spaced off ceilings or soffits of beams.

All trunking brackets shall be uniform in finish (e.g. enamelled or galvanised) with the trunking which it supports. Changes of level, of direction shall be effected by the use of standard fittings where possible. Bracket spacings shall be as indicated in BS 7671 : IEE Wiring Regulations.

The fixing of all support brackets and trunking to structural grounds regardless of type shall be carried out by the General Electrical Contractor under the terms of this contract.

Where trunking passes through walls or obstructions a short length of fixed cover shall be provided, through the obstructed area, and projecting 50mm beyond each face, also where these walls or obstructions form a fire barrier suitable sealing and fire barriers will be installed as BS 7671 : IEE Wiring Regulations.

Where switches, socket outlets, or other accessories are mounted on timber grounds (i.e. laboratory service shelves) a conduit connection shall be maintained between the accessory box and the trunking, and additionally, a flexible circuit protective conductor shall be bonded between the accessory and the trunking, minimum size 2.5mm<sup>2</sup> copper.

Where trunking is used for the connection of circuit conduits to distribution boards, continuous matching slots shall be cut, in both distribution board cases and trunking, which shall be bolted together securely, the joint

## 2. 15 CABLE TRUNKING AND CONDUIT.DOC

shall then be faced accurately and truly, and fitted with a continuous insulating edging strip, to prevent damage to circuit cables.

Duplicate copper link bonds shall be provided at all trunking joints.

The lids on metal trunking shall be fitted throughout with a returned edge which shall overlap the trunking joints.

Continuity shall be maintained throughout the length of the metal trunking system by means of copper linking straps bonded to the trunking across each joint on the inside face, in addition coupling spigots and the inside face of the trunking making contact shall be left unpainted and cleaned free from dust and grease.

All angles and tees shall be supplied by the manufacturer and not fabricated on site, all accessories other than straight through connectors shall be gusseted.

Where loose dividers are required, the minimum thickness of such dividers shall be not less than 1.2mm

Trunking shall be connected together by means of standard factory made bends, tees, and offsets . Manufacturer's copper earth continuity tags shall be fitted in duplicate at each joint position. The throat of all angle connectors shall be splayed wherever practicable, and the removable covers shall be arranged in the front, or in the top of all trunking runs as fitted. Where lengths of trunking exceeding 2m. overall are installed with "front covers", cable restraining straps shall be provided, to prevent displacement of cables when front covers are removed.

Vertical trunking runs exceeding 3m. overall rise in any section shall be provided with cable pet racks at 3m. intervals, preferably at floor levels, to limit stress in rising cables, and to form the basis of any fire-retarding barrier.

Lighting trunking shall in general conform with the requirements of general purpose trunking and shall be 50mm x 50mm nominal, galvanised unpainted finish in lengths of not less than 3½m overall, but the in turn of the lipped lower face shall be angled and profiled to accept Flush Fitted Plastic covers.

Where heavy duty multi-compartment skirting or dado trunking is required, the general provisions of this specification shall apply, but the equipment shall conform in detail with the terms of Part 3 the Supplementary Specification.

Segregation of multi-compartment trunking shall be complete, and any internal separators shall be purpose made, mechanically attached, and completely earthed. The use of conduit, passing through one compartment to connect to another, will be permitted subject to the retention of a space factor not exceeding 45% in the most restricted area of the restricted compartment.

Special attention must be given to the protection of High Speed Data Cables within multi-compartment trunking, where noise (interference) could be caused if the routes of cables are not totally enclosed throughout the length of the run.

### ***Plastic Cable Trunking***

Plastic trunking and associated components shall comply with the current British Standards.

The uPVC material used in the manufacture of the trunking and components, shall have been tested by a Department of Environment approved laboratory in accordance with the requirements of British Standards, and test certificates shall be available for inspection if so required.

Lids for plastic trunking shall have a positive snap closure, not requiring special tools for removal.

Unless otherwise specified, all plastic trunking and components shall be solid white through the full thickness of the material.



## 2. 15 CABLE TRUNKING AND CONDUIT.DOC

### Method of Installation – Conduit

All conduit routes shall be identified on drawings and submitted to the Engineer/Contract Administrator for comment before commencement of work. The conduit system shall be carefully planned and erected to avoid all unnecessary bends, sets or changes of direction. Conduit shall be installed in straight and symmetrical lines with easy sets or bends and angles; where multiple runs change direction, the radii of the bends shall be laid out from a common centre.

Draw-in points for multiple conduit runs having right angle changes of direction, shall be provided by the use of adequately sized adaptable boxes.

All conduit fittings installed on exposed surfaces shall be of the tangent entry type. Straight through boxes used as outlet points or draw-in points and installed on ceilings shall be of the standard circular pattern.

Each length of conduit shall be perfectly smooth inside and outside and free from flaws and imperfections of any kind. Each end shall have any sharp edges removed and be properly cleaned and reamed before erection.

The minimum diameter conduit used shall be 20mm. A conduit box or other fitting must be provided and fixed at every outlet point. All conduits shall be cleaned through with a swab prior to the drawing-in of cable.

Conduit shall be nominal bores of 20mm, 25mm, 32mm to B.S.4568 Parts 1 and 2 (Metric heavy) Screwed. No other sizes to be used

Draw wires shall not be left in conduit during erection.

No wiring shall be commenced until the respective conduit and accessories are fully erected.

All Flameproof installations shall be surface fixed.

Final connections to apparatus shall be surface fixed.

The minimum cover to be maintained over all embedded conduits shall be as follows:-

Cover on concrete	35mm
Cover on plaster	6mm

The conduit shall be arranged as a loop in/draw-in system, and wiring shall not be commenced until all walls are plastered. Conduit in non-removable false ceilings shall be arranged so that all wiring can be carried out after ceilings are fixed.

Conduit is to be connected to concealed unspouted accessories such as fuseboards, switchgear, lighting switches, socket outlets, adaptable boxes, etc., by means of machine faced, screwed solid couplings and hexagonal smooth bore male bushes. Flanged couplers shall be used for all surface work. Spanners must be used to tighten these fittings. All mutilated or marked bushes shall be removed and replaced. Conduit terminations in switches, distribution boards, adaptable boxes, trunking and all unspouted accessories shall be made in conduit couplings retained by hexagon smooth bore bushes with compression washers or serrated washers, designed to penetrate any protective enamel and make and maintain a tight electrical joint of low impedance.

All couplings and locknuts shall be of the heavy duty type. Box spanners shall be used to tighten all bushes in loop-in boxes.

All metal joints shall be painted with metallic paint immediately after erection. All vice and wrench marks shall be filed out and painted with metallic paint. Ends of conduit shall be plugged up and metal threads which are likely to remain exposed for any length of time shall be painted with metallic paint to prevent rust.

All conduits directly after they have been installed and at other times as necessary shall be examined by the Contractor who must allow in his tender for such examination and the painting of all parts of the conduit where the surface has been removed or scratched or rust has started to form. The painting shall be at least equal to the original finish.

## 2. 15 CABLE TRUNKING AND CONDUIT.DOC

Where a conduit is exposed to different temperature (either by surrounding air conditions or by virtue of the surrounding medium with which it is in contact) at any particular time, the section of the conduit at the higher temperature shall be isolated from the section at the lower temperature by means of a conduit box filled with an approved permanently plastic compound. Such a condition would arise if a conduit running in a warmed building is run to exterior points.

Tests of the continuity of metal conduits shall be taken as erection proceeds. A written record of these tests shall be sent to the Engineer/Contract Administrator.

Conduits shall be threaded to butt close together in couplings and sockets, the ends filed square and carefully reamed. No threads shall be exposed, except at running couplings (which shall be reduced to a minimum) and the exposed threads shall be painted to match the conduit finish. Joints in a galvanised conduit system shall be watertight using paint, hemp and/or gaskets. The joints shall be partially screwed up before the paint and hemp are applied to maintain continuity. All screwed joints shall have at least six full turns of thread engaged. Joints between conduits and equipment with clearance holes shall be made with flanged couplers and smooth bore male bushes. The surface shall make good electrical and mechanical contact all around.

Conduits throughout shall be of sufficiently large section and so arranged with draw-in or inspection boxes to permit the easy drawing-in or removal, of one or all of the cables in the conduits.

Care shall be taken to prevent water, dirt or rubbish entering the conduit system during erection. Screwed metal caps or plugs shall be used for protecting open ends.

Particular care shall be taken when setting out conduit runs to outlet points which are to be installed in furniture, etc., fitted so that all conduit work shall wherever possible be concealed.

In the conduit installation, the following services shall be regarded as separate systems and no conduit box shall contain conduits of another system.

- 230 Volts AC lighting connected to 1-phase.
- 230 Volts AC power connected to 1-phase.
- 400 Volts AC (3-phase) power.
- Miscellaneous services and/or systems as specified elsewhere in this specification.

Where conduits of more than one system terminate by necessity at one conduit box, the box shall be of the partitioned adaptable pattern.

Elbows, tees and stock bends, plain, inspection or split will not be allowed.

All bends using less than 32mm diameter conduit shall be made on site using a slow hand bender. Made bends will be allowed for conduits 32mm diameter and over, or standard boxes as defined above shall be used. The radius of any bend shall not be less than that given in the British Standards for normal bends. All bends and sets shall be made cold and the conduits shall not sustain any reduction of cross-sectional area.

Not more than two right angle bends or more than four sets shall be installed between consecutive draw-in or inspection boxes.

Generally where conduit runs are installed from point to point in a straight run without bends, draw-in boxes shall be provided at maximum intervals of 8.0 metres. Where conduits, having not more than two right angle bends, are installed, the draw-in boxes shall be provided at not more than 6.0 metre intervals.

Conduits crossing expansion joints shall be fitted with proprietary couplings with an earthing clip at each side of the coupling, connected by a 4mm<sup>2</sup> copper wire. Provision shall be made throughout the conduit installation for the draining of condense moisture.



## **2. 15 CABLE TRUNKING AND CONDUIT.DOC**

All conduit fittings shall have long bushed spouts, except where conduits are run on the "loop-in" principle, when they shall be of the multiple back entry outlet type.

All box covers shall be of heavy cast type with face edged and for sunk conduit boxes shall have 12mm overlap all round to cover all unsightly edges of plaster. All boxes shall have machine faced edges, and covers shall be fixed to boxes by means of greased brass screws.

Positions of all lighting points must harmonise with ceiling patterns. The Contractor is to ensure that all lighting points fit in with ceiling patterns, before positioning any points.

In locations where solid, non-demountable or plastered ceilings occur, conduit boxes shall only be permitted at lighting points.

At positions where the appearance of the conduit run is likely to be improved by the introduction of dummy lengths of conduit and where a more secure fixing for the suspension of fittings would be obtained, dummy conduits and continuations shall be provided and deemed to be included in the tender.

All adaptable boxes shall be grey cast iron pattern unless otherwise specified. Where adaptable boxes are fitted flush, the cover plates shall be heavy gauge metal with 12mm overlap on all sides. The internal depth of a box shall not be less than 40mm.

Covers for boxes shall be of the same material as the box. For boxes mounted in weatherproof situations, the cover shall have a machined surface around the perimeter mating with a similar machined surface on the box and be gasketed.

Particular care shall be taken in the fixing of accessory boxes on concealed installations to ensure that the finished box shall fit not more than 2mm behind the finished face in each case.

### **Surface Conduit Installations**

All surface conduits shall fit in with Architectural features, all runs being horizontal or vertical. Diagonal runs are not permitted. All accessories shall lie on the same horizontal and vertical lines. Corners and angles shall be neatly turned and runs shall be kept straight. Branches shall be taken off at right angles.

Vertical conduit runs shall have saddles at 300mm maximum from their points of emergence from floors or ceilings, and the remaining saddles shall be fixed consistent with the requirements of spacing and appearance. Saddles shall be fixed on each side of every bend at 300mm maximum from the points of intersection of the centre lines of the conduits.

Conduits installed on exposed surfaces shall be securely fixed at intervals by distance saddles, except in cases where galvanised conduit is installed on the surface where distance pattern galvanised saddles shall be used and fixed with non-ferrous screws.

Where surface conduit is installed a solid brass screwed nipple entry shall be installed to all switches and socket outlets, etc., where these are contained in cast iron boxes having a tapped entry.

Flanged couplers and smooth bore brass bushes shall be used for all accessories/equipment.

### **Concealed Installations**

Conduit boxes shall, wherever possible, be concealed in ceilings, voids and wall chases, etc. In rooms with fair faced brickwork back entry to outlets etc., may be used with surface conduit in Secondary Rooms behind.

The Contractor shall include for installing wherever required flush type accessories, and where it is not possible to use flush accessories they shall be surface pattern, with conduits run as inconspicuously as is practicable to harmonise with architectural features of the buildings, due allowance being made for accessibility, inspection and maintenance.

## 2. 15 CABLE TRUNKING AND CONDUIT.DOC

Where ceilings and roofs are pre-cast concrete, the conduit shall be run as a "loop-in" system. Conduit is to be laid on top of the pre-cast units, holes being punched at light points and multiple back outlet boxes fixed at these positions arranged flush with the finished plaster ceiling surface.

Conduits in "insitu" concrete ceilings shall be laid immediately over reinforcement and fixed to the shuttering before concrete is poured.

Conduit boxes for "insitu" concrete shall be of the deep type to allow the box to fit hard on the shuttering, extension rings are to be fixed to these boxes after shuttering is removed to allow for the finished face of the ring being flush with the plaster surface.

Conduits in floor screeds shall be securely fastened down before the screed is laid. Adequate protection for the conduit must be provided during the period between installation and the screeding being laid.

The Contractor shall provide a wire mesh over conduits where these cross over in screed depths of less than 60mm and over all conduit where the screed depth is less than 50mm.

The Contractor shall arrange for a competent person to be in attendance whilst the pouring and/or screeding operation is being carried out, in order to avoid damage being caused to the conduits and also to ensure that the conduit work is in a sound condition, properly and efficiently installed.

Any conduit box installed under timber floors shall be readily accessible for maintenance purposes. Floor traps or boards shall be securely refixed by means of greased countersunk wood screws and cup washers with common routes of conduit as appropriate to provide common local access.

In timber joisted roofs and floors, conduit shall as far as possible be run with the joists. Where of necessity, conduits cross the joist, they shall be run at right angles to the joists and be not larger than 20mm and shall be 150mm or less from a load bearing wall. Diagonal runs across joists will not be permitted.

Conduits shall be supported independently of suspended ceilings and installed to approximate termination position and completed in conjunction with ceiling erectors. Lighting outlets shall be positioned symmetrically in relation to the ceiling and arranged so that no weight is suspended from ceiling panels or metalwork used in connection therewith. Boxes for luminaires shall be fixed independently of the conduit.

Conduits installed in chases of walls and/or floors shall be firmly secured by wrought iron pipe hooks or crampets and these fixings shall in themselves be sufficient to hold the conduits in place.

Concealed runs shall be run in chases cut in the brickwork, fixed by crampets and shall have a full 6mm thickness of plaster cover.

Where a surface mounting accessory such as an isolating switch, bell, etc., is fixed to a recessed conduit, a flush fitting conduit box is to be fitted behind the accessory to obviate conduits bending out of the plaster wall surface, the surface accessory having a bushed hole provided in the back for the purpose of cable entry.

### **Galvanised Conduit**

Where galvanised conduit is specified all conduit, accessories, switchboxes and all associated apparatus used in the installation must also be galvanised. Galvanised conduit shall be used when mounted outside a building, installed in plantrooms, switchrooms, floor trenches and areas subject to dampness or accidental flooding, or buried in the ground. The conduit system shall be weatherproof when erected outside a building.

Exposed conduit threads shall be painted with a zinc rich paint of the same colour as the conduit. Conduit in the ground shall be bitumastic painted and then wrapped with DENSO tape along its full length, the taping shall extend for a distance of 150mm beyond the point where the conduit emerges from the ground.

## 2. 15 CABLE TRUNKING AND CONDUIT.DOC

### Non-Metallic System

Non-Metallic conduit and accessories shall be installed in accordance with the manufacturers instructions which must be strictly adhered to and demonstration and training obtained as and when necessary.

Unless otherwise specified normal gauge rigid slip jointed or screwed conduit shall be used, with corrugated flexible conduit in situations where flexible metallic conduit would be used. In damp situations, the slip jointed conduit shall have joints cemented with a cement approved by the conduit manufacturer. Tropical grade conduit shall be used where the ambient temperature exceeds 35°C.

Allowance shall be made for expansion using expansion joints or flexible bands to cope with the greater movement inherent with PVC conduit.

Surface conduit runs shall be fixed with maximum saddle spacing of 900mm unless otherwise agreed with the Engineer/Contract Administrator.

Bending of PVC conduits up to and including 25mm standard gauge shall be carried out cold by insertion of the correct size steel bending spring. Any conduit bent by means of a direct flame or by bending without a spring will not be accepted. Purpose made bends may be used for larger sized conduit but where insitu bends are required then a special conduit insert and heat may be used. Any conduit which has had a flame directly applied to it will not be accepted.

Conduits terminating in unspouted boxes shall use the appropriate manufactured coupling and bushing devices. Where necessary slip couplings with special cement shall be used to take up expansion.

When threading is required it is important that a new die be used which has not been used on steel conduit.

The requirements for the general installation of plastic conduit systems shall generally be as specified for Metal Conduit systems.

### Flexible Conduits

Flexible conduit shall be steel and comply with the current British Standard. In damp situations the conduit shall be fibre packed. Flexible conduit shall NOT be used in flameproof installations.

Flexible conduit connections to equipment shall be at least 450mm long terminating with a conduit termination box enclosing sufficient conductor length to enable "Tong Test" readings to be taken on each conductor.

Flexible conduits shall be continuous in length, joints will not be allowed without the use of a fixed conduit termination box.

All terminations are to be made using proprietary manufactured connections complete with male / female brass bushes.

Earth continuity shall be maintained by a stranded conductor installed externally to the flexible conduit.

### Installation of Conductors in Conduit and Trunking Systems

The use of single strand conductors in conduit and trunking systems is prohibited. No drawing in shall be commenced until the building is substantially weathertight, and in cases of doubt conduits shall be 'pulled through' and if necessary blown through, before drawing in is commenced. The following general conditions shall apply:-

- Cables shall be continuous throughout.
- A loop in system shall be adopted.
- All circuit wires forming any single circuit shall be contained within one continuous conduit or trunking system.
- Limited slack shall be left at all intermediate draw-in boxes, and ample slack at all terminations.
- The colour conventions detailed in Regulation 5.1.4.06 including Table 51A of the 16th Edition and Amendments of the IEE Regulations shall be strictly observed.

## **2. 15 CABLE TRUNKING AND CONDUIT.DOC**

- Box lids and covers shall be fitted immediately “drawing in” is complete.
- Pending second fixings, all drawn in cable shall be suitably marked, coiled, and made safe against damage.

## **2.16 LUMINAIRES.DOC**

### **General**

At all lighting points marked on the drawings, the Contractor shall supply, erect and connect all luminaires complete with lampholders, lamp and glassware as specified in later sections of this specification or shown on the drawings. All luminaires shall be cleaned by the Contractor before the installation is finally handed over.

The Contractor shall include for any modifications to the manufacturer's standard luminaires to comply with the requirements relative to mounting height. In the event of extra long suspensions being required, these shall be ordered concurrent with the luminaires.

Where lampholders are not supplied with the luminaires, the Contractor shall supply them and they shall be of a type and make approved by the manufacturer. Unless stated otherwise in later sections of this specification or shown on the drawings.

Luminaires shall be suspended on drop rods or where lightweight fixed to a conduit box.

All luminaires not already wired, shall be wired by the Contractor and all flexible wiring for luminaires shall be joined to the hard wiring by means of high temperature connectors of ample size in the conduit box to which the luminaire is mounted.

Unless otherwise specified or detailed, the hard wiring shall terminate at the terminal block of fluorescent luminaires.

Totally enclosed luminaires and others subject to high temperature shall be fitted with brass or porcelain lampholders.

All wiring contained within tungsten luminaires shall be silicon impregnated rubber insulated, or equivalent heat resisting material.

Noise control gear shall be replaced.

Luminaires shall be provided with radio interference suppression devices.

All fluorescent luminaires shall be complete with high efficiency control gear which shall be electronic high frequency unless stated otherwise in later sections of this specification or shown on the drawings together with power factor correction. Twin tube luminaires shall be corrected to remove any stroboscopic effects from the lamps. Power Factor Correction shall be provided to give a power factor of 0.9 or better, and control gear shall not exceed 15% third harmonic content. Each luminaire shall be provided with a fused terminal block fitted with a 3 A BS 1361 HRC fuse link.

Every luminaire shall be complete with the number and size of lamps indicated. The lamps shall be of the correct voltage rating and type corresponding to the control gear fitted; fluorescent lamps for dimming shall be pre-burnt for a minimum of 200 hours.

In the event of a particular manufacturer's reference being noted on the drawings or later in this specification, the Contractor shall confirm that the luminaires provided comply with the details of this Specification.

### **Method of Installation**

Connections to luminaires recessed or semi-recessed into suspended ceilings shall be made by means of a plug in ceiling rose, plug and three core flexible PVC or LSF insulated and sheathed cable. (Refer to later sections of this specification). Where connection is to a tungsten luminaire the flexible cable shall be heat resisting as previously specified.

Connections to surface mounted tungsten luminaires shall be made with porcelain connectors to which heat resisting tails to the luminaires shall be connected. A heat resistant gasket shall be inserted between the luminaires and the terminal conduit box to prevent the lamp heat affecting the final circuit wiring.

## **2.16 LUMINAIRES.DOC**

Circuit cables shall not be routed via luminaires unless shown on the drawings.

Bulkhead luminaires connected to a surface conduit installation shall be installed via a circular conduit box fixed external to the luminaire for the purpose of terminating the final circuit wiring as previously specified.

The Contractor shall ensure that all luminaires mounted flush in suspended ceilings are located symmetrically in the suspended ceiling panels.

The Contractor is to include for the slotting or drilling of luminaires to accommodate any surface mounted wire ways that let into the side or ends of them. In certain instances, where surface luminaires are being used on a surface conduit system, a suitable pattress is to be supplied and installed behind the luminaires to provide the necessary spacing for the full dimensions of the luminaire.

Where luminaires are smaller than the box they are being fixed to, the Contractor shall provide suitable break-joint rings between the luminaire and the ceiling.

### **Lamps**

Lamps of the sizes and colour temperatures indicated shall be provided and fitted to all luminaires.

Fluorescent lamps shall where practical be obtain from a single manufacturer, and be 4000° colour temperature unless stated otherwise in later sections of this specification or shown on the drawings.

All low voltage tungsten halogen lamps shall be encapsulated.

### **Amenity Lighting - Standard Path & Road Lighting**

Street lighting installations shall be as described in Part 3 The Supplementary Specification.

#### **Columns**

5m column as BSC 5PTK as supplied by D Webster of Ware, Herts.

"University of Reading" swan neck bracket as supplied by D Webster of Ware, Herts.

Each column and swan neck bracket is to be rubbed down and painted with undercoat and 2 coats of gloss paint in standard University of Reading olive green

#### **Lanterns**

Beta 79 (without photo cell) with 70W tubular son lamp and gear as Thorn Lighting Ltd. QB79VWB - 1070.4.

#### **Fuse Cutouts**

Fuse Cutouts to be 1, 2 or 3 way double pole fused cut-outs as Technical Support Services Ltd., DPSC001, 002 or 003. As supplied by Manwood Electrical Co. Ltd of Tonbridge.

#### **Wall Mounted Lanterns**

Wall mounted lanterns shall be weatherproof type as specified in Part 3 The Supplementary Specification and fully gasketted, with M.I.C.S. P.V.C. long waterproof glands, sheathed overall

#### **Cables**

Cables to be minimum 6mm<sup>2</sup> 2 core PVC SWA cables or split concentrics buried direct in the ground with minimum 450mm of cover. Or as otherwise described in Section 3

#### **Underground Cable Joints**

Underground cable joints in street lighting installations shall be avoided wherever practical. When necessary Messrs. B.I.C.C. BICAST joint systems may be used.

#### **Lantern to Cut Out Flexes**

Cable connection between junction unit and lantern shall be in 1.0mm<sup>2</sup> 3-core circular butyl insulated and neoprene sheathed flexible cable

## **2.16 LUMINAIRES.DOC**

### **Earth Rods**

Every 3rd column or end of the run to have sufficient 2.4m earth rods installed give a resistance of not more than 10 ohms.

### **Erection of Columns:**

Columns to be erected with concrete sub base to prevent movement. Set plumb and level to ensure that the terminal box is at the correct level relative to the finished ground. Install a 50mm diameter uPVC tube (hockey stick shaped) through the concrete and into the column base.

### **Time Switches**

Sangamo Q553 Form 14 solar time switch with steel box

### **Traffic Bollards**

The cable termination arrangement on Traffic Bollards and Bollard lights shall be integral with the fitting, to suit P.V.C.S.W.A.P.V.C. cable.

### **Belisha Beacons**

Zebra Road Crossings will be provided with illuminated flashing Belisha Beacons (internally). Crossing Flood Lights will only be installed under special circumstances, where the flow of traffic is high and pedestrians crossing are above the norm of the Campus, ie a hall of residence.

The columns to be manufactured to BS873 3.5m high. Similar to that manufactured by STREET FURNISHING SERVICES, WARGRAVE,BERKSHIRE.

## **2.17 ACCESSORIES.DOC**

### **Lighting Switches**

All lighting switches unless otherwise specified shall be of the rocker operated grid switch pattern. Front plates shall be plastic or metal, with rockers to match, as stated in later sections of this specification or shown on the drawings.

Flush switches shall be mounted in steel boxes fitted with adjustable grids and shall have overlapping front plates.

Surface switches shall be metal clad mounted in steel boxes and shall be of the type noted in later sections of this specification or shown on the drawings.

Switches installed in plant rooms and other areas subject to moisture shall be metal clad zinc or sheradised.

The switches shall be rated at 230V, 20A, 50Hz, AC unless stated otherwise.

Unless otherwise specified wall switches shall be mounted at a height of 1350mm, above finished floor level to centre line of box, and installed adjacent to the closing stile of doors.

Where more than one phase enters a switch box, fireproof non-warping phase barriers shall be used and each phase shall be identified by its appropriate colour on a purpose made underplate.

Ceiling switches shall be suitable for mounting direct to a conduit box (50mm fixing centres) without use of adaptor plates. Semi-recessed ceiling switches shall be complete with white break joint ring. All ceiling switches shall be fitted with a pull cord and moulded knob. Where appropriate the cord shall be retained in position against the nearest wall.

Unless otherwise specified, the indicator in switches with pilot lamp shall be neon with resistor and red colour lens.

Key operated switches shall be of the tumbler key with the same key operating all switches throughout the installation unless noted to the contrary.

Multi-gang switches are to be arranged so that there is a logical relationship between the luminaires and switches.

Switches shall be engraved as indicated in later sections of this specification.

### **Socket Outlets**

Unless otherwise specified, socket outlets shall be switched 13 A, 3-pin to BS 1363.

Outlets shall be finished white plastic or metal faced as noted in later sections of this specification or shown on the drawings and be of the recessed pattern where employed with buried conduit and surface metal clad pattern where surface conduit is employed.

Where socket outlets are required to be inset into cable trunking they shall be of the panel mounted type unless noted otherwise in later sections of this specification or shown on the drawings.

Where sparkless switch socket-outlets are specified, they shall have single pole switches (tilting mercury pattern) which shall interlock with the plug.

Switches shall be of the microgap pattern and sockets shall have insulating sleeves around the pin apertures. Sockets shall be shuttered on the live and neutral outlets so that entry of the plug in the pin apertures moves the shutters.

Plug tops of the finger-shield pattern with insulated pins shall be provided for each outlet installed including outlets in floor outlet boxes, unless indicated to the contrary in other parts of this Specification.



## **2.17 ACCESSORIES.DOC**

All socket boxes shall be fitted with an earth screw terminal pillar and the Contractor shall bond the socket outlet using PVC insulated cable coloured green/yellow in compliance with British Standard 7671.

### **Fuse Connection Units**

Fused connection units shall be manufactured in compliance with the current British Standard with fuse holder and fuse rated at 3 or 13 A as appropriate, where switched, the switch shall be of the microgap pattern.

Flex outlets comprising a 10mm bushed hole in the face plate shall be provided for units serving fixed equipment.

Face plates, boxes, finishes, etc., shall be as specified for socket outlets.

### **Plug Ceiling Roses/Connectors**

Plug ceiling roses/connectors shall be manufactured to BS 5733.

Units for 250V use shall be rated to the current protective device rating and have either 3 or 4 terminations. Plugs shall be colour coded to indicate 3 or 4 terminations and 3 termination plugs shall fit 4 termination sockets.

Plugs shall be complete with a cord grip and white ceiling rose cover.

### **Plain Pendants and Ceiling Roses**

Plain pendants shall comprise a ceiling rose (with break joint ring as necessary) a flexible cord of sufficient length to give the required mounting height of shade, and a lampholder. If no height is given the shade shall be located to afford reasonable access for lamp changing and to avoid any door swings etc.

Ceiling roses shall, unless otherwise specified, be of white moulded insulating materials and suitable for direct mounting on circular conduit boxes. For concealed wiring a break joint ring of white moulded material shall be provided.

### **Lampholders**

Lampholders for use with tubular fluorescent lamps shall be bi-pin type.

Generally, lampholders for use with tungsten filament lamps shall be BC for lamps up to and including 100 watts ES for 150 and 200 Watt ratings.

Lampholders shall be brass pattern where fitted to conduit and/or metal suspensions.

Shade carrier rings shall be provided except where the lampholder is part of an enclosed fitting.

Lampholders for use with flexible cords shall be all insulated cord grip pattern with solid stem plungers having external springs. The cable entry for sheathed cords shall be large enough to allow the sheath to enter the lampholder.

All insulated lampholders (including batten type) shall be complete with a skirt.

Lampholders incorporated in weatherproof fittings shall be porcelain.

### **Installation Methods - Mounting Heights**

The contractor shall as far as is practicable in any installation, adhere to the undernoted standard mounting heights for electrical accessories.

Mounting Heights of Standard Accessories

TYPE OF EQUIPMENT	HEIGHT
Distribution Fuse-gear (to Lower Edge)	as detailed
Light Switches ( to Centre)	1.40m
Switch Socket Outlets Low Level (to Centre)	1.00m
Switch Socket Outlets Intermediate (to Centre)	1.00m
Switch Socket Outlets High Level (to Centre)	2.00m
Control Thermostats	1.50m
Bench Sockets (Above Bench Top)	0.175m minimum

## **2.18 MECHANICAL SERVICES EQUIPMENT WIRING.DOC**

### **General**

Supply, install, test and connect all cables from the control panel, switchboards and distribution units to those items of heating and ventilating plant and controls detailed on the drawing and schedules.

Include for liaison with any named Specialist Supplier and Installer employed for the works to ensure that all wiring for power, motive or control systems are correctly installed, connected, tested and commissioned including all works prior to the commencement of the final testing.

The general location of all items of equipment are shown on the drawings but include for finally agreeing these with any specialist installers, and for confirming the routes of all wire-ways, cables, trunking, trays, conduits and the like together with all isolators, knock-off stop buttons, and connection positions to be provided.

### **Method of Installation**

Provide a means of isolation within 1800mm of every motor. In general, the isolators shall be "ON LOAD" pattern 3 pole for direct on line and six pole for Star Delta pattern with auxiliary contacts as necessary (min. 2 sets). Lock off stop buttons will not be accepted as the only means of isolation. All isolators and push buttons shall be fixed adjacent to the equipment served where there is no suitable adjacent structure for locating these, supply and fix purpose made galvanised floor stands to support the equipment. The isolator shall be mounted so that it does not come in contact with any section of the motor base or equipment.

Ensure that all items of plant are effectively earthed.

Generally all wiring in the plant rooms shall be in galvanised conduit or trunking unless otherwise specified. Wiring in boiler rooms and kitchen extract canopies where the ambient temperatures are higher than normal shall be carried out in MICS cables unless otherwise specified.

Conduits shall not be connected directly to a motor or other appliances liable to vibration, in these cases it shall terminate in through type conduit boxes fixed at a convenient position adjacent to the motor. The cable shall be continued in short lengths of PVC covered flexible metallic tubing which shall be coupled to the motor terminal box. The flexible conduit shall be terminated at either end in a ET adaptor with a separate earth wire installed throughout its length.

Where MICS cable is connected to a motor the motor shall be fitted with voltage surge suppressors to prevent voltage spikes exceeding twice the cable voltage rating. In addition where MICS cable is connected to a motor or an appliance liable to vibration the cables should be connected direct to the terminal box. A coil of cable to a radius not less than 100mm shall be formed in the cable to take up the relative movement between the machine and the cable.

Where motors are mounted on slide rails or other means of adjustment is provided, the solid conduit system shall terminate with a "adaptable" conduit box and the wiring shall continue in flexible conduit of sufficient length to permit full adjustment of the motors.

Where the motor control gear is permanently mounted immediately adjacent to the motor, the flexible conduit shall be connected direct to the control gear.

For final connections to motors and similar equipment, cables shall be carried in watertight flexible conduits. Separate external earth wires shall be provided between the main conduit system and equipment which shall be bound to the flexible conduits at 150mm intervals.

### **Tubular Heater Installation**

Supply and install all necessary equipment and wiring for the tubular electrical heaters located in the positions indicated on the drawings.

The heaters shall be wall mounted with the lower tube 200mm above finished floor level.

## 2.18 MECHANICAL SERVICES EQUIPMENT WIRING.DOC

The heaters shall, unless noted otherwise, be controlled by a wall mounted thermostat and be connected to an adjacent small power ring main circuit through a switched fused connection unit complete with neon indicator.

The heaters shall be wired in 2.5mm<sup>2</sup> PVC insulated cables with the final connection to the heaters in heat resisting tails enclosed in flexible conduit from a circuit conduit box fitted with a fixed base terminal block.

### Motor Control Panels

#### (a) General

All electrical components, products and installations forming any part of the works, shall fully comply with the current British Standards, Health and Safety at Work Act and the Electricity at Work Regulations.

This specification shall apply to all pre-manufactured and assembled components, all site assembled components and all Electrical or Electro-Mechanical items forming any part or sub-part of the works.

In connection with this specification, two functions shall be performed as an integral part of the sub-contract. Testing shall mean the proving of individual components or wiring, for correct function or connection. The testing of the installation shall be a collective term for the individual tests required separately.

Commissioning shall mean the proving of complete systems including regulation, adjustment and measurement of action sequences. Commissioning shall include co-ordination between any specialists employed in proving the satisfactory inter-relationship of the Mechanical services works in the working of the system as a whole.

The locations of control panels are shown on the drawings. The panels shall be front access with cables entering and leaving from the top unless indicated otherwise.

Each panel shall be fabricated in mild steel with stove enamel finish to BS colour selected by the Engineer/Contract Administrator and shall be pre-wired to an outgoing terminal rail contained within a separately accessible compartment at high level. The whole shall form a composite unit.

Each panel is to include the following:-

- Lifting eyes as necessary.
- Neutral Block.
- Earth Terminal Bar.
- Fuses including a set of spares of each rating.
- Engraved labels, internal and external.
- Cables core identification.
- Indicating lamps, low voltages transformer type.
- Interlocking relays and outgoing terminals as necessary.

Each panel shall be divided into two sections:-

#### **Section A - Motor Starters**

Complete with door interlocked load breaking, fault making isolating switch to contain the electric motor starters and equipment accessible only with the plant in the off position.

#### **Section B**

To contain controllers and accessible with the panel live when motors and controls are in operation.

Each panel shall be provided with the following for each motor drive or power supply:-

- Run trip lamps for each electric motor source or power supply.
- Hand/Off/Auto switches.
- High/Low/Auto Selection for 2 speed motors.

## 2.18 MECHANICAL SERVICES EQUIPMENT WIRING.DOC

Interlocking relays.  
Select switch for Run/Standby equipment.  
Distribution terminals.

Co-ordination between protective devices shall be as denoted by the British Standard.

### (b) Control Panels

The general description of the operation and performance required of controls for each plant or system to be provided are noted in later sections of this or other accompanying specification.

The system shall include control panels as indicated on the drawings and as described below, which shall, unless noted otherwise, be of the cubicle type factory built assembly to BS EN 60439 Form 3 having a degree of protection of IP54.

Where indicated a multi-core MICC cable for fire operate/control shall be connected to the panels to allow a shutdown of specified plant through the fire alarm panel.

Panels shall also conform to the general requirements of BS EN 60947. The doors and casing shall be of sheet steel, folded and seam welded to form a rigid self-supporting structure. Bracing and stiffening shall be used as necessary to take the weight of the internal components and control assemblies. No sharp edges or corners will be accepted.

Internal equipment mounting plates, 2.5mm minimum thickness, shall be provided. Plates less than 600mm high shall have one vertical edge returned to stiffen the plate. Larger plates shall have all edges returned to stiffen the plate. One mounting plate shall be installed per door.

All fixing holes shall be drilled and tapped or fitted with a proprietary fixed nut. Loose nuts and bolts or self-tapping screws will not be accepted. Fixing screws through the outer shell shall be kept to a minimum. Where unavoidable, mushroom or pan heads shall be used. All screws, nuts, washers used throughout the panel shall have a corrosion proof finish such as chromium plating, cadmium plating, etc. Painted finishes such as black japanning are not acceptable.

Doors shall be constructed in the form of a rigid tray, stiffened internally as necessary. They shall be fitted with recessed sealing gaskets giving dust protection at all edges. The type of hinge used shall enable the door to open through 150°, to enable the door to lift off if required. Stay bars shall be provided to hold the door at an open angle of approx. 110°. All doors shall be provided with locking type door handles using one key type only, for all control panel doors on the project. Where hinged instrument or switch facias are specified, these shall be similar to doors in construction, but bottom hinged with slide catches to hold in the open position.

Where slide out instrument racks are specified, these shall disengage from all power and signal connections within the first 25mm of travel, otherwise shall be lockable as for doors.

The panel materials shall be of 2mm thickness. Eye bolts shall be fitted to each panel section to facilitate transportation, off loading and installation. Where floor mounting panels are supplied in sections, a pre-drilled and pre-finished steel channel plinth shall be provided to form a common base to all sections. The plinth shall be painted black and be of 2mm minimum thickness of metal.

### (c) Test At Works

All control panels shall be fully tested at works.

The following tests shall be carried out by the control panel manufacturer:-

1. Visual check of panels for completeness, neatness of finish, visual symmetry, etc.
2. Visual check of all installed components for compliance with wiring diagrams (correct quantity of components).

## 2.18 MECHANICAL SERVICES EQUIPMENT WIRING.DOC

3. Visual check of all installed component values and settings for compliance with wiring diagrams (correct quality of components).
4. Set target values of all overloads, protective relays, timers, etc.
5. Visual check of all equipment labelling, identification, etc., for compliance with layout drawings.
6. Measure output of all transformers, rectifiers, etc.
7. Test all volt free connections and note on wiring diagrams.
8. Measure panel internal earthing and earth continuity. Record on wiring diagrams/schedules.
9. Test operation of all Electrical components within the panel - record on wiring diagrams.
10. Carry out insulation resistance tests to all wiring and connections within panel (where applicable).
11. Carry out test under load of all contactors, circuit breakers, etc.
12. Visual and measured tests of the completeness of the controls installation and correctness of the controls installation.
13. Proving of the correct operational response of all controllers and sequential control (within panel) from simulated input signals and confirmation of correct output signal.

### (d) Testing on Site

All control panels shall be thoroughly tested after completion of the wiring connection/installation.

All panels and internal equipment are to be vacuum cleaned by the Contractor of all dust and debris and the plantroom ambient conditions are to be within acceptable limits before testing shall be allowed to commence.

If water is evident on, or around the panels, no testing shall be permitted.

Notwithstanding any factory tests or commissioning, the tests defined within this clause shall be fully and completely performed to the entire satisfaction of the Engineer/Contract Administrator.

A clean set of wiring diagrams shall be used, together with the testing and commissioning schedules. The diagrams and schedules shall be ticked or specific information added during the tests, signed by each responsible Contractor for his section of the testing and submitted to the Engineer/Contract Administrator. Only after this procedure shall performance commissioning of the systems commence. Testing will require the co-ordination of all Contractors involved and may not necessarily follow the numerical sequence below.

The following tests shall be carried out by the specialist:-

1. Visual check of panels and equipment for damage.
2. Visual check of all externally installed components for compliance with wiring diagrams (correct quantity of components).
3. Visual check of all externally installed component values and settings for compliance with wiring diagrams (correct quality of components).
4. Visual check of all external equipment labelling, identification, etc., for compliance with layout drawings.
5. Measure output of all transformers, rectifiers and power packs etc., under load, record test values on wiring diagrams.

## **2.18 MECHANICAL SERVICES EQUIPMENT WIRING.DOC**

6. Test all volt free connections and note on wiring diagrams.
7. Measure panel internal earthing and earth continuity, record on wiring diagram/schedules.
8. Test operation of all Electrical components within and external to the panel - record on wiring diagrams.
9. Carry out insulation resistance tests to all wiring and connections within panel (where applicable).
10. Confirm correct termination/connection of all power and signal/control wiring.
11. Confirm tightness of all field terminations within the panel.

The Contractor shall also carry out the testing required by BS 7671 for all wiring, etc.

### **(e) Expansion Provision**

All panels shall have provision for expansion. 10% of the space on each back plate, bus bar, door etc., shall be left totally clear to allow in a practicable manner for additional controls, cabling, indication, etc. In the case of panel sections containing starters, contactors, etc., space shall be provided for two additional starters or contactors in each section.

### **(f) Safety Interlocks**

All doors on any panel shall be Mechanically and Electrically interlocked such that no door can be opened unless the isolator is in the "off" position, i.e. the panel is isolated.

When the door is open it shall be possible to switch "on" the isolator, i.e. make the panel live, ONLY by deliberate use of a special tool. Interlocking shall be automatically reset when the door is closed.

For panel sections that are electrically separate, each section shall be provide with interlock/isolation protection as above.

The isolator shall be capable of interrupting the maximum overload current of all equipment connected to it. Also for making at the maximum system fault level (25kVA minimum). The isolator shall disconnect all live conductors. The isolator terminals shall be shrouded to prevent accidental contact with live conductors.

### **(g) Safety Warning - Internal**

All panel sections shall be provided with a 25mm diameter RED indicating lamp on the panel back plate such that, with the panel section door open and the electrical circuitry in the respective section made live, the lamp is prominently seen. A spare bulb shall be fitted in a holding clip adjacent to the indicating lamp.

### **Equipment Wiring**

Where detailed in the specification and/or shown on the drawings, carry out the wiring from Distribution Board, Motor Control Centres, etc., to items of equipment.

The termination of the wiring shall be in a local means of isolation using either an isolator, connection unit, socket outlet or other specified device located adjacent to the equipment. Unless specified to the contrary in other parts of the specification or on the drawings, the Contractor shall connect from the isolating device to the equipment and to leave same in a working condition.

The method of wiring and other information will be detailed in other parts of the specification and/or drawings.

## **2.19 CO-ORDINATION OF MOTOR PROTECTION.DOC**

Where electrical drive motors form part of a circuit, that circuit and its upstream components shall be protected by devices co-ordinated to - Type 2 - as set out in IEC 947-4-1.

Type 2 co-ordination requires that under short circuit conditions the device shall cause no danger to persons or installation and shall be suitable for further use.



## 2.20 RADIO AND TELEVISION AERIAL SYSTEMS.DOC

### General

The manufacture, assembly, installation and wiring of the Radio and TV aerial systems shall be in accordance with the current Codes of Practice and British Standards EN 50083 Part 1 and IEC 728 Part 1. Should these items change during the construction period, notify the Engineer/Contract Administrator of the implications associated with this as detailed elsewhere in this document.

The system shall operate as described in later sections of this specification and shall be wired as therein described and/or shown on the drawings.

The Contractor shall include for a specialist to complete the installation, commissioning and testing to confirm the system is fully operational. The system is to comprise of aerials, amplifiers, wiring, boosters and outlets. It shall provide a signal at each outlet for a normal TV set to operate. The signals required are BBC1; BBC2; ITV; Channels 4 and 5 plus spareways for 4 further channels.

### Method of Installation

The siting of the receiving aerial shall be arranged in consultation with the Engineer/Contract Administrator. Field strength measurements and signal quality tests shall be carried out, where necessary, on all channels to confirm the suitability of the site and of the aerials.

The aerial and its supporting structure shall be of adequate structural strength and shall be provided with all the necessary foundations or stay to resist failure under known local weather conditions.

The system is to be wired as specified in later sections of this specification, where no particular method is stated it shall be wired in high quality 75 ohm. CT 100 double screened LSF sheathed cable.

The cable network would be a tree and branch configuration consisting of main feed, spur feed and drop in cables. These would all require cable management and route facilities.

General conduit requirements:-

**Mainfeed**            32mm conduit with slow bends and adequate pull through points.

**Spur Feed**            25mm conduit with slow bends and adequate pull through points.

**Drop-In**                20mm conduit with slow bends and adequate pull through points.

Where it is intended to pull more than one cable through a single conduit then the diameter must be increased accordingly. All conduits shall be pre-installed with draw wires.

Where cables are routed through accessible ceiling voids or rising ducts with free working space then a minimum 50mm cable tray shall be installed.

When outlets are indicated on drawings, supply, fix and terminate in a suitable accessory box.

Outlet face plates shall be as described later in this specification.

### Testing

Test the cable installation and system to ensure that the signal received is acceptable, demonstrate the strength of the signal received upon a TV receiver and provide the test certificate stating the test results to the Engineer/Contract Administrator.

## **2.21 FIRE ALARM SYSTEMS.DOC**

### **General**

The manufacture, assembly, installation and wiring of the fire alarm system shall accord with the current Codes of Practice and British Standards. Should these change during the construction period, notify the Engineer/Contract Administrator of the implications associated with this as detailed elsewhere in this document.

The system shall operate as described in later sections of this specification and shall be wired as therein described and/or shown on the drawings.

Include for a specialist to complete the installation and to carry out sufficient tests to confirm that the system is fully operational in time to allow the Fire Officer to carry out his tests together with any subsequent adjustments prior to the date of practical completion.

Sounders are to be wired as two circuits with alternate sounders connected to each circuit. Sounders shall be installed and adjusted such that they project the maximum sound into the space. The fixing of sounders direct to surfaces is to be avoided and spacers are to be installed between the rear of a bell and outlet boxes to ensure a minimum clearance of 3mm.

The System is to be wired as specified in later sections of this Specification; where no particular method is stated it shall be wired in MICS cables with a RED LSF sheath.

The system is to be wired in such a manner as to enable easy extensions of the system to take place without major disruption to the building structure, finishes or the installation.

Batteries and chargers shall be of sufficient capacity to ensure the standby time period of the system complies with the requirements of the Codes of Practice, British Standards and local Fire Officer with a third extra capacity for future extensions or adaptations to take place without detriment to the system.

### **Trigger Devices**

Trigger devices such as manual call points, smoke and heat detectors etc. shall conform to the relevant parts of BS 5445, 5446 and 5839.

All smoke and heat detectors shall incorporate a neon LED indicator to face normal entrance to a room or corridor to indicate when the detector has operated. Where detectors are obscured from normal view, eg. locked rooms, ceiling and floor voids etc., remote LED type indicator units shall be installed and wired from the detectors.

### ***Manual Call Points***

Manual call points shall be of the break glass type where breaking of the glass releases and alarm, be surface/flush mounted with red casing and the method of operation clearly indicated by a concise inscription, including the words "FIRE BREAK GLASS" on the casing or on a suitably inscribed plate behind the glass cover. Means whereby operation may be individually tested by a special key shall be incorporated without destroying the seal. These units shall be fully addressable and compatible with the detectors and wired on the same two wire ring loop circuit and bring up a fault alarm if removed.

The enclosures for these units are to be selected to be suitable for dry (IP30), wet (IP66) or explosive/hazardous areas as appropriate. Manual call points shall be located on exit routes in particular on the floor landings of staircases and all exits to the open air to comply with the relevant parts of the above British Standards and the approval of the Local Authority and Fire Office.

## **2.21 FIRE ALARM SYSTEMS.DOC**

### ***Ionisation Type Smoke Detectors***

Ionisation smoke monitoring detectors shall be plug in and complete with addressable type bases suitable for interchanging with another type detector if necessary and conform to the relevant parts of the above British Standards. (NB: If used, specify where.)

### ***Optical Type Smoke Detectors***

Optical smoke detectors shall be plug in and complete with addressable type bases suitable for interchanging with another type detector if necessary. The detectors shall be photoelectric type operating on the light scattering principle and conform to the relevant parts of the above British Standards.

### ***Duct Probe Type Smoke Detectors***

Duct probe smoke detectors shall comprise of an ionisation or optical plug in type smoke complete with an addressable base all enclosed in a sampling box fixed outside the extract or supply air duct. Presence of smoke in the duct shall be detected by sampling tubes connected to the detector unit from the duct airflow.

### ***Photoelectric Type Beam Smoke Detectors***

Beam smoke detectors shall comprise of a transmitter unit projecting an invisible modulated infra-red light beam onto a separate receiver unit up to a maximum of 100m away to detect presence of a determined level of smoke for a pre-set period. (The Manufacturer is to state details depending on the environmental conditions.) The system is to comply with the relevant parts of the British Standards and be convertible and compatible with the addressable system provided (the Manufacturer is to state the system proposed).

### ***Rate of Rise Type Heat Detectors***

Rate of rise heat detectors shall be plug in and complete with addressable type bases suitable for interchanging with another type of detector if necessary. The detectors shall be dual sensing combining a rate of rise response with a fixed temperature response being suitable for detecting rapidly increasing temperatures or a slow increase. They shall conform to the relevant parts of the above British Standards.

### **Fire Alarm Sounders**

Fire alarm sounders shall be polarised and suppressed and conform to the relevant parts of BS 5445 and BS 5839 (and BS 5345 if areas where explosive or flammable atmospheres are applicable) and be suitable for dry (IP30), wet (IP66) or explosive/hazardous areas as appropriate. These devices shall be suitable for 18 to 24 Volts dc and have a low power consumption, be red in colour and installed throughout the building to provide a minimum of 65dB(A) at any location or 5dB(A) above any background noise, whichever is the greater. Systems required to wake sleeping persons shall provide a minimum of 75dB(A) at bedhead with doors closed.

Sounders shall be of the following type:-

#### ***Bells***

Alarm bells shall be underdone internal 150mm dia. and external bells 200mm in dia.

#### ***Horns***

For use in noisy plantrooms or similar environments supplemented by flashing beacon units where necessary.

#### ***Electronic Sounders***

Electronic Sounders shall be of the omni-directional type using solid state technology.

### ***Public Address Fire Alarm Warning***

## **2.21 FIRE ALARM SYSTEMS.DOC**

Fire alarm warning by intelligible speech messages relayed to all parts of the building via the public address system in full compliance with BS.5839. The system shall employ strategically located loudspeakers to provide a minimum of 65dB(A) at any location or 5dB(A) above any background noise, whichever is the greater, to give a high intelligible and clear transmission without audible distortion.

### **Testing & Commissioning**

The complete system shall be fully tested and commissioned by the System Manufacturer in accordance with BS.5839:2002 who shall demonstrate that the system operates fully with these requirements and this specification. A full audibility test shall be carried out in the presence of the Fire Officer and any other bodies who require to be present.

### **Certification & Documentation**

The contractor shall, in accordance with BS5839-1:2002 section 5 –41, ensure that a certificate is issued for each of the processes of Design; Installation and Commissioning by those parties responsible for each of these processes.

On completion of the installation the Contractor shall issue an acceptance certificate for completion by Reading University, and together with this certificate shall provide Reading University with Design, Installation and Commissioning certificates as well as “as fitted drawings”, operating and maintenance instructions and log book.

UNIVERSITY OF READING  
STANDARD SPECIFICATION  
FOR  
DATA COMMUNICATIONS INSTALLATIONS

**Revision H**

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## Introduction

- The specification of materials and practices specifically for data installations is the work and responsibility of the University of Reading **Network Design Authority (NDA)**.
- The Telephone Systems Manager specifies voice communications aspects of installations.
- The University of Reading **Estates and Buildings Department (EBD)** is responsible for other aspects of installations including Electrical, Mechanical and Building work.
- The EBD acts also as Project Manager and Contract Administrator.
- This is Revision **H** of this document.
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## Standards Reference

This specification makes references to the following standards:

<b>Standard</b>	<b>Title</b>
EN 50173 : 1996	BS EN 50173 : 1996 Information technology – Generic cabling systems
TIA/EIA-568-A	Commercial Building Telecommunications Cabling Standard
TIA/EIA TSB67	Link Performance Transmission Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems
ISO/IEC 11801	Information technology - Generic Cabling for Customer Premises
BS 7718 :1996	Code of Practice for Installation of fibre optic cabling
BS EN 60825-1:1994	Safety of laser products. Equipment classification, requirements and user's guide
BS 7671 : 1992	Requirements for electrical installations. IEE Wiring Regulations. Sixteenth edition

Copies of all current British Standards are available in the University Library and may be consulted but not copied. Copies may be obtained from the British Standards Institution: Tel: 0181-996-7000.

The University Safety Manual is available from the EBD.



## Specification

### 1 Standards, Regulations and Workmanship

- 1.1 All data communications installations shall be in accordance with this Standard Specification and the drawings and Supplementary Specification particular to individual contract.
- 1.2 It is essential that all contractors carrying out UTP or fibre installations should have access to and be familiar with the standard EN 50173 : 1996. Additionally all contractors carrying out fibre installations should have access to and be familiar with the standard BS 7718 : 1996.
- 1.3 The University Standard Technical Specification for Electrical Services shall apply to the contract other than where herein varied.
- 1.4 In addition other relevant specifications for general building and mechanical work, safety and site practices must be observed, as advised by the EBD.
- 1.5 This **Standard Specification** may be augmented by a **Supplementary Specification** for a particular project or part of a project: in such case the Supplementary Specification must also be observed. Where such Supplementary Specification differs from the Standard Specification the former shall take precedence.
- 1.6 In cases of queries regarding this specification the queries shall be passed to the EBD with a copy to the NDA.

### 2 Safety

- 2.1 The installer must fully comply with all aspects of the University Safety Manual as related to the above works. A copy of this is freely available from the EBD.
- 2.2 As hazardous substances and environments may be encountered on the University campus, contractors must ensure that they have authority to commence work in any particular area. The University Clerk of Works (at the EBD) will indicate from whom this authority should be obtained.
- 2.3 Contractors must ensure the safety of themselves and others whilst working, in particular:
  - 2.3.1 Working areas should be signed and cordoned-off where possible whilst allowing necessary access (e.g. when working in corridors).
  - 2.3.2 Care must be taken when drawing cables into ceiling voids that hanging cables do not pose a hazard to passers-by.
  - 2.3.3 Where cables are installed below a false floor the working area must be clearly marked, or closed off, to prevent danger to others due to missing floor tiles.
  - 2.3.4 Debris should not be allowed to accumulate, and must be removed entirely when works are completed.
- 2.4 Upon completion contractors should inform the contracts administrator that they have completed the work.
- 2.5 Contractors installing optical cables should be familiar with section 4 of BS 7718 - **(Optical fibre safety)** and ensure that they have the relevant procedures in place to ensure that those carrying out such work follow the guidelines which are issued there.

### 3 Unshielded Twisted Pair (UTP) Installations

#### 3.1 Standards

- 3.1.1 The installation shall be compliant with **EN 50173:1996 Link class D** (100Mhz).
- 3.1.2 Test results will be provided which shall show conformance **EN 50173:1996 Link class D**. Results from test equipment designed to show conformance with either **TIA/EIA-568-A Category 5E**, using an **EIA/TIA TSB67 level II** classification test instrument, or **ISO/IEC 11801** will also be acceptable.
- 3.1.3 Cables shall be sheathed with a low smoke and low toxic gas emitting material as currently approved by the EBD as being suitable for the area of installation concerned.

#### 3.2 Outlet Ports

- 3.2.1 Outlet faceplates shall fit BS4662 single gang or double gang wall boxes.
- 3.2.2 Outlet ports shall have a means of clearly indicating, by means of icons representing a telephone and a computer, whether the circuit is configured for data or voice usage. The means of indication must be tamper-resistant, e.g. if the labels bearing the telephone and computer icons are removable without a special tool then they must not be reversible, to prevent unauthorised changes to the indication. Where a tool is required to change the label then at least three such tools must be supplied to the NDA.
- 3.2.3 Outlet ports shall have sprung slide shutters over RJ45 sockets.
- 3.2.4 Outlets shall be mounted so that contacts are at the top of the socket, except where the sockets are angled at 45° to the faceplate, in which case the sockets shall face downwards.
- 3.2.5 Connectors shall have Krone IDC terminations
- 3.2.6 Modules shall be capable of insertion into a wall plate of dimensions 86mm x 86mm single gang with double aperture of 50mm x 50mm suitable for two full modules. Wall plates shall be flat face with no installers' logos showing.

#### 3.3 Patch panels

- 3.3.1 Patch panels shall be suitable for modular RJ45 sockets.
- 3.3.2 Terminations shall be Krone IDC.
- 3.3.3 If patch panels are conductive then they shall be bonded to an electrical earth for safety purposes.
- 3.3.4 Cables must be terminated on patch panel outlets in accordance with manufacturers' recommendations

#### 3.4 Labelling

A summary and illustration of the scheme for labelling and identifying UTP cables, patch panels and outlets is given in **Appendix A**.

- 3.4.1 Patch panels shall be numbered sequentially from the top (and from the left if there is more than one bay) starting with number 1.
- 3.4.2 Patch panel outlets shall be numbered sequentially from left to right and top to bottom, and shall also be labelled to identify the room outlet to which each patch outlet is connected:



- 3.4.3 Outlet sockets shall be marked with the patch panel outlet number and the number of the room where the patch panel end of the circuit is located:

Wiring Closet Room Number	/	Patch Panel Number	/	Patch Panel Outlet Number
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### 3.5 Installation practices

- 3.5.1 Installers must be aware of and observe good installation practices. Some guidelines are given in **Appendix D**.

### 3.6 Documentation

- 3.6.1 Contractors shall submit the following documentation to the Contract Administrator (see **Appendix E**):
- 3.6.2 A list of cables installed. This shall be supplied on electronic, and optionally also on paper media. The list shall be in the format described in **Appendix B**.
- 3.6.3 Test results showing compliance with the standards as specified. Each circuit tested will be identified as in the format specified in **Appendix B**. Test results shall be supplied on electronic and paper media. The records of these results may be combined with the cable list specified above.
- 3.6.4 A record of the Make, Model and Serial Number of each item of test equipment used in testing the installation along with photocopies of valid calibration certificates carrying the serial number of the test equipment. The Contractor may be required to produce the original calibration certificate for inspection. All equipment must be calibrated at periods recommended by the manufacturer by a testing organisation approved by the manufacturer.
- 3.6.5 As-fitted drawings showing the location of the outlets and labelled as the outlets themselves are marked. Where possible the EBD will provide building layout diagrams in AutoCad format to facilitate this process.

## 4 Fibre Optic Cable installation

### 4.1 Standards

- 4.1.1 Contractors installing optical cables must be familiar with section 4 of **BS 7718 (Optical fibre safety)** and ensure that they have the relevant procedures in place to ensure that those carrying out such work follow the guidelines which are issued there.
- 4.1.2 Fibre optic installations shall have performance characteristics which meet the requirements of section 6.4 of **BS EN 50173 :1996** - Generic cabling with optical fibre links.
- 4.1.3 Cables that run within buildings shall be sheathed with a low smoke and low toxic gas emitting material as currently approved by the EBD as being suitable for the areas of installation concerned.
- 4.1.4 External cabling must be capable of withstanding, without degradation in performance, temperatures in the range -15C to +60C.
- 4.1.5 Internal cabling must be capable of withstanding, without degradation in performance, temperatures in the range 0C to +50C.
- 4.1.6 Where multi-mode fibre is specified it shall be graded-index optical fibre waveguide with nominal 62.5/125  $\mu\text{m}$  core/cladding diameter.

### 4.2 Testing

- 4.2.1 See **BS 7718: 1996 Annexe A** for further information on optical fibre test methods.
- 4.2.2 Optical Time Domain Reflectometer (OTDR) measurements shall be made at the following wavelengths and in accordance with the manufacturer's instructions and specification:

Multimode	850nm	1300nm
Singlemode	1310nm	1500nm

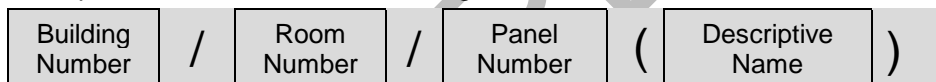
- 4.2.3 Details of measurement procedures shall be provided together with the type, serial number and proof of calibration of the measurement equipment. The following information shall also be recorded:
- 4.2.3.1 fibre optic span identification or, if prior to installation, the span(s) for which it is intended.
- 4.2.3.2 location of the OTDR during testing.
- 4.2.4 **Pre-installation** testing shall be carried out in accordance with **BS 7718 :1996 section 7 Cabling component acceptance**. The OTDR test results supplied by the contractor shall contain the following information:
- 4.2.4.1 Length using the refractive index as supplied by the manufacturer for the cable used.
- 4.2.4.2 A measure of the attenuation coefficient.
- 4.2.5 **Post-installation** testing shall be carried out in accordance with **BS 7718 :1996 section 10 Final cabling acceptance (stage II) tests**. The OTDR test results supplied by the contractor shall contain the following information and shall be made from each end of the fibre optic span:
- 4.2.5.1 Fibre optic span length using the refractive index as supplied by the manufacturer for the cable used.
- 4.2.5.2 A measure of the attenuation coefficient.
- 4.2.5.3 Connector insertion loss.
- 4.2.5.4 Joint insertion loss as detailed in **BS 7718 : 1996 figure A.1**

- 4.2.6 OTDR launch leads shall be of a length suitable to give unambiguous readings of the optical fibre and cabling components under test.
- 4.2.7 Loss measurement of the installed fibre optic span shall be carried out using a light source-power meter combination as described in **BS 7718 : 1996 section A.4.4.2 (configuration A)**. This shall be carried out at the appropriate wavelengths as described in section 10.2.1. The results obtained shall be recorded together with the following:
  - 4.2.7.1 identification of the fibre optic span
  - 4.2.7.2 location of light source during test
  - 4.2.7.3 location of power meter during test
  - 4.2.7.4 the optical losses budget for the fibre optic span (for comparison with the measured result).
- 4.2.8 The connector end faces shall be subjected to visual inspection using a microscope to ensure compliance with the visual standards specified in **BS 7718 sections A.7.2 and A.7.3**.
- 4.2.9 Mechanical stability of the mating connectors shall be ensured by inspection in accordance with **BS 7718 sections A.7.4.2 to A.7.4.4**.

### 4.3 Labelling

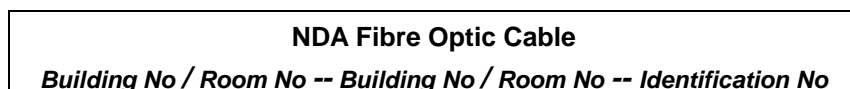
A summary and illustration of the scheme for labelling and identifying fibre-optic cables is given in **Appendix C**.

- 4.3.1 Fibre-optic patch panels shall be numbered sequentially from the top (and from the left if there is more than one bay) starting from 1.
- 4.3.2 Patch panels shall be labelled indicating the location of the remote end of the fibre:



where the Building Number and Room Number refers to the far end of the fibre cable, the Panel Number identifies the patch panel on which the cable is terminated at the far end, and the Descriptive Name is a convenient reference for the destination of the cable (see the example in **Appendix C**). Where both ends of a fibre-optic cable terminate in the same building the Building Number may be omitted from the identification labels.

- 4.3.3 The individual fibre cores within a cable shall be numbered sequentially from left to right where they terminate on patch panel outlets (i.e. each fibre terminated in an SC duplex connector will be numbered).
- 4.3.4 Where a cable uses only part of a patch panel, and/or where a cable is terminated on an existing partly-populated patch panel, the division of the panel between the cables must be clearly marked.
- 4.3.5 All fibre cables where exposed in underground service walkways, plant rooms and above false ceilings shall be labelled at 5m intervals for the full length of the cable run as described below. Further, at any position along the route where there is a manhole cover or trap and at entrance and exit points to individual buildings, the fibre optic cable shall be labelled as shown:



- 4.3.6 All individual fibres in each cable shall be uniquely colour coded.

### 4.4 Application of cable types

- 4.4.1 For information regarding optical cable design concepts see **BS 7718 : 1996 section B.7.3.1**.
- 4.4.2 If an optical cable is to be installed through a duct or other conduit then a loose tube construction cable or sheath construction cable with a central- or sheath embedded/bonded-

strength member is required. This strength member should be used as tensile load protection during cable installation.

- 4.4.3 Tight buffer constructions incorporating longitudinally laid aramid yarns acting as strength members may be installed through duct or other conduit using the strength members as tensile load protection provided that evidence supporting its use is provided by the manufacturer and copies provided to the Contracts Administrator.
- 4.4.4 Tight buffer constructions incorporating wrapped, braided or wound aramid yarns may be employed over shorter cabling routes. However, the use of the aramid yarn as tensile load protection during cable installation should be avoided.
- 4.4.5 An UV stabilised sheathing material shall be used for outdoor applications in which the cable is to be subjected to UV radiation e.g. sunlight.
- 4.4.6 Where Fibre Optic cables are installed in vertical runs particular attention must be given to manufacturers' recommendations for the type of cable used and the method of installation to avoid damage due to the weight of unsupported fibre in e.g. loose-tube cables.

## 4.5 Closures

- 4.5.1 Closures shall be capable of withstanding temperature variations in the ranges specified for cables.
- 4.5.2 The material of construction shall eliminate external light being coupled to the optical fibres contained within the closure.
- 4.5.3 The sealing properties of closures used in external applications shall prevent the ingress of moisture.
- 4.5.4 Strain relief shall be provided for each cable entering the closure.
- 4.5.5 The design of the closure and/or its immediate surroundings shall allow for storage of service loops of optical cable. The loops shall be sufficient to allow the removal of the closure from its specified location to a position that will allow access to the optical fibres contained for purposes of repair, rework or modification.
- 4.5.6 Closures should be bonded to an electrical earth for safety purposes.
- 4.5.7 Optical safety labels in accordance with **BS EN 60825** shall be applied adjacent to all accessible optical interfaces.
- 4.5.8 Internal physical features of the closure shall provide the features of: protection, identification and restraint as described in **BS 7718 : 1996 section B.8.3.1**.

## 4.6 Connectors

- 4.6.1 Duplex SC connectors shall be used except where otherwise specified. The connectors must be installed with the polarising cutout facing **up**.

## 4.7 Installation Practices

- 4.7.1 The precautions, procedures, tests, preparations and protection of the cable during installation shall comply with **BS 7718 : 1996 section 8**.
- 4.7.2 Jointing and termination shall be carried out in accordance with **BS 7718 : 1996 section 9**.

## 4.8 Documentation

Contractors shall submit the following documentation to the Contracts Administrator (see **Appendix E**).

- 4.8.1 Test results of pre- and post-installation testing as described in the section on testing
- 4.8.2 A record of the Make, Model and Serial Number of each item of test equipment used in testing the installation along with photocopies of valid calibration certificates carrying the serial number of the test equipment. The Contractor may be required to produce the original calibration

certificate for inspection. All equipment must be calibrated at periods recommended by the manufacturer by a testing organisation approved by the manufacturer.

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## **5 Equipment housing**

### **5.1 Selection of housing**

- 5.1.1 Where equipment is to be installed in a wiring closet dedicated to data (and possibly also voice) communications an open frame type of housing without front or rear doors shall be used.
- 5.1.2 Where equipment is to be installed in any other location an enclosed cabinet shall be used.
- 5.1.3 Enclosed cabinets shall have glazed doors.
- 5.1.4 Doors and removable panels shall be lockable. Three keys shall be supplied to the NDA.

### **5.2 Mechanical**

- 5.2.1 Equipment housing shall have 19" mounting strips at the front. Where the housing has a door there shall be 100mm clearance between the mounting strips and the door.
- 5.2.2 Mounting hardware (cage nuts, bolts and washers) to fit the 19" mounting strips shall be supplied in quantity sufficient to populate half of all the mounting holes left spare after installation of patch panels and cable management accessories.
- 5.2.3 Equipment housings shall be designed and installed to permit ready access to the rear of installed equipment.

#### **5.2.4 Floor-standing housings**

- 5.2.4.1 The height of the housing shall be 2000mm / 42U.
- 5.2.4.2 The width of the housing shall be 800mm.
- 5.2.4.3 The depth of the housing shall be 800mm.
- 5.2.4.4 Cable management strips shall be fitted at the front of the housing, at each side of the equipment mounting area.
- 5.2.4.5 Enclosures must be fixed so as not to move easily, whether by being screwed or bolted to the floor, standing on a plinth or on feet which resist slipping. The housing must not be free to move on wheels or castors.
- 5.2.4.6 Open frames must be fixed securely to the floor or otherwise prevented from toppling over.
- 5.2.4.7 Multiple floor-standing open frame housings installed side by side must be mechanically fixed together.

#### **5.2.5 Wall mounting housings**

- 5.2.5.1 Wall mounted housings shall normally be enclosures, rather than open frames.
- 5.2.5.2 The height of the housing will normally be specified for the particular job: otherwise the tallest housing practicable in the space available should be used.
- 5.2.5.3 The width of the housing shall be 600mm.
- 5.2.5.4 The depth of the housing shall be 500mm.
- 5.2.5.5 The fixing to the wall must be capable of withstanding a load of 100Kg applied to the front of the housing.
- 5.2.5.6 Wall mounted enclosed cabinets shall have facilities for cable entry from top and bottom.
- 5.2.5.7 Particular attention should be paid to provision of access to the rear of equipment as specified in 5.2.3, e.g. by having hinges at the rear as well as the front of the enclosure. If the housing has a rear hinge then cables must be installed to allow this



hinge to operate freely and without danger of trapping cables when closing the hinged part.

- 5.2.5.8 Enclosed equipment housings must be vented for heat dissipation and must be capable of being fitted with additional forced ventilation units retrospectively.

### 5.2.6 Cable entry facilities

- 5.2.7 It must be possible to install further cables without damaging or excessively disturbing existing installed cables.
- 5.2.8 It must be possible to remove or dismantle the cabinet leaving existing installed cables attached to patch panels (e.g. to replace a damaged cabinet or replace a cabinet with a larger unit).
- 5.2.9 Cable entry cutouts in panels shall be fitted with protection for cables from rough edges of the panel.

## 5.3 Electrical

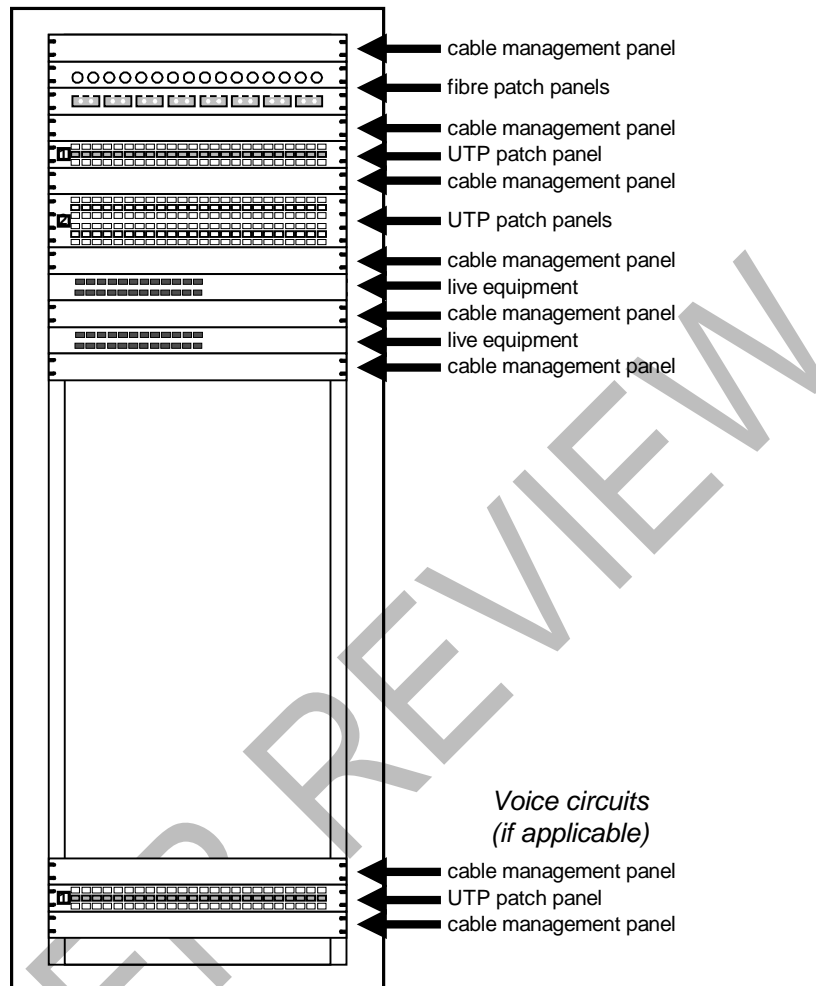
- 5.3.1 Electrical installations shall generally conform to the EBD **Standard Specification for Electrical Services** and **BS 7671 : 1992**.
- 5.3.2 Each equipment housing shall be fitted with a mains power distribution unit with 13A sockets.
- 5.3.3 The distribution strip shall have an illuminated indicator to show that mains is present.
- 5.3.4 The power distribution strip shall normally be vertical, running the full height of the frame, unless this would provide fewer than 6 mains sockets in which case a 6 outlet horizontal distribution unit shall be used.
- 5.3.5 The distribution strip shall be mounted to the rear of the frame in such a way that it does not take up the space available for rack-mounting equipment in the front of the housing. Where a horizontal strip is used it shall be mounted at the bottom of the frame.
- 5.3.6 The distribution strip shall be connected to the 240V mains power supply by an unswitched fused connection unit with illuminated indicator.
- 5.3.7 Where an unswitched fused mains power connection is to be provided it shall be wired from an independent circuit at the local distribution board, as advised by the EBD.
- 5.3.8 The fused spur from which the equipment cabinet is supplied shall be labelled:

<p><b>DO NOT DISCONNECT OR REMOVE POWER WITHOUT PERMISSION OF IT SERVICES</b></p>
---

- 5.3.9 Equipment housings shall have points suitable for earth bonding of patch panels.
- 5.3.10 Equipment housings shall be connected to mains earth by a secure connection separate from the mains supply cable to the housing.
- 5.3.11 Where more than one housing is installed each shall be connected separately to mains earth.

## 5.4 Patch panels and cable management accessories

5.4.1 Panels shall be installed in the order illustrated below:



5.4.2 Cable management panels shall be 1U high comprising guide hoops or similar.

5.4.3 Additional cable management panels shall be fitted between patch panels: one 1U cable management panel below every 2U of UTP patch panels or 4U of fibre patch panels. Where patch panels are larger than these heights extra cable management facilities shall be provided below and/or at the sides of the panels.

5.4.4 Patch panels for voice circuits shall be mounted separately from those for data circuits, as specified by the Telephone Manager.

5.4.5 Where additional patch panels are installed in an existing equipment housing the existing panels and live equipment shall, if necessary, be repositioned so that the new panels can be installed in the order specified above. The Contractor shall liaise with the NDA to ensure that no damage or avoidable disruption to existing equipment or services is caused in so doing.

## 5.5 Documentation

5.5.1 Details of the make and model of housings installed, their locations, and mains connections shall be supplied as described in **Appendix E**.

## **6 Trunking, tray and ductwork**

### **6.1 Trunking and tray**

- 6.1.1 The materials, choice of routes, methods of installation etc. for trunking and cable tray shall generally be as covered by the EBD's specifications for building and electrical work, with the following specific provisions:
- 6.1.2 Where new trunking or cable tray is to be installed it shall be sized to have the capacity to carry double the currently planned installation of cables.
- 6.1.3 Where multi-compartment trunking already exists the contractor must use the compartment provided for communication services.
- 6.1.4 Where multi-compartment trunking is to be provided each compartment must be large enough to accommodate BS4662 standard single and double size faceplates without intrusion into the other compartment.
- 6.1.5 At corners and junctions means shall be provided to prevent UTP and fibre-optic cables from being bent more sharply than the minimum bend radii specified in the appropriate standards.
- 6.1.6 Where metal trunking or tray is cut or drilled rough edges must be smoothed to avoid damage when drawing cables.
- 6.1.7 PVC trunking shall be fixed according to the specifications of the EBD.
- 6.1.8 The segregation of wiring categories shall be in strict accordance with the latest edition of **BS 7671 Requirements for Electrical Installations** including amendments.
- 6.1.9 Under no circumstances must trunking be installed on the outside of walls or structures.

### **6.2 Duct**

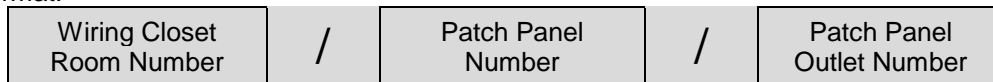
- 6.2.1 PVC ducts shall be 100mm normal British Telecom Standard duct 54D unless otherwise stated.
- 6.2.2 The routes and methods of installation for ductwork shall generally be as covered by the EBD's specifications for building and electrical work and the Supplementary Specification for the job. Where additional cables are drawn into ducts the draw wire must be replaced for subsequent use.

## Appendix A Identification and Labelling of Cat-5 UTP cables

This appendix summarises and illustrates the scheme specified in section 3.4.

### Outlet Ports

Outlets must be labelled to identify the circuit at the patch panel. The information on the label must be in the format:



### Patch Panels

Patch panels must be numbered (starting from 1).

Patch panel outlet sockets must be numbered (most panels are supplied already numbered).

Patch panel outlet sockets must also be labelled with the number of the room where the wall-box outlet end of the circuit is terminated.

### Cables

Cables are identified (e.g. on test results) by the combination of the building number plus the two codes above (see the example below).

### Example

(See diagram overleaf.)

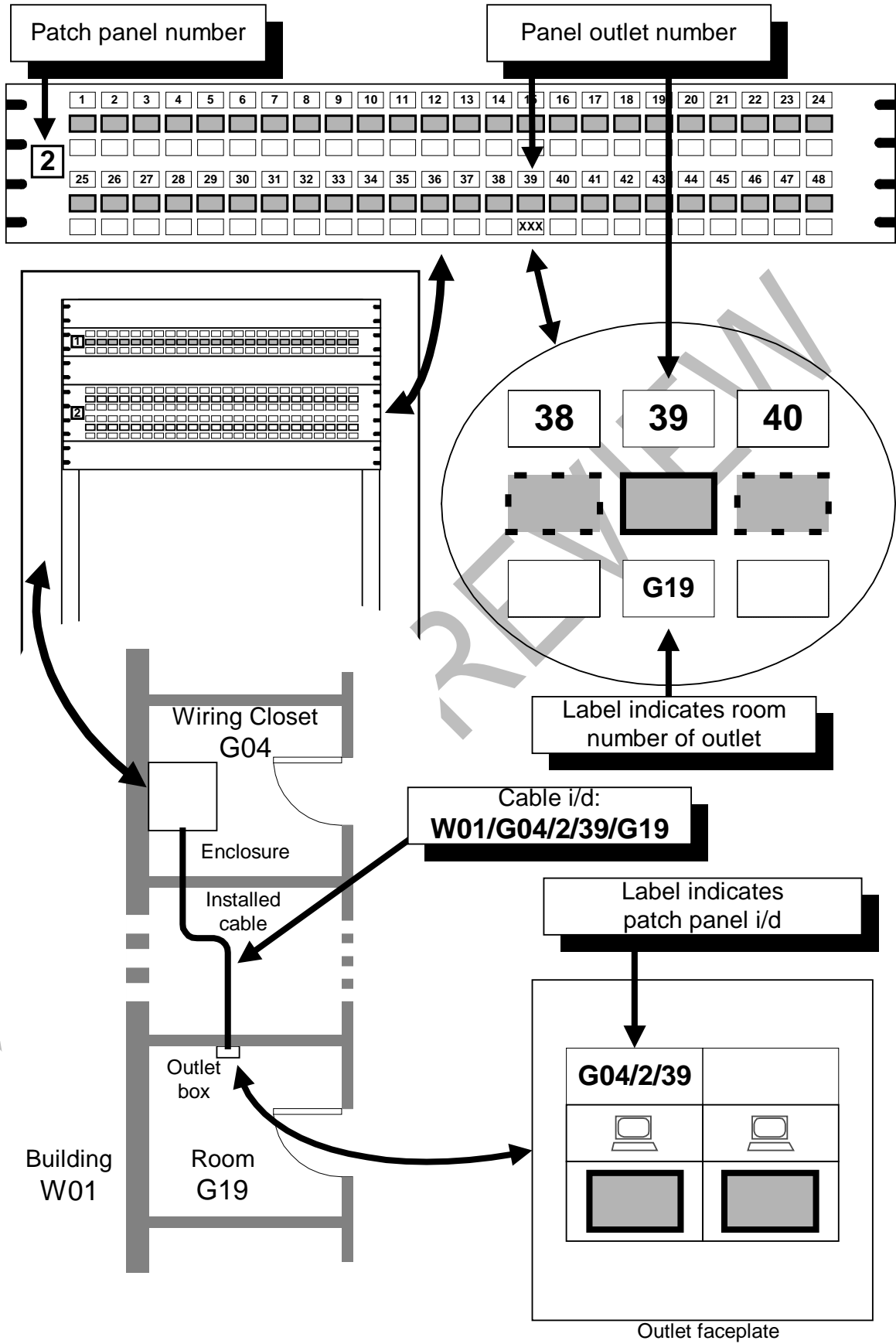
The code

**W01/G04/2/39/G19**

identifies a cable in building **W01**, which is terminated at the following points:

1. in room **G04**  
on patch panel number **2**  
on outlet number **39** (of a 48-way patch panel)
2. in room **G19**  
on an outlet labelled **G04/2/39**

The following diagram illustrates this scheme:



## Appendix B UTP Cable List format

The list of UTP circuits installed is in the form of a table:

<b>Column Title:</b>	<b>Building</b>	<b>Wiring Closet</b>	<b>Patch Panel</b>	<b>Patch Outlet</b>	<b>Room</b>
<b>Contents:</b>	Building Reference	Room Reference	Patch panel number	Patch panel outlet number	Room Reference

### Example:

<b>Building</b>	<b>Wiring Closet</b>	<b>Patch Panel</b>	<b>Patch Outlet</b>	<b>Room</b>
W012	G.01	1	1	G.02
W012	G.01	1	2	G.02
W012	G.01	1	3	G.02
W012	G.01	1	4	G.03
...	...	...	...	...
W012	G.01	1	24	G.19
W012	G.01	2	1	G.19
W012	G.01	2	2	G.20
...	...	...	...	...
W012	103	1	1	100
W012	103	1	2	100
W012	103	1	3	101
...	...	...	...	...

(where ... indicates more records)

This list may be supplied as an ASCII file, a tab- or comma-separated ASCII file, or as a spreadsheet in the native format of Microsoft Excel (version not greater than Office '97).

This list may be supplied as part of the list of test results for these cables provided that the fields above are present in the order shown, i.e. the test results may be incorporated as additional columns appended to the right of the table.

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UNDER REVIEW

## Appendix C

### Identification and Labelling of fibre-optic cables

This appendix summarises and illustrates the scheme specified in section 4.3

#### Patch Panels

Fibre-optic patch panels must be numbered (starting at 1 for the top (left) panel).

The terminations of each fibre core on the patch panel must be numbered (starting at 1) so each SC duplex connector will have two numbers (1+2, 3+4 etc.)

The patch panel must be labelled to show clearly which fibres are part of each cable (e.g. the first 8 cores are on one cable and the next 8 on another).

The patch panel must carry a label indicating where the other end of the fibre is terminated, in the format:

Building Number*	/	Room Number	/	Panel Number	(	Descriptive Name	)
------------------	---	-------------	---	--------------	---	------------------	---

#### Cables

Cables must be identified (by physical labels, and on drawings and test results etc) in the format:

Building Number*	/	Room Number	--	Building Number*	/	Room Number	--	Identification number
------------------	---	-------------	----	------------------	---	-------------	----	-----------------------

The first building number must be the alphanumerically lower of the two e.g. building W04 should come before W27, and L29 should come before either.

\* Where both ends of a fibre-optic cable terminate in the same building the Building Number may be omitted from the identification labels.

The identification number is to distinguish between multiple fibre cables installed between the same end-points: the first cable will have identification number 1 etc.

Cables must be physically labelled at intervals with their identification code on labels as shown:

<b>NDA Fibre Optic Cable</b>
<b><i>Building No* / Room No – Building No* / Room No – Identification No</i></b>

#### Example 1

(See diagram.)

The code

**W04 / G12 — W27 / 101 -- 1**

identifies the first cable installed between building **W04** room **G04**, and building **W27**, room **101**.

The cable is terminated on patch panel **1** in **W27/101** and on patch panel **5** in **W04/G12**: this information is clear from the labels on the patch panels.

The following diagram illustrates this scheme.

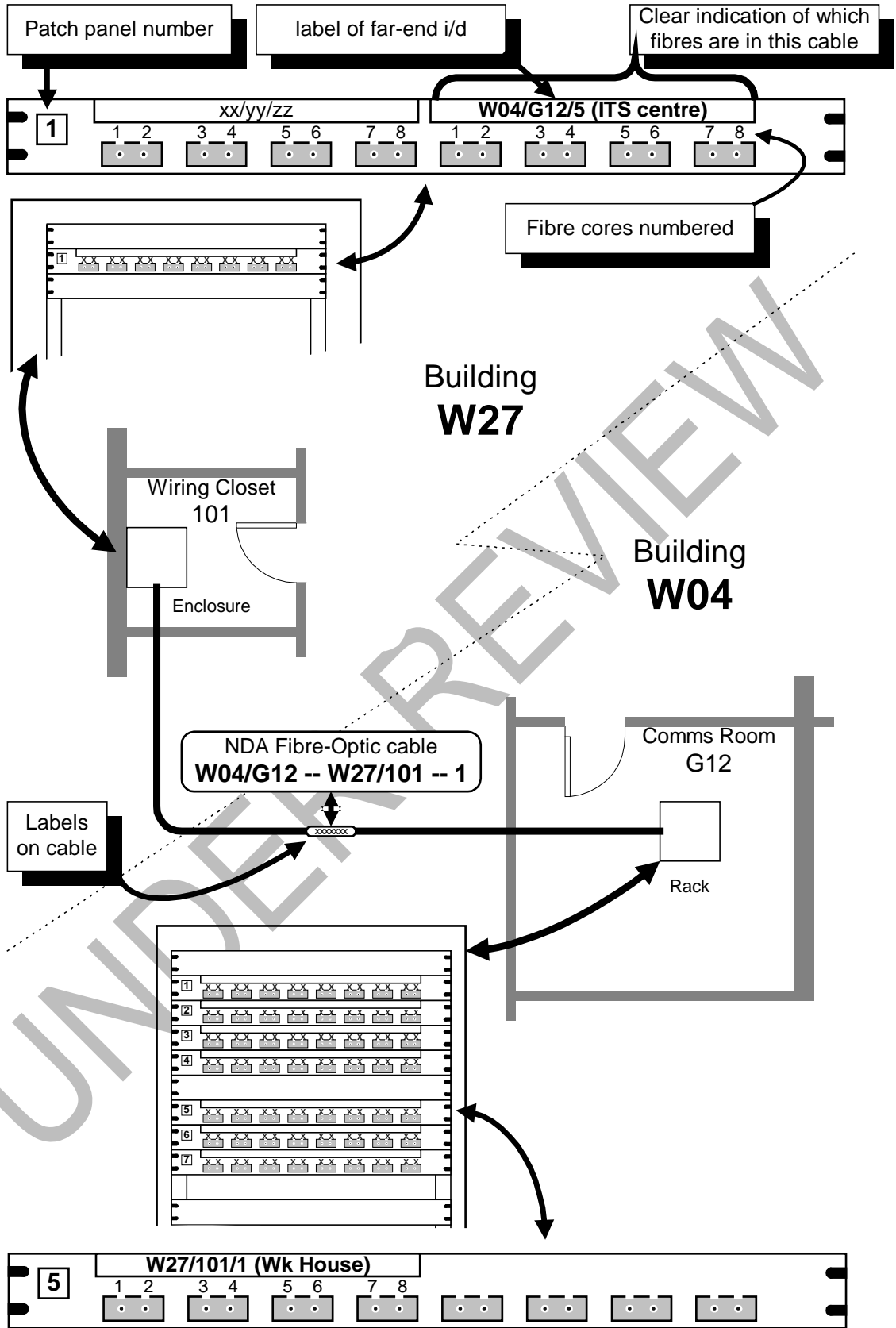
#### Example 2

The code

**G03 — 101 -- 2**

identifies a cable within a building, installed between room **G03** and room **101**. This is the second cable installed between these points: the first should be identified as **G03 — 101 – 1**.





## Appendix D Installation Practices

Cable installers must be aware of the limitations specified by the manufacturers on the force which can be applied when pulling in cables before damage to the cable results, and must take care to ensure that damage does not result from the use of excessive force. Extra care must be taken when pulling bundles of cables which are not taped, as the force will not be evenly applied across all cables.

Cables should not be pulled through more than two 90° bends. To do so may exceed the maximum pulling strength and could lead to cable damage.

When pulling in cables the minimum bend radius of eight times the overall cable diameter must be observed.

When pulling cabling through ducting, it is advisable to apply some form of lubrication to the cables. Any liquid based lubricant which is used should be designed for cable pulling. Chalk dust is an excellent lubricant.

Where cables are pulled onto cable trays or wire baskets allow a minimum of 10% extra slack at each bend.

Bundles of cables should be marked:

<p><b>WARNING</b> <b>Datacoms Cable</b> <b>Maintain Separation Distances</b></p>
--

at intersections and other suitable points along the path of the cable.

Where Fibre Optic cables are installed in vertical runs particular attention must be given to manufacturers' recommendations for the type of cable used and the method of installation to avoid damage due to the weight of unsupported fibre in e.g. loose-tube cables.

When installing UTP patch panels and outlets in dusty environments e.g. sites undergoing building construction or refurbishment work, precautions must be taken to prevent ingress of dust into connectors. Such measures may include taping over outlets and/or enclosing panels and outlets in plastic bags taped closed over the cables whilst construction work and concomitant dust persists. Especial care must be taken with outlets mounted in underfloor boxes which are particularly susceptible to contamination with dust.

## Appendix E Documentation

### General

Please copy and complete the following form, and other forms below as applicable, and return to the Contract Administrator with the relevant documentation (test results, calibration certificates etc).

Contractor	Company name	
	Telephone	
	Fax	
	Email	
Job	EBD reference (BOE number)	
	Contractor's reference No.	
Dates of work	Start	
	Finish	
Types of work	UTP cable installation	
	Fibre-optic cable installation	
	Equipment housing installation	
	Trunking/tray/ductwork	
	Other ( <i>please specify</i> )	
Location(s) of work	Building/room name/number (1)	
	Building/room name/number (2)	
	(3)	

### UTP installations

		Tick
Cable List	Electronic	
	Paper ( <i>optional</i> )	
Test Results	Electronic	
	Paper	
		Fill in details
Test Equipment	Make	
	Model	
	Serial Number	
	Copy of calibration certificate	
	Other equipment ( <i>Details as above</i> )	
		Tick
As-fitted drawings	Electronic	
	Paper	

**Fibre installations**

				Tick
Test Results	Pre-installation	OTDR	Electronic	
			Paper	
	Post-installation	OTDR	Electronic	
			Paper	
		Power meter	Electronic	
			Paper	
				Fill in details
Test Equipment	OTDR		Make	
			Model	
			Serial Number	
			Copy of calibration certificate	
	Power meter		Make	
			Model	
			Serial Number	
			Copy of calibration certificate	
	Other equipment		<i>Details as above</i>	
As-fitted drawings			Electronic	
			Paper	

**Equipment housings**

For each equipment housing please copy and complete the form below:

Location	Building name	
	Building number	
	Room number	
Type of housing	Enclosure/open frame	
	Manufacturer	
	Model	
Keys	Key type/number	
	Number of keys supplied	
Electrical	Location of mains distribution board	
	Identification of circuit at distribution board	

## 2.23 EMERGENCY LIGHTING.DOC

### General

The installation of lighting for emergency escape or stand-by lighting shall comply with BS.5266, ICEL 1003 and TM12.

The minimum standard of installation shall provide an average level of illuminance at floor level of 1 Lux on all escape routes for a period of three hours.

The system shall generally be of the maintained pattern with local sub-circuit monitoring using slave inverters and “hold off” relays within each converted luminaire .

Every emergency luminaire shall be provided with a key operated test switch . The test switches may be used for a number of fittings and grouped in a centralise location such as next to the general mains lighting distribution board.

All installations shall be provided with key operated means of testing. The normal voltage for emergency lighting equipment shall be 50 Volts or 110v dependent upon the voltage drop constraints.

Existing system, which are to be extended, must operate on the same voltage. If the operating voltage is incompatible then an holistic approach should be adopted in the best way of providing a single system.

All DC voltage distribution boards, and means of isolation shall be double pole switches.

### Self-Contained Systems

These systems must form part of the local lighting circuit and as such may be wired in the same wiring system and containment. The use of Self-Contained Luminaires is restricted to domestic size installations with less than 5 luminaires

Where the equipment is housed within the luminaires, the luminaire, its mounting arrangement and environment shall be designed to minimise the affect of high ambient temperature conditions.

Where this equipment is self-contained it shall be supported by others than the ceiling support grid mounted within the outgoing cable length specified by the Manufacturer and be readily accessible for inspection and maintenance.

Self contained luminaires shall be of the 8w fluorescent type for three hour duration and shall be fitted with a “mains healthy” neon, also a key operated mains switch to facilitate testing. Each unit shall have a “change status” indication visible from the inhabited space.

Circuit wiring shall be carried out in P.V.C. in steel conduit, unless indicated otherwise in Part 3 The Supplementary Specification.

### Central Systems

#### Maintained Emergency Lighting - Central Battery

Maintained Emergency Lighting installations shall be arranged to give a D.C. output in both “maintained” and “standby” state for use in conjunction with low wattage fluorescent and tungsten light sources.

#### Non-Maintained Emergency Lighting - Central Battery

Non-Maintained Emergency Lighting installations shall be arranged to give a D.C. output in “standby” state for use in conjunction with low wattage fluorescent and tungsten light sources.

#### Central Battery Units

The Central Battery Unit shall incorporate an automatic two-stage constant voltage battery charger, a mains failure relay, Nickel Alkaline cells and suitable stand or enclosure for the battery. The charging circuit shall also include an output voltmeter and ammeter.

## **2.23 EMERGENCY LIGHTING.DOC**

### **Wiring**

Circuit wiring shall be carried out in MICC cables with LSF sheath as indicated in Part 3 The Supplementary Specification

These systems shall be ventilated and installed in cool locations.

Cables to luminaires shall be installed in the specified insulation types, be correctly protected and segregated from other circuits.

### **Luminaires**

All luminaires for use on emergency lighting systems shall be power factor corrected.

Where forming an illuminated sign, the luminaire shall comply with BS.5499 and be installed with the correct pictogram and with the correct orientation for the pictogram as required by the enforcing authority.

## **2.24 CALL AND ALARM SYSTEMS.DOC**

See Part 3 of this Specification for specific description of materials, workmanship and scope of works for this project.

## **2.25 SECURITY AND ACCESS CONTROL.DOC**

See Part 3 of this Specification for specific description of materials, workmanship and scope of works for this project.



## **Builders Work**

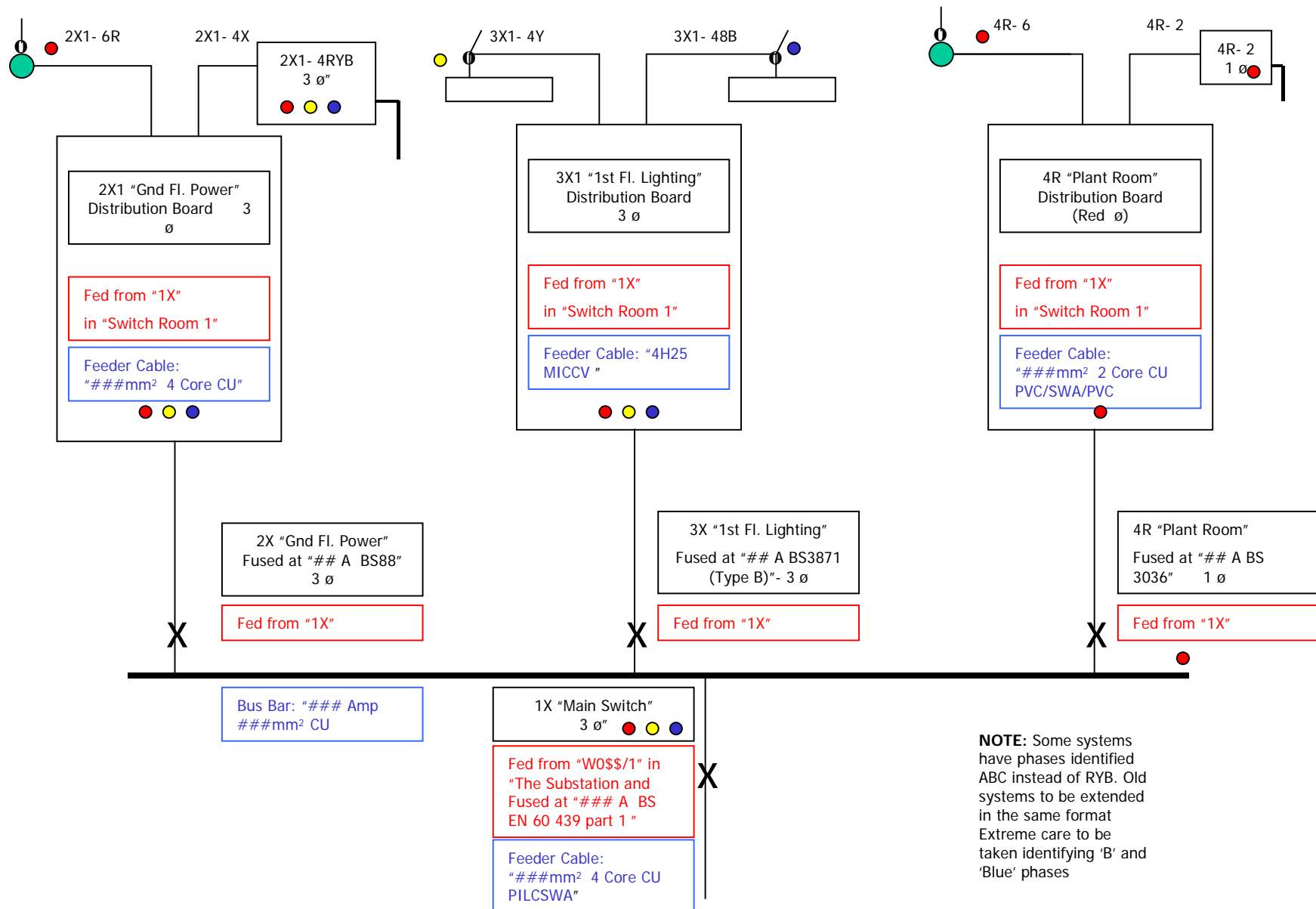
The responsibility for all marking out and for minor builders work (as for example the fixing of brackets to grounds) is the responsibility of the Electrical Contractor, and shall be carried out without extra charge to the Contract, under the general superintendence of the CA.

As a rule any hole less than 25mm diameter will be cut by the electrical contractor and all holes and chases shall be cut away and made good by the main contractor. But all hole cutting, chasing and builders work shall be carried out by the electrical contractor if they are the sole, main, or principal contractor.

Major buildings work, e.g. switch apparatus bases, fixing of built in pipe supports, chasing, formation of trenches, decorative painting will be carried out by the main Contractor, but the Electrical Contractor shall provide all details, drawings, and attendance to enable the work to be carried out promptly and economically.

The works shall not be attempted without the prior knowledge and consent of the CA:-

- Notching of joists in excess of 15mm.
- Holing of joists in excess of 15mm.
- Lifting or cutting of hardwood floors, parquetry, woodblock, mosaic, terrazzo, or similar floors.
- Cutting or removal of wood panelling, or high quality finished joinery.
- Cutting and/or drilling of steelwork.
- Chasing in ornamental plaster, through decorative cornices, or in situations where serious damage to decorations will result.



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**DWG No:** W099E476