



**EQUANS  
Manchester Royal Infirmary  
Nelson Street Sub Station  
Life Cycle Upgrade  
LC1839**

Prepared By:  
Approved By:  
Job No:  
Project Number:  
Issue:  
Date:

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3341  
LC-1839  
Stage 3  
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**CONTENTS**

| <b>SECTION</b> | <b>DESCRIPTION</b>                                   | <b>PAGE</b> |
|----------------|------------------------------------------------------|-------------|
| <b>1</b>       | <b>PARTICULAR SPECIFICATION</b>                      | <b>1/1</b>  |
|                | 1.1 Description of Works                             | 1/1         |
|                | 1.2 Removals                                         | 1/5         |
|                | 1.3 New Low Voltage Switchboard                      | 1/6         |
|                | 1.4 Access                                           | 1/11        |
|                | 1.5 Testing                                          | 1/12        |
|                | 1.6 Service Cable Trench                             | 1/13        |
|                | 1.7 Sequence of Diverting Cables                     | 1/14        |
|                | 1.8 Generators                                       | 1/15        |
|                | 1.9 Sub Main Cabling                                 | 1/16        |
|                | 1.10 Earthing Main, Equipotential, Supplementary     | 1/17        |
|                | 1.11 Containment                                     | 1/19        |
|                | 1.12 Fire Precautions                                | 1/20        |
|                | 1.13 Socket and Small Power                          | 1/21        |
|                | 1.14 General Lighting                                | 1/22        |
|                | 1.15 Emergency Lighting                              | 1/23        |
|                | 1.16 Fire Alarms                                     | 1/24        |
|                | 1.17 Structured Cabling                              | 1/25        |
|                | 1.18 BMS                                             | 1/26        |
|                | 1.19 Lightning Protection System                     | 1/27        |
|                | 1.20 “As Fixed” Drawings                             | 1/28        |
|                | 1.21 Maintenance Service Manuals                     | 1/29        |
|                | 1.22 Testing and Commissioning                       | 1/31        |
|                | 1.23 Queries                                         | 1/32        |
|                | 1.24 Schedule of Drawings                            | 1/33        |
|                | 1.25 Schedule of Manufacturers                       | 1/34        |
| <b>2</b>       | <b>GENERAL PREAMBLES AND PRELIMINARIES</b>           | <b>2/1</b>  |
| <b>3</b>       | <b>GENERAL REQUIREMENTS</b>                          | <b>3/1</b>  |
|                | 3.1 Definitions                                      | 3/1         |
|                | 3.2 Construction (Design and Management) Regulations | 3/1         |
|                | 3.3 Scope of Work                                    | 3/2         |
|                | 3.4 A Schedule of Rates                              | 3/3         |
|                | 3.5 Technical Information                            | 3/3         |
|                | 3.6 Quality Control Resources                        | 3/3         |
|                | 3.7 Visit to Site                                    | 3/3         |
|                | 3.8 Installation and Detailing Information           | 3/4         |
|                | 3.9 Builders Work Information                        | 3/4         |
|                | 3.10 Drawing Types                                   | 3/5         |
|                | 3.11 Setting Out of the Works                        | 3/6         |
|                | 3.12 Documents and Drawings On Site                  | 3/6         |
|                | 3.13 Person In Charge and Quality of Workmanship     | 3/7         |
|                | 3.14 Materials and Workmanship                       | 3/7         |
|                | 3.15 Contractor’s Temporary Electrical Supplies      | 3/8         |
|                | 3.16 Carriage of Goods                               | 3/9         |

| SECTION  | DESCRIPTION                                              | PAGE       |
|----------|----------------------------------------------------------|------------|
|          | 3.17 Test Certificates                                   | 3/9        |
|          | 3.18 Use of Installation by Contractor                   | 3/10       |
|          | 3.19 Earthed Equipotential Bonding                       | 3/10       |
|          | 3.20 Suitability of Materials and Products               | 3/11       |
|          | 3.21 Handling                                            | 3/12       |
|          | 3.22 Storage                                             | 3/12       |
|          | 3.23 Protection of Contract Works                        | 3/12       |
|          | 3.24 Room Terminal Location                              | 3/13       |
|          | 3.25 Maintenance of Existing Services                    | 3/13       |
|          | 3.26 Identification of Plant and Equipment               | 3/13       |
|          | 3.27 Cleaning of Materials and Works                     | 3/14       |
|          | 3.28 Testing and Commissioning of Services               | 3/14       |
|          | 3.29 Record Documents                                    | 3/15       |
|          | 3.30 Training of Client Staff                            | 3/17       |
|          | 3.31 Defects Liability Period                            | 3/18       |
| <b>4</b> | <b>LV SUPPLIES AND DISTRIBUTION EQUIPMENT</b>            | <b>4/1</b> |
|          | 4.1 Rated Voltage                                        | 4/1        |
|          | 4.2 Switch Board Panels                                  | 4/1        |
|          | 4.3 Moulded Case Circuit Breakers (MCCB)                 | 4/4        |
|          | 4.4 Contactors                                           | 4/4        |
|          | 4.5 Fuses                                                | 4/5        |
|          | 4.6 Enclosures                                           | 4/5        |
|          | 4.7 Distribution Boards                                  | 4/5        |
|          | 4.8 Identification of Switchgear and Distribution Boards | 4/6        |
|          | 4.9 Miniature Circuit Breakers (MCB)                     | 4/6        |
|          | 4.10 Residual Current Devices (RCD and RCBO)             | 4/7        |
|          | 4.11 Labels and Diagrams                                 | 4/7        |
|          | 4.12 Instruments                                         | 4/7        |
|          | 4.13 Notice and Labels                                   | 4/8        |
| <b>5</b> | <b>CONTAINMENT AND WIRING</b>                            | <b>5/1</b> |
|          | 5.1 Containment                                          | 5/1        |
|          | 5.2 Wiring                                               | 5/9        |
|          | 5.3 General                                              | 5/16       |
| <b>6</b> | <b>LUMINAIRES AND ACCESSORIES</b>                        |            |
| <b>6</b> | <b>LUMINAIRES AND ACCESSORIES</b>                        | <b>6/1</b> |
|          | 6.1 Luminaires                                           | 6/1        |
|          | 6.2 Plug In Ceiling Roses and Modular Wiring Systems     | 6/1        |
|          | 6.3 Lamps                                                | 6/2        |
|          | 6.4 Flexible Cables and Cords                            | 6/2        |
|          | 6.5 Lighting Switches                                    | 6/2        |
|          | 6.6 Socket Outlets                                       | 6/3        |
|          | 6.7 Fused Connection Units                               | 6/3        |

|          |                                               |            |
|----------|-----------------------------------------------|------------|
| <b>7</b> | <b>EARTHING</b>                               | <b>7/1</b> |
|          | 7.1 Earthing                                  | 7/1        |
| <b>8</b> | <b>INSPECTION AND TESTING</b>                 | <b>8/1</b> |
|          | 8.1 General                                   | 8/1        |
|          | 8.2 Visual Inspection                         | 8/1        |
|          | 8.3 Testing in Compliance with BS7671         | 8/1        |
|          | 8.4 Factory Proving Tests and Trials          | 8/2        |
|          | 8.5 Commissioning                             | 8/2        |
|          | 8.6 Documentation                             | 8/2        |
|          | 8.7 Treatment - Electric Shock                | 8/3        |
| <b>9</b> | <b>LABELLING AND IDENTIFICATION</b>           | <b>9/1</b> |
|          | 9.1 General                                   | 9/1        |
|          | 9.2 Label Types                               | 9/1        |
|          | 9.3 Warning Notices                           | 9/1        |
|          | 9.4 General Information/Identification Labels | 9/1        |
|          | 9.5 Emergency Labels                          | 9/3        |
|          | 9.6 Prohibition Labels                        | 9/3        |
|          | 9.7 Fire Fighting Labels                      | 9/3        |
|          | 9.8 Labelling Material                        | 9/3        |
|          | 9.9 Labelling for HV Switchgear               | 9/4        |

Summary of Tender  
Schedule of Dayworks

**SECTION 1****SPECIFIC DETAILS****1.1 DESCRIPTION OF WORKS****1.1.1 General**

The scope of works for this element of the contract shall be the complete **design, installation and setting to work** of the Electrical Building Services Works as described in the tender documents.

The project consists of Life Cycle Works to Nelson Street Sub Station at the Manchester Royal Infirmary.

Nelson Street Sub Station is referenced DSS 430 on the MRI site and is served via the Hospital private high voltage open ring network, (Ring No. 4 @ 6.6kV/415V).

The sub-station comprises a single oil filled 1250kVA transformer and high voltage ring main unit with low voltage switchgear.

Further high voltage ring main units are provided at the sub-station which provide a high voltage interconnector between high voltage rings No. 1 and No. 4.

The low voltage switchgear provides both essential and non-essential services and via an automatic change-over contactor arrangement is interfaced into a 400KVA standby generator Ref G8 located externally adjacent to the Education Centre.

Nelson Street sub-station serves the following departments:

| <b>Non Essential Supplies</b>                                                                                                                                                                                                      | <b>Essential Supplies</b>                                                               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| Local Car Park Lighting D/B<br>Grafton Street Car Park<br>Ward 27<br>Social Club<br>Sub Station D/B<br>Education South<br>Grafton Street Car Park Extension<br>Rehabilitation Unit<br>Education North<br>Heli-pad (Grafton Street) | Education South<br>Sub Station D/B<br>Ward 27<br>Education North<br>Rehabilitation Unit |

This Life Cycle project consists of the replacement in full of the low voltage switchgear only, diverting all existing sub main feeder cables to the new low voltage switchboard.

**Note:** No works are required associated with the high voltage installation, i.e. high voltage, network, RMU's, transformer, etc.

In order to facilitate this Life Cycle project, a new switchroom shall be constructed adjacent to the Nelson Street sub-station which shall house the new low voltage switchboard.

When this new LV switchboard has been installed, tested and commissioned, the new switchboard shall be made live by installing new tails wiring from the Nelson Street existing transformer (during this exercise a mobile generator shall be connected into the non-essential existing LV switchboard providing the primary supply).

One by one, the existing sub main cables connected to the existing low voltage switchboard shall be disconnected, jointed and extended to the new low voltage switchboard as detailed on the tender drawings.

When all sub main cables have been transferred over to the new low voltage switchboard, the existing low voltage switchboard shall be removed.

A comprehensive change-over proposal has been identified on the tender drawings.

The new Nelson Street low voltage switchroom shall also be provided with ancillary services by the Electrical Contractor, i.e. small power, lighting, emergency lighting, fire alarms and BMS.

Prior to any isolations of services, the Electrical Contractor shall provide a full Risk Assessment and Scope of Works. The Scope of Works shall detail in full the “down time” of all services (which must be kept to a minimum).

All isolation works/down time works shall be undertaken outside of normal working hours between the hours of 20.00hrs and 05.30hrs the following day with all services being live and available at 05.30hrs.

The Electrical Contractor shall note that no isolation works shall commence (as this is a live Hospital) until Sodexo have signed and issued a Permit to Work certificate.

The Electrical Contractor shall note that Sodexo will undertake all isolations of electrical supplies.

All builderswork shall be included by the Electrical Contractor, which shall include but not limited to:

- Forming holes as required and fire stopping.
- Dismantle of the existing switchboard into sections and removed from site.

### **1.1.2 Existing Services and Removals**

All services to be removed by the Electrical Contractor shall and offered back to the Trust.

Should the Trust not require the existing equipment, items of plant, the Electrical Contractor shall dispose of said equipment.

### **1.1.3 New Low Voltage Switchboard**

The new Nelson Street low voltage switchboard shall be supplied and installed by the Electrical Contractor in the new LV switchroom adjacent to Nelson Street sub-station.

The new LV switchboard shall be complete with devices as detailed on the tender drawings and further in this specification.

The new LV switchboard shall be supplied and installed by the following manufacturer:

R&B Switchgear, details are:

Contact: Mr J Harvey  
Tel: 01706 369933  
Email: john.harvey@rbswitch.com

### **1.1.4 Distribution Boards**

The existing Nelson Street essential and non-essential MCB distribution boards shall be utilised to supply the general lighting and small power services to the new LV switchroom utilising multicore Draka FTP120 fire rated cables.

### **1.1.5 Sub Mains Cabling**

The Electrical Contractor shall joint and extend the existing outgoing sub main cables from the old Nelson Street LV switchboard and terminate said cables into the new LV switchboard as detailed on the tender drawings.

The cable joints shall be straight through, resin propriety type in compliance with BS788/HD623.

New extension sub main cables shall be of the type as detailed on the tender drawings and installed on new ladder racking.

The cables shall be jointed in the existing LV switchroom or within the brick built floor trench and enter the new switchroom from the floor trench at 3 No. different locations as detailed on the tender drawings.

The Electrical Contractor shall note that separate ladder racks shall be provided for essential and non-essential cables as detailed on the tender drawings.

### **1.1.6 Cable Tray/Ladder Rack**

The Electrical Contractor shall supply and install a new cable containment system as detailed on the tender drawings (ladder racking).

### **1.1.7 Testing and Commissioning**

The Electrical Contractor shall carry out the testing and commissioning in accordance with this specification.

The Electrical Contractor shall note the departments served from Nelson Street sub-station will remain fully operational and will remain operation throughout the duration of this contract.

Out of hours working will be necessary. All out of working hours and “break in” to existing services shall be agreed with the Hospital.

The Electrical Contractor shall refer to the Main Contractor programme.

### **1.1.8 As Fitted Drawing**

As fitted drawings are provided with the tender documents, however the Electrical Contractor shall visit site to assess the level of services which are to be removed.

### **1.1.9 Visit to Site**

The Electrical Contractor shall visit site to assess the extent of the works as no claim on the grounds of want of knowledge in such respect will be accepted.

Prior to visiting the site, the Electrical Contractor shall obtain permission from:

Mr Paul Darcy  
Design Manager  
EQUANS  
Ground Floor  
Cobbett House  
Oxford Road  
Manchester Royal Infirmary  
M13 9WL

Email: paul.darcy@engie.com

## **1.2 REMOVALS**

### **1.2.1 General**

As built' drawings that are available have been included within the tender documentation, however these do not cover all the areas.

The Electrical Contractor shall therefore visit site to assess the extent of services to be removed as no claim on the grounds of want of knowledge in such respect will be accepted.

All services, items of plant/equipment to be removed are to be offered back to the Trust.

Should the Trust require to retain any equipment, the Electrical Contractor shall include for transporting said equipment to a location to be agreed with the Trust on the site of the Manchester Royal Infirmary.

Should the Trust not require the any existing services/equipment, items of plant etc., the Electrical Contractor shall dispose of said equipment safely off site.

### 1.3 NEW LOW VOLTAGE SWITCHBOARD

#### 1.3.1 General

The new essential and non-essential switchboard shall be designed, supplied and installed by the Electrical Contractor in the new Nelson Street low voltage switchroom.

The switchboard shall accommodate 4 Pole 2500A ACB(s), 4 Pole 2500A ACB(s) for use with a mobile generator and load bank, essential and non-essential sections complete with an ASCO 2600A ATS, closed transition with dual bypass switch and associated controls.

Outgoing ways are detailed further in this specification and as detailed on the tender drawings.

Prior to ordering the new Low voltage switchboard, the Electrical Contractor in conjunction with Sodexo shall arrange for a survey of the existing essential and non-essential switchboard to establish the actual fuse ratings of each existing outgoing way and forward this report to Redworth Associates.

Any deviation from the tender drawings required will be corrected and covered by a Contract Instruction.

Prior to ordering the new low voltage switchboard, the Electrical Contractor shall submit to EQUANS/Redworth the LV switchboard proposal for comment.

The switchboard non-essential ACB incomer shall be served from the existing Nelson Street 1250kVA ONAN 6.6/415 Volt transformer via new tails wiring.

The switchboard essential ACB incomer shall be served from the existing Nelson Street 400kVA generator, the supply cable generator to the new switchboard shall be cable jointed and extended as required.

**Note:** The essential switchboard is to be rated at 2500A to accept a new generator under a future scheme rated at 1500kVA.

#### 1.3.2 Essential / Non-Essential Section Boards

The new essential and non-essential switchboard shall form separate sections and be located in separate fire compartments within the new LV switchroom to improve resilience with bus coupler connecting the essential to the non-essential.

- Each section boards shall be manufactured to Form 4 Type 6 Construction (metallic individual compartments with remote cable terminations).
- Each switchboard shall be FRONT cable access and designed for TOP entry and exit cables.
- All incoming and outgoing ways will be fitted with CT(s) fuses network cabling and ABB-DELTA-APlus meters.

- A digital phase indicator shall be provided to the non-essential incomer.
- All ACB(s) as detailed on the drawings shall be of the draw out type and be rated at 2500A 4 Pole complete with 5.0 trip units.
- All outgoing MCCB's shall be 4 Pole Plug-In type fitted with Micro Logic 2.2 trip units up to 200A and Logic 2.3 trip units greater than 250 Amps.
- All MCCB's shall be fitted with door interlocked rotary handles.
- All MCCB's shall have a minimum breaking capacity of 36KA.
- Section boards shall be complete with Bus couplers rated at 2500A and be of the manual Castell key locking arrangement as detailed on the tender drawings.
- The 2600A ATS/closed transition with dual bypass shall be supplied by ASCO (Schneider) and be integrated into the new LV switchboard by the switchboard manufacturer.

### **1.3.3 Devices**

All devices shall be of the Merlin Gerin/Schneider manufacture.

All metering shall be of the ABB-DELTA-APlus format.

All meters shall be wired internally (network twisted pair as detailed on the tender drawings and be terminated in an external termination box (for further connection to the Hospitals Schneider BMS).

### **1.3.4 Enclosure**

The Switchboards shall be manufactured with fully welded outer units using 2.00mm CR4 sheet steel, Internal compartments will be manufactured from 1.6/2mm Zintec sheet steel.

### **1.3.5 Form of Segregation**

The Switchboards shall be manufactured to BS EN 60439 FORM 4 TYPE 6 (metallic individual compartments with remote cable terminations).

### **1.3.6 IP Rating**

The Switchboards shall be ingress protected to a minimum of IP2X

### **1.3.7 Cable Access and Entry**

The Switchboards shall be designed for FRONT cable access, with TOP entry incoming and TOP entry outgoing cables

### 1.3.8 Painting

External Doors and covers will be finished as follows: -

Pre-treatment Vapour Degrease High Temp Pressure Wash Phosphate wash  
One coat Epoxy Polyester powder coating and stove.  
Finish to a minimum 50 microns.  
Colour: RAL7035, others available on request

### 1.3.9 Short Circuit Protection Devices

Each ACB/MCCB shall be mounted in a individual compartment behind individual front doors. Operation of the MCCB's will be by means of the unit's independent door interlocked rotary handle.

### 1.3.10 Busbars

Busbars shall be made of high conductivity electrical copper of not less 97% and shall have adequate cross-sectional area for maximum temperature rise of 45 deg cent, for stated normal full load.

Main Busbars shall be rated to suit the incomer and be A.S.T.A certified to BS EN 60439 as follows: -

50KA for 1 second

### 1.3.11 Earthing

A bolted earthing point and busbar complete with adequate connecting point for all earth conductors shall be provided.

A continuous copper bar rated at 1200Amp shall be installed externally on top of the switchboard to run full length of the switchboard.

### 1.3.12 Works Tests

Include for standard routine works tests with certification provided.

### 1.3.13 Site Assembly/Test/Commissioning

Include for site delivery, site assembly and site test/commissioning with certification provided.

### 1.3.14 Schedule of Equipment

#### Essential Section Board

- 1 x 2500A ACB Incoming Switch
- 2500A 4 Pole Rack In/Rack Out ACB c/w Micro Logic 5.0 Trip Unit
- c/w Castell Lock to the mobile generator ACB
- Door Interlocked Rotary Handle
- ABB-DELTA-APlus meter
- LED Phase Indication

- 1 x 2500A ACB – Mobile Generator Incoming Switch  
2500A 4 Pole Rack In/Rack Out ACB c/w Micro Logic 5.0 Trip Unit, c/w Castell Locking with main essential incomer ACB and ABB-DELTA-APlus meter
- 1 x 2500A ACB – Load Bank  
2500A 4 Pole Rack In/Rack Out ACB c/w Shunt Trip to the ASCO ATS and ABB-DELTA-APlus meter
- 1 x 2500A ACB – Essential Main Panel Incoming Switch  
2500A 4 Pole Rack In/Rack Out ACB c/w Micro Logic 5.0 trip unit c/w shut trip to ASCO ATS and ABB-DELTA-APlusmeter
- 1 x ASCO 7000 series G frame 2600A ATS/closed transition with dual bypass switch ASCO controller
- 1 x 100A 4P Outgoing MCCB  
100A 4P Plug In MCCB c/w Micro Logic 2.2 Trip Door interlock Rotary Handle sets of CT;s, fuses and ABB-DELTA-APlus meter
- 8 x 200A 4P Outgoing MCCB's  
200A 4P Plug In MCCB's c/w Micro Logic 2.2 Trip Door interlock Rotary Handle sets of CT;s, fuses and ABB-DELTA-APlus meter
- 3 x 400A 4P Outgoing MCCB's  
400A 4P Plug In MCCB's c/w Micro Logic 2.3 Trip Door interlock Rotary Handle sets of CT;s, fuses and ABB-DELTA-APlus meter
- 1 x New Surge Protection Unit  
200A Outgoing MCCB  
200A 4 Pole Plug-in MCCB  
Door Interlocked Rotary Handle  
In Built Surge protection unit

#### **Non-Essential Section Board**

- 1 x 2500A Incoming Switch  
2500A 4 Pole Rack In/Rack Out ACB c/w Micro Logic 5.0 Trip Unit  
c/w LED phase indication and sets of CT(s), fuses and ABB-DELTA-APlus meter
- 2 x 2500A ACB  
2500A 4 Pole Rack In/Rack Out c/w Castell locking with bus coupler
- 8 x 400A Outgoing MCCB's  
400A 4 Pole Plug-in MCCB's c/w:-  
Micro Logic 2.3. Trip  
Door Interlocked Rotary Handle  
Sets of CT's, fuses and ABB-DELTA-APlus meters on all outgoing ways
- 1x New Surge Protection Unit  
200A Outgoing MCCB  
200A 4 Pole Plug-in MCCB  
Door Interlocked Rotary Handle

### Inj Built Surge Protection Unit

- 1 x 1250A 4 Pole ACB  
1250A 4 Pole Rack In/Rack Out ACB c/w Micro Logic 5.0 Trip Unit, cw LED Phase Indication, CT's, fuses ABB-DELTA-APlus meter
- 8 200A 4 Pole Plug-in MCCB's c/w:-  
Micro Logic 2.2. Trip  
Door Interlocked Rotary Handle  
Sets of CT's, fuses and ABB-DELTA-APlus meters on all outgoing ways
- 1 x 100A Outgoing MCCB  
100A 4 Pole Plug-in MCCB c/w:-  
Micro Logic 2.2. Trip  
Door Interlocked Rotary Handle  
Sets of CT's, fuses and ABB-DELTA-APlus meter
- 1 x Digital meter, voltage, current including LED phase available indication.
- 1 x Restricted earth fault relay.
- 1 x 30V DC tripping UPS unit as detailed on tender drawings.

#### 1.3.15 Active Harmonic Filter Unit

The Electrical Contractor shall supply and install a Active Harmonic filter unit as manufactured by Schneider of the Accusine type rated at 120 Amps.

#### 1.3.16 Power Factor Connection

The Electrical Contractor shall allow a PC Sum of £10,000.00 should power factor connection be required.

#### 1.3.17 Neutral Paralleling Contactor

The Electrical Contractor shall include a provisional sum £8,000.00 for the neutral paralleling contactor and all associated controls.

**1.4 ACCESS**

Access into Nelson Street Sub Station shall only be via a Permit to Work document, signed by Sodexo.

## **1.5 TESTING**

Full testing of the switchboard and ASCO ATS shall be undertaken by the switchboard manufacturer and Schneider (ASCO) on site in the presence of EQUANS/Sodexo and the Trust representative.

The Electrical Contractor shall include all costs associated with the attendance by Schneider to demonstrate correct operation of the ASCO ATS and obtain full acceptance certificates from Schneider prior to commencement of installing the new transformer tails and all subsequent cable transfers.

## 1.6 SERVICE CABLE TRENCH

An existing cable trench (brick construction with concrete lid covers) currently provides cable access into the existing Nelson Street low voltage switchroom (refer to tender drawings for further information and location).

The majority of the sub main cables exit Nelson Street Sub Station via this cable trench (apart from the sub main cable that serves Grafton Street Car Park and the Helipad).

The new Nelson Street low voltage switchroom is to be positioned over this cable duct and cables are intended to be cast resin jointed in the cable duct and rise into the new switchroom for top entry onto the new switchgear.

Prior to the construction of the new low voltage switchroom, the main building contractor shall arrange to “lift up” the concrete covers to expose the existing sub main cables and clear the duct of asbestos.

When the asbestos has been cleared and a Certificate of Clearance Safety Certificate has been issued, construction of the low voltage switchboard shall commence (which will be of a modular construction) and subsequent diversion of sub main cables.

## **1.7 SEQUENCE OF DIVERTING CABLES**

Prior to any isolations of services, the Electrical Contractor shall provide a full Risk Assessment and Scope of Works. The Scope of Works shall detail in full the “down time” of all services (which must be kept to a minimum).

The Scope of Works shall also list all departments affected by the shutdown.

Shutdown of services per department shall be limited to undertaking separate essential and non-essential shutdowns on separate days such that each department always has a supply available.

Where Bus Couplers are provided on the remote department switchboards, these shall be closed to provide full services for the respective departments.

All isolation works/down time works shall be undertaken outside of normal working hours between the hours of 20.00hrs and 05.30hrs the following day with all services being live and available at 05.30hrs.

For tender purposes only, the Electrical Contractor shall base their tender on the sequence of diverting cables as detailed on the tender drawings.

The sequence of works drawing details the minimum requirements which include temporary mobile generators/temporary cabling.

The Electrical Contractor shall be responsible for the supply and installation of the temporary mobile generator including all fuel as required to provide the primary supply to the existing low voltage distribution board as detailed on the tender drawings.

## **1.8 GENERATORS**

### **1.8.1 Existing Generator**

The Electrical Contractor shall note the existing Nelson Street standby generator is to be retained and re-connected to the new low voltage switchboard as detailed on the tender drawings.

The Electrical Contractor will note the essential section of the new low voltage switchboard is rated at 2500Amp, far greater than required for a 400kVA generator.

The rating of the essential switchboard has been selected such that in future the existing 400kVA generator may be replaced with a new generator providing 100% sub-station back up @ 1500kVA.

### **1.8.2 Existing Generator Governor**

The Electrical Contractor shall include a PC sum of £5,000.00 to change the existing generator governor to an “Isochronous Governor Type” should the existing governor NOT be of the Isochronous type.

### **1.8.3 Mobile/Temporary Generator**

The Electrical Contractor shall include within their tender for a mobile generator rated at 750kVA including all temporary cables and fuel to provide the primary supply to the existing low voltage switchboard whilst installing new transformer tails wiring to the new low voltage switchboard, temporary back feed, (new low voltage switchboard to the existing low voltage switchboard) and also the transfer of existing sub main cables old switchboard for new.

Whilst the mobile generator is providing the primary supply (LV tails installation) and the back-up supply (transferring/extending sub main cables) the Electrical Contractor shall provide on site a dedicated trained generator operator at all times, the mobile generator is providing the primary and secondary supply as manual control of the generator will be required i.e. switching on line – switching off line.

## **1.9 SUB MAIN CABLING**

### **1.9.1 General**

The Electrical Contractor shall supply and install a new cable containment system as detailed on the tender drawings.

The Electrical Contractor shall note the cable sizes associated with the sub main cables to be jointed, extended and replaced are for tender purposes only.

Prior to ordering any materials (cables/resin joints) etc. the Electrical Contractor shall undertake a full survey of the existing sub main cables and produce a schedule of cable sizes for issue to Redworth Associates.

Any discrepancies between the tender drawings and the actual installed drawing shall be agreed and any variations required shall be instructed through the contract.

## 1.10 EARTHING MAIN, EQUIPOTENTIAL, SUPPLEMENTARY

### 1.10.1 General

The Electrical Contractor shall supply and install an earthing and bonding system in accordance with the details on the various drawings and this section of the Specification.

The earthing and bonding shall comply with the IET Regulations and BS Codes of Practice CP 1013.

The Electrical Contractor shall supply and install a new earth bar in the new low voltage switchroom adjacent to the new LV switchboard as manufactured by Furse.

This new earth bar shall be connected to the existing Nelson Street sub-station earth bar (which is to remain) via a new 1000mm<sup>2</sup> CU LSF cable.

This new 1000mm<sup>2</sup> CU LSF cable shall be provided with an engraved traffolyte label at each earth detailing source of supply at the new earth bar and new earth bar serviced at the existing earth bar.

Where the protective conductors are separate and do not form an integral part of a cable, they shall be LSF insulated, coloured green and yellow. They shall be installed on cable trays when run in groups and fixed using LSF coated metal clips. Where they are installed singly they shall be fixed using LSF coated saddles with sheradised double threaded screws and nylon plugs.

The ends of the protective conductors which are to be connected to the earth bar shall be terminated in a crimped cable socket, and bolted separately to the earth bar using brass bolts, nuts, washers, and locking arrangements. All connecting faces shall be tinned.

Each protective conductor connected to the earth bar shall be identified by having fixed to the cable an engraved label, describing the service to which it is connected.

All cable trays/baskets shall be effectively bonded. Manufacturers bonding links being provided across connecting pieces, fish plates etc.

The new earth bar shall provide the main equipotential bonding to the new Low Voltage Switchroom which shall consist of:

- New low voltage switchboard – Essential – 1000mm<sup>2</sup> – Allow 25m
- New low voltage switchboard – Non-Essential – 1000mm<sup>2</sup> – Allow 25m
- New switchroom steel frame – 35mm<sup>2</sup> – Allow 25m
- New switchroom lightning protection system – 35mm<sup>2</sup> – Allow 25m
- Existing MCB distribution boards – 35mm<sup>2</sup> – Allow 60m
- New ladder racking – 35mm<sup>2</sup> – Allow 25m

Where cables are terminated at the agreed position associated with each service it shall be via a commercially manufactured earthing clamp, the type used being suitable for the particular application. At each location a

permanent label of the type specified in the IET 18th Edition Regulations shall be provided. This arrangement shall also apply to supplementary bonds.

## **1.11 CONTAINMENT**

### **1.11.1 Containment Systems**

The Electrical Contractor shall design, supply and install a new containment system comprising of sub main ladder racking as indicated on the tender drawings.

Whilst the Tender drawings have been co-ordinated to ensure that all services can be accommodated within the areas available, it cannot be assumed that the ladder racking routes indicated on the various drawings can be installed as a straight run without deviation and the Electrical Contractor must make due allowance for this in his tender.

The Tender drawings also indicate the electrical service equipment locations diagrammatically and the Electrical Contractor shall therefore make due allowance to closely liaise and co-ordinate all installation works with other trades to ensure no conflict of services particularly where these other services pass through the electrical zone.

The Electrical Contractor shall design, supply and install Unistrut supports, to support each cast resin cable joint – proposals shall be submitted to EQUANS/Redworth for comment.

All supports associated with the ladder racking shall be in compliance with BS5819.

## **1.12 FIRE PRECAUTIONS**

### **1.12.1 Electrical Services Fire Precautions**

In order to maintain the fire integrity of the various parts of the building it is essential that whenever services penetrate building fabric in the various compartment/sub-compartment/enclosures etc., that they are adequately sealed, protected or enclosed to ensure no degradation of the fire rating.

### **1.12.2 Approved Party**

All fire stopping shall be completed by an approved third party fire stopping company using third party accredited products, each penetration being recorded, photographed and logged on an approved system and included into the As built documentation.

## 1.13 SOCKET AND SMALL POWER

### 1.13.1 General

The Electrical Contractor shall design, supply and install new socket outlets and connection units as indicated on the Tender Drawings.

Socket outlets and fused connection units shall be connected to the existing essential distribution boards utilising 3c 4mm<sup>2</sup> XLPE/SWA/LSF cables as detailed in this specification, run on cable trays serving surface mounted electrical accessories.

The minimum conductor size for small power circuits shall be 4.0mm<sup>2</sup>.

All circuits shall be provided with separate earth conductors identical size to phase conductor.

General horizontal runs of conduit concealed in walls are prohibited, except for interconnecting sockets which are less than 300 mm apart.

### 1.13.2 13 Amp Socket and Fused Connection Units

Socket outlets and fused connection units where connected to the essential supply shall be surface wall mounted MK metal clad and have "Red" coloured switch operating rockers unless stated otherwise.

All connection units are to be engraved to indicate the item of equipment served. All socket outlets, connection units are to be engraved with the circuit reference. Exact wording to be agreed with Engineer.

**Note:** Tape labelling of circuit references/connection unit labelling will not be accepted.

### 1.13.3 Tubular Heaters

The Electrical Contractor shall supply and install 2 No 1.5Kw Tubular heaters and room thermostats as detailed on the tender drawings. The tubular heaters shall form a new radial circuit derived from the existing sub station essential mcb distribution board. The electrical contractor shall provide a new 16A mcb and wire the radial circuit in a 3c 4mm sq xlpe/swa/lsf cable

## 1.14 GENERAL LIGHTING

### 1.14.1 General

The Electrical Contractor shall design supply, install, test and commission a new lighting installation as detailed on the tender drawings.

Luminaires within the new low voltage switchroom shall be of the LED proofed type and be controlled via manual switching as detailed on the tender drawings.

All luminaires shall have a minimum of two drop rod supports connected to the ceiling slab.

All to conform with the requirements of this specification.

Final sub circuit wiring for the lighting installation shall be connected to existing essential distribution boards utilising 3c 1.5mm<sup>2</sup> XLPE/SWA/LSF cable run on cable trays to provide a surface installation.

**Note:** 2 No. lighting circuits are to be provided for resilience.

The minimum conductor size for lighting circuits is 1.5 mm<sup>2</sup>.

All circuits shall be provided with a separate earth conductor (minimum size 1.5mm<sup>2</sup>).

All to conform with the requirements of this specification.

Connections between final circuit wiring and luminaires will be by plug-in ceiling rose (Klick) and flexible cable. All such plug-in ceiling roses are to be fixed not more than 0.5 metre from the cable entry to the luminaire.

Switches shall be MK metal clad wall mounted and be complete with Red rocker switches when connected to the essential supply.

Mounting heights shall be 1200 mm from finished floor level to centre of switch plate.

All switch face plates shall be engraved with the circuit ref – (as 1.14).

## **1.15 EMERGENCY LIGHTING**

### **1.15.1 General**

The Electrical Contractor shall design, supply, install, test and commission a fully compliant emergency lighting installation as detailed on the tender drawings.

The emergency lighting installation shall be designed in accordance with BS5266-1 to give illumination in the event of a failure of the local main electrical supply.

The system shall consist of wireless self-testing emergency lighting luminaires with integral battery units, suitable for a 3 hour non-maintained operation and networked to provide a single system.

Standby lighting will be supplied by essential circuits backed up by standby generators.

The illuminated exit sign legend shall match the Hospital standards.

### **1.15.2 System Manufacture**

The system shall be as manufactured by Luxonic.

Contact: Martyn Whittaker  
Tel: 0772 542 3693

### **1.15.3 Wiring**

The Electrical Contractor shall wire the emergency luminaires from local sub circuits to operate on local sub circuit failure connecting to a new Luxonic collator supplied and installed by the Electrical Contractor.

The collator will require both a data and power supply.

### **1.15.4 Commissioning**

The Electrical Contractor shall employ Luxonic to commission the emergency lighting installation.

## **1.16 FIRE ALARMS**

### **1.16.1 General**

The Electrical Contractor shall design, supply, install, test and commission a new fire alarm installation to the new low voltage switchroom as detailed on the tender drawings in full compliance of BS5839 Type L1.

The Electrical Contractor shall note that a conventional fire alarm installation is installed within Nelson Street existing sub-station which shall be extended to serve the new low voltage switchroom.

The Electrical Contractor shall employ the Trusts approved fire alarm specialist to complete all works associated with the fire alarms:

Mr Phil Odell  
PJC Fire Protection Ltd

Email: phil@pjcfireprotection.co.uk

During the working day, the Electrical Contractor shall arrange with the Sodexo team to isolate all the devices and re-arrange with the Sodexo team to re-connect these devices when the site is closed.

### **1.16.2 Fire Alarm Panel**

The Electrical Contractor shall note that a conventional fire alarm system control panel is located within the existing Nelson Street sub-station which serves only the Nelson Street sub-station.

The existing conventional fire alarm is to be retained and used to serve the new low voltage switchroom.

This existing conventional fire alarm system reports to the main Hospital fire alarm network and reports a single "Alert" or "Fail" signal.

### **1.16.3 Accessories**

The Electrical Contractor shall design, supply and install all accessories, the accessory type shall be fully compatible with the existing fire alarm system.

For quantities and locations of accessories the Electrical Contractor shall refer to the tender drawings.

### **1.16.4 Cables**

All cables associated with the fire alarm installation shall be of the FP200 gold (red LSF sheath) enhanced type being minimum size 1.5mm<sup>2</sup> to provide a flush installation.

### **1.16.5 Commissioning**

The Electrical Contractor shall employ PJC to fully test and commission the fire alarm installation.

## **1.17 STRUCTURED CABLING**

### **1.17.1 General**

The Electrical Contractor shall employ the following incumbent data installer to install, test and commission 2 No. new data outlets within the new LV switchroom – 1 No. dedicated for the emergency lighting collator, the other spare.

The Electrical Contractor shall note the new data cabling shall emanate from the Grafton Street data cabinet.

Complete Network Solutions (CNS)

Contact: Andy Firth – Tel: 07891 913 426

Leanne Green – Tel: 07983 336 159

### **1.17.2 Wiring**

From the existing communication (patch) cabinet the Electrical Contractor shall supply and install Cat 6 CCA LSZH data cables to the RJ45 outlets as indicated on the tender drawings, making all final terminations at the RJ45 outlets and communication (patch) cabinet.

### **1.17.3 RJ45 Sockets**

The Electrical contractor shall supply and install RJ45 (Cat 6) sockets to provide a flush installation.

### **1.17.4 RJ45 Patch Cords**

The Electrical Contractor shall supply RJ45 patch cords (Cat 6) (colour to be agreed) – 1 No. per data outlet.

### **1.17.5 Fly Leads (RJ45/RJ45)**

The Electrical Contractor shall supply fly leads (Cat 6). Each lead shall be 2m in length – 1 No. per data outlet.

### **1.17.6 Testing and Commissioning**

The Electrical Contractor shall obtain full test certificates from the specialist data sub-contractors.

### **1.17.7 Containment**

The Electrical Contractor shall design, supply and install a containment system for the Hospitals approved data cable installer to undertake the data cabling.

The containment shall consist of a 25mm galvanised cable tray.

**1.18 BMS****1.18.1 New BMS (Schneider)**

The Electrical Contractor shall employ the following incumbent BMS provider to establish a new BMS out-station within Nelson Street Sub Station.

Schneider Electrical Ltd  
Europa House  
Gemini Business Park  
WARRINGTON  
WA5 7XR

Contact: Mr Mark Blewitt  
Tel: 07792 825 799

The new Nelson Street BMS out-station shall be connected into the site wide Schneider BMS system via the existing Grafton Street BMS Schneider out-station.

It is envisaged, an armoured single mode fibre cable shall emanate from the Grafton Street BMS panel and via an existing buried cable ducts, be installed into Nelson Street sub-station where it shall terminate into the new BMS control panel.

The new Nelson Street sub-station shall have the following inputs/outputs:

- |             |                                          |
|-------------|------------------------------------------|
| 35 No.      | - Pulse Meters – ABB-DELTA-APlus         |
| ASCO Alarms | - Mains Healthy                          |
|             | - Mains Failure                          |
|             | - Generator Running                      |
|             | - Generator Fail                         |
|             | - Loss of Normal and Secondary Supply    |
|             | - ASCO Bypass Open                       |
|             | - ASCO Bypass Closed                     |
|             | ▪ Allow for 5 No. Additional ASCO Alarms |
|             | - Restricted Earth Fault alarm           |

**1.18.2 Existing BMS (Sauter)**

The Electrical Contractor shall employ Sauter to decommission the exiting Nelson Street BMS outstation and all associated alarms, upon removal of the existing low voltage switchboard.

**1.19 LIGHTNING PROTECTION SYSTEM**

The Electrical Contractor shall employ a specialist lightning protection contractor to design, supply and install a lightning protection system to protect the new low voltage switchroom to fully comply with BS6651 and BS EN 62305.

## 1.20 “AS FIXED” DRAWINGS

### 1.20.1 Drawings

**Note:** To be read together with EQUANS Preliminaries and General Conditions Section A37.

On practical completion or sectional completion of the works and before the release of any Retention Fund, the Electrical Contractor shall, at his own expense, supply to the Engineer “as fixed” drawings consisting of the following:-

- Two complete sets of white prints.
- Disks containing all As fitted drawings in Autocad Release 2020 format.

The above drawings, which shall be executed by a competent cadperson, must be in sufficient detail to enable the Hospital Engineering staff to maintain, dismantle, re-assemble and adjust all parts of the works.

Generally the drawings shall be submitted in a similar format to the original Redworth Associates tender drawings, namely separate drawings for each of the following services in any given area:-

- Sub main distribution within area being served, this may be incorporated in common Electrical Distribution drawing, where appropriate.
- Ladder racking indicated on 1/50th scale building/room layout plan, clearly showing individual sizes and routes with relevant fire stopping details.

Separate identification shall be used for conduits of differing services, together with explanatory key (e.g. continuous line, dotted line, chain dot line etc.).

- Routes and description of cables together with details of switchgear.

All drawings finalised “as fixed” drawing must be submitted to the Engineer at the Actual Technical Inspection meeting.

## 1.21 MAINTENANCE SERVICE MANUALS

### 1.21.1 Draft Submission

A complete manual shall be submitted in draft form in accordance with the EQUANS Preliminaries and General Conditions Section A37.

### 1.21.2 Final Submission

Two such finalised manuals shall be submitted to the Engineer at the Technical Inspection meeting.

The manual shall also be issued in electronic format.

### 1.21.3 Manual Content

- **General**

The loose leaf type A4 size manuals shall be housed within a rigid, hard back metal edged “lever/arch” retaining file - marked with the scheme/file title.

Page 1 shall comprise a detailed index - identical to the list of work contained in Section 1 of the Specification plus the following additional items:-

- General description of scheme, including A4 location (site plan).
- Schedule of material and manufacturers.
- Schedule of symbols used on “as fixed” drawings.
- Test certificates and test sheets - for general electrical installation only (i.e. the current edition of the IET Regulations 18<sup>th</sup> Edition).
- All distribution board schematic diagram and/or schedules of the specification shall contain the following information:-
  - a. Type and classification of the protective devices associated with sub-circuits.
  - b. Measured values of earth loop impedance on each sub-circuit.
  - c. The value of the earth loop impedance up to the distribution board.
- Manufacturers technical manuals for each item of equipment, including service and maintenance schedules and information to enable planned preventative maintenance to be performed.

- **Sub Divisions**

Each sub division shall be separated by a stiff card having protruding numbered tag - staggered to facilitate quick and easy location.

Page 1 of each sub division shall be suitably indexed, Item 1 being a brief description of installation system, so that a “layman” not familiar with the scheme can readily understand the scheme content and function.

Each sub section shall contain the following items:-

- Description of the system and equipment.
- Typed schedule of material and manufacturer's catalogue/part numbers - with manufacturer's address and telephone number clearly identified.
- Relevant manufacturer's literature for all materials used including lists of standard replacement parts - suitably cross referenced and indexed.
- Manufacturers instruction manuals for routine and periodic servicing and maintenance.
- Wiring diagrams, electronic circuit diagrams and cable routes.
- Manufacturer's setting to work and operating instructions of plant including safety precautions.
- Schedule of emergency measures and fault finding techniques.
- Schedule of lubrication and servicing requirements.
- Test and guarantee certificates.
- Commissioning documentation.
- Insurance and inspection reports.
- Local and other authority certificates.
- Special tools, keys and other equipment with documents relating to their use.
- List of recommended spares.

Prior to submission of his tender the Electrical Contractor shall ensure that all manufacturers specified are made aware of the preceding requirements and are able to provide the relevant documentation.

The names of any specified manufacture not able to provide the necessary items shall be brought to the attention of the Engineer, prior to submission of tender.

## 1.22 TESTING AND COMMISSIONING

### 1.22.1 General

The Electrical Contractor shall in addition to or in conjunction with the requirements stipulated in this specification, comply with and allow in the Tender for the following:-

- The Electrical Contractor shall prepare and agree with the Contractor a programme and a schedule of tests inclusive of method and instrumentation/apparatus to be used. A copy of the agreed programme shall be distributed to the Project Manager.

Tests shall be carried out, witnessed by and to the satisfaction of the Engineer or his Agent, the Electrical Contractor providing all necessary instrumentation and apparatus as required by the Engineer to complete the tests satisfactorily with accurate results.

All results of tests shall be recorded and submitted to the Engineer in triplicate. Serial numbers of instrumentation and apparatus used shall also be recorded and where practicable the same instruments used for tests throughout the whole of the installation.

### 1.22.2 Tests

All testing shall be as detailed in the 18th Edition of the IET Regulations (latest amendment).

### 1.22.3 Drawings

The Electrical Contractor shall provide the Project Manager with a set of "marked up" drawings, one week prior to commencement of tests detailing the following:-

### 1.22.4 Main Switchboard Sub-Main Switchboards, Final Distribution Boards and at Extremities of all Three Phase Final Circuits

The measurement of:-

- Phase to phase mains source impedance ( $Z_{mpn}$ ).
- Phase to neutral mains source impedance ( $Z_{mpn}$ ).
- Total earth loop impedance ( $Z_s$ ).
- Total AC protective Conductor Impedance ( $Z_p$ ) back to the earth electrode.
- Fault level in KA.

## **1.23 QUERIES**

### **1.23.1 General**

Should the Electrical Contractor have any queries regarding the tender specification/drawings, the tenderer should contact:-

Mr M. Reed  
Redworth Associates  
Ryefield House  
180 Highgate Road  
BRADFORD  
BD13 1DS

Tel: 01274 577 171

E-mail: [mike.reed@redworthassociates.co.uk](mailto:mike.reed@redworthassociates.co.uk)



**Ryefield House**  
180 Highgate Road  
**BRADFORD BD13 1DS**  
**CONCRETE**  
**ENGINEERS**  
Tel: 01274 577171

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Manchester Royal Infirmary  
Nelson Street Sub Station  
Life Cycle Upgrade – LC1839

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3341 : October 2021

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**1.25 SCHEDULE OF MANUFACTURERS**

| <b>No.</b>    | <b>Description</b>                                                                                                                                       |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1.25.1</b> | <b>Cables HV and LV</b><br>BICC Ltd<br>AWCO Ltd<br>Pirelli General<br>AEI Cables Ltd<br>Pyrotenax Ltd                                                    |
| <b>1.25.2</b> | <b>New Switchboard</b><br>R&B Switchgear (Bespoke switchboard)                                                                                           |
| <b>1.25.3</b> | <b>Meters &amp; Protective Relays</b><br>Schneider                                                                                                       |
| <b>1.25.4</b> | <b>Conduit and Accessories - Steel/Screwed</b><br>Simplex GE<br>Walsall Conduits Ltd<br>GEC Installation Equipment Ltd                                   |
| <b>1.25.5</b> | <b>General Trunking, Ladder Racking and Accessories - Steel - (Galvanised)</b><br>Cary Ltd<br>Davis Sheet Metal Co Ltd<br>Walsall Conduits Ltd<br>Swifts |
| <b>1.25.6</b> | <b>Cable Trays</b><br>Swifts Ltd                                                                                                                         |
| <b>1.25.7</b> | <b>Cable Support System Components</b><br>Unistrut Ltd<br>BICC Ltd<br>AEI Ltd                                                                            |

**1.25.8 Cable Terminating & Jointing Materials**

BICC Ltd

AEI Ltd

**1.25.9 Control Cable Terminations**

BICC Ltd

Kippon Electrical Ltd

Critchley Ltd

**1.25.10 BMS**

Schneider (New) Souter ( Old)

## **SECTION 2**

### **GENERAL PREAMBLES AND PRELIMINARIES**

- 2.1 The Electrical Contractor shall refer to and comply with the Main Contract Documentation.

## SECTION 3

### GENERAL REQUIREMENTS

#### 3.1 DEFINITIONS

**Mechanical Contractor** – Where this term is used within the specification it shall be taken as the contractor completing the mechanical installation works as detailed in this specification and associated drawings etc. Depending upon the type of contract the term Mechanical Contractor shall equally refer to the Mechanical Sub-Contractor or Building Services Sub-Contractor.

**Electrical Contractor** – Where this term is used within the specification it shall be taken as the contractor completing the electrical installation works as detailed in this specification and associated drawings etc. Depending upon the type of contract the term Electrical Contractor shall equally refer to the Electrical Sub-Contractor or Building Services Sub-Contractor.

**Specialist** – Refers to a specialist contractor employed by the Building Services Contractor, Mechanical Contractor or the Electrical Contractor to complete part of the works on their behalf, the Building Services Contractor, Mechanical Contractor or the Electrical Contractor shall be fully responsible for all works undertaken by the specialist.

**Services Contractor** – Where this term is used it shall refer equally to the Mechanical and Electrical Contractor completing the mechanical and/or electrical installation works as detailed in this specification and associated drawings etc. Depending upon the type of contract the term Services Contractor shall equally refer to the Building Services Contractor, Mechanical Services Contractor or Electrical Contractor.

**Main Contractor** – Where this term is used within the specification it shall be taken as the contractor completing the overall contract for the client as detailed in the main contract specification and associated drawings etc. Depending upon the type of contract this shall equally refer to the Builder, Principal Contractor or the Mechanical or Electrical Contractor if they are the Main Contractor for the project.

**Engineer** – Refers to a representative of Redworth Associates.

**Contract Administrator** – Refers to representative of the company administering the project as defined in the Main Contract Preliminaries.

#### 3.2 CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS

All works undertaken shall be completed in accordance with Construction (Design and Management) Regulations 2007.

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

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

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

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

The Electrical Contractor shall take all necessary measures to satisfy himself/herself that all Contractors, whether appointed by him/her directly or not, are competent and have allocated sufficient resources to comply with the requirements on Contractors imposed by the Construction (Design and Management) Regulations 2007.

### **3.3 SCOPE OF WORK**

The work shall include all services described or noted in the tender documents including the production of all information, drawings, documents, demonstrations, testing required by this specification and the Main Contract Documentation including:

- Provision of technical information for tender valuation.
- A schedule of rates
- Statement on quality control resources.
- Programme of works with ordering times etc. to be issued to the Contract Administrator and incorporated into the Main Contract programme.
- Builderswork information.
- Installation drawings including ductwork drawings, control drawings, performance characteristics for electrical equipment etc.
- Record documents.
- Method statements.
- Liaison with any occupiers, owners etc. re shutdowns, connections into existing etc.
- Liaison with other Contractors and Consultants.
- Provision of costs for variations broken down and using the schedule of rates.
- Removal of redundant services and removals where noted.
- The provision of the electrical services detailed on the drawings and in this specification including the supply of, carriage to site, storage, installation, testing, cleaning, commissioning and setting to work of the installations.

- The incorporation of all equipment, accessories, controls, supports and ancillaries required by the tender documents and/or in accordance with manufacturers recommendations and accepted current practice to allow assembly testing and commissioning to achieve the specified duties/performance.

### **3.4 A SCHEDULE OF RATES**

A quantified schedule of rates must be submitted within one week of request.

The schedule shall be broken down to show each service, each area, with sub totals, individual items, costed and multiplied by their number to give their number and location.

It must include all items and materials included in the tender, together with their rates, extended and totalled. Preliminaries are to be separately priced. Such totals shall agree with the Subcontract Sum and subtotals shall agree with the priced breakdown of the tender.

Lump sum items will not be accepted.

Correction of errors in the quantification will not lead to adjustment of the Subcontract Sum.

Rates to include or exclude Contractor's cash discount as required by the Main Contract Conditions.

If a schedule of rates is not received pricing of variations will be by the Quantity Surveyor.

### **3.5 TECHNICAL INFORMATION**

Technical information relating to the Electrical Contractor's tender must be submitted within one week of request.

### **3.6 QUALITY CONTROL RESOURCES**

A statement must be submitted within one week of request describing the organisation and resources which the Electrical Contractor proposes and undertakes to provide to control the quality of the Contract Works. The statement must include the number and type of staff responsible for quality control, with details of their qualifications and duties.

### **3.7 VISIT TO SITE**

Tenderers are required to visit the site before completing their tenders, and will be deemed to have satisfied themselves as to the means of access, the extent and nature of the works, the site conditions under which the works will be carried out, the conditions affecting the supply of labour and material and all other matters which may affect their tenders. Claims on the grounds of want of knowledge in such respects will not be accepted.

### **3.8 INSTALLATION AND DETAILING INFORMATION**

Complete the detailing of the work and provide complete production information (including, as appropriate, fabrication/installation drawings etc.) based on the drawings, this specification and other information provided, liaising with the Engineer, Contractor and others as necessary to help ensure co-ordination of the work with related building elements and services.

Provide Installation Drawings, Manufacturers Drawings and Wiring Diagrams.

Provide performance characteristics of electrical equipment.

Provide Builder's Work Information, appropriate to the stage of design development.

Co-ordination of the Engineering Services Installations will be carried out as part of the Contract.

Agree principles of co-ordination with all parties concerned.

Incorporate details provided by others into the Co-ordination Drawings.

Provide all necessary details/drawings/schedules etc. required to enable the co-ordination drawings to be prepared by others.

Ensure the installation drawings make due allowance for all building elements, structure and other services.

For services identified as Electrical Contractor design, provide design calculations and drawings in addition to installation drawings.

#### **Late or Incorrect Information**

If delays occur due to late, incomplete or incorrect information provided by the Subcontractor, claims for extension of time, other than those allowed under the Contract, and/or additional costs will not be entertained.

#### **Additional Information**

Request, in writing, additional information as necessary from the Engineer and/or Contractor and provide design/production information as necessary in accordance with the agreed programme.

### **3.9 BUILDER'S WORK INFORMATION**

The Electrical Contractor shall provide detailed builders work information on drawings for comment. The details shall include positions and sizes of all holes, chases, ducts, trenches, anchors, manholes, plinths, bases, building in requirements and all making good requirements.

The Electrical Contractor shall also confirm and amplify any builder's work information provided by the Engineer.

### **3.10 DRAWING TYPES**

The following definitions shall apply to drawings referred to in this Specification.

**3.10.1 Tender Drawings**

Drawings prepared by the Engineer showing the design in such detail as may be necessary to enable those tendering to interpret the design for the Works and in conjunction with the specification to submit competitive tenders for the execution of the Works.

**3.10.2 Contract Drawings**

Drawings issued with the Contract Documents for the purpose of signing a contract. Tender drawings will normally be reissued for this purpose.

**3.10.3 Co-ordination Drawings**

Drawings showing the inter-relationship of two or more Engineering Services and their relation to the structural and architectural details. Such drawings shall be provided by the Engineer where he considers them to be necessary, in such detail so as to demonstrate that the engineering services will be properly separated from one another and can be satisfactorily installed and maintained.

**3.10.4 Builders Work Drawings**

Drawings prepared by the Electrical Contractor to show requirements for architectural or structural provisions necessary to facilitate the execution of the Works and allow their integration into the Project. Such drawings shall include requirements for ducts, holes, chases, trenches, foundations, bases and supporting structures for plant or equipment and all related making good requirements.

**3.10.5 Construction or Installation Drawings**

Drawings prepared by the Electrical Contractor based on the Contract Drawings showing details of the proposals for the execution of the Works. The drawings shall be in such detail including dimensions so as to enable the Works to be installed.

The Electrical Contractor, in preparing his/her installation drawings, shall continue the design co-ordination before tender to ensure that all areas are fully co-ordinated. He/she shall liaise closely with all other trades to ensure that this is achieved.

**3.10.6 Manufacturers Drawings**

Drawings issued by the Electrical Contractor to show the construction, arrangement and sizes of suppliers equipment. Such drawings shall be certified by the manufacturer and shall not be 'typical' arrangements.

### 3.10.7 Shop Drawings

Drawings issued by the Electrical Contractor produced for the purpose of explaining how the components of the designs are to be fabricated.

### 3.10.8 Record Drawings

Drawings prepared by the Electrical Contractor in order to provide the Employer with a record of Works as installed including details, sizes, types, locations, duties and descriptions of all plant, material, equipment and installations including “free issue” items.

The Electrical Contractor shall take, and be responsible for, all particulars and dimensions from site and details on any drawings prepared by him/her.

Drawings shall be prepared to a scale of 1:50 for all services and builders work in the buildings and 1:20 for all plant rooms, confined spaces and similar locations.

Drawings shall include symbols, plans, sections, elevations and isometric interpretations as required to provide a comprehensive record of the installations.

The inspection of the Electrical Contractors drawings by the Contract Administrator shall not diminish the Electrical Contractors responsibility for ensuring both their accuracy, and their compliance with the requirements of the Specification.

## 3.11 SETTING OUT OF THE WORKS

The Electrical Contractor shall be responsible for the setting out of the Contract Works and for the correctness of the positions, levels and dimensions of the works. The Electrical Contractor shall supervise and be responsible for the accuracy of all information provided by him/her under the Contract.

If at any time during the progress of the Works any error shall appear or arise in the positions, levels or dimensions of the Works, the Electrical Contractor shall at his/her own expense remove and amend the work to the satisfaction of the Contract Administrator and shall become liable for any costs associated with such error including any delay caused to the Contract due to such error.

## 3.12 DOCUMENTS AND DRAWINGS ON SITE

The Electrical Contractor shall ensure that one copy of the current Contract Documents and Contract and Installation Drawings are kept in his/her office on site at all times and that his/her staff and operatives are fully conversant with same.

The Electrical Contractor shall also include for keeping one set of the Installation Drawings in his/her office on site upon which he/she shall keep marked up, on a weekly basis, the installation progress as installed. These drawings shall be kept solely for this purpose and shall be kept up to date at all times together with any amendments or variations to the works which shall be recorded upon them. Failure to keep the record drawings up to date will result in a deduction on the monthly valuation.

The "marked up" set of Installation Drawings shall form the basis of the "Record Drawings" required upon completion of the works and shall also serve as a means of recording the progress of the works, in that two up to date copies shall be issued to the Contract Administrator at four weekly intervals at the Electrical Contractors expense.

The drawings and documents on site shall be available for inspection by the Contract Administrator at all times.

### **3.13 PERSON IN CHARGE AND QUALITY OF WORKMANSHIP**

The Electrical Contractor shall in the execution of the Contract Works employ such employees and workmen as are careful and skilful in their trades and callings, have had previous experience of the class of work involved and shall keep on site at all times a competent person in charge, duly qualified and authorised to act for him/her in every way. The person in charge shall give his/her whole time and attention to the works for the full duration of the Contract and shall be responsible for no other contract or commitment.

The person in charge shall be fully conversant with all relevant aspects of the works and shall have had previous experience of the class of work involved.

The Electrical Contractor shall not be allowed to replace the person in charge without written confirmation from the Contract Administrator.

### **3.14 MATERIALS AND WORKMANSHIP**

The Electrical Contractor shall ensure that all materials, goods and workmanship used in the works shall be the best of their respective kinds and shall conform to the current British Standard Specifications and the recommendations of the respective current Codes of Practice including test pressures, methods of testing etc.

Electrical installations shall be in accordance with BS 7671 the IEE Regulations for Electrical Installations : Latest Edition.

No materials brought to site for the incorporation into the works shall be used for scaffolding, any other temporary purpose or misused in any way.

All materials, goods or workmanship considered by the Contract Administrator to be unsound, unacceptable and/or not in accordance with the Specification shall be immediately removed by the Electrical Contractor and properly replaced by the Electrical Contractor to the satisfaction of the Contract Administrator at the Electrical Contractors own expense. Should the Electrical Contractor neglect or refuse to do this, the Contract Administrator shall have the power to employ other monies that may then be due or shall become due to the Electrical Contractor.

Where manufactured items are not specified by name, the Electrical Contractor shall submit these to the Contract Administrator for comment before their use is permitted.

The work shall, unless otherwise stated, be carried out in strict accordance with the recommendations of the manufacturers of the materials, plant and equipment to be installed.

The Contract Administrator may require the Electrical Contractor to submit correctly identified and documented samples of any materials or workmanship to be used in the Contract Works for his/her approval, and the Electrical Contractor shall allow for any charges he/she may consider necessary in complying with this condition. All materials and workmanship for which samples have been approved must conform in every respect with such samples, and any items not conforming to the approved standard shall be removed and replaced with new materials at the Electrical Contractors own expense.

### **3.15 CONTRACTORS TEMPORARY ELECTRICAL SUPPLIES**

All wiring, cabling etc., serving temporary installations, shall be so designed, installed and operated as to be safe and in full accordance with the appropriate regulations and details as follows:-

#### **3.15.1 Regulations**

The whole installation shall comply with all concurrent regulations as issued by the Factories Act, the Construction (General Provisions) Regulations, BS 7671, the Regulations for Electrical Installations : Latest Edition, and the relevant Codes of Practice.

#### **3.15.2 Types of Supply**

The following distribution voltages shall be considered as suitable for use on site:-

- Fixed Plant - 400V 3 phase.
- Movable plant fed via suitably sheathed or armoured tracking cable (e.g. electric arc welding plant) - 400V 3 phase.
- Installations in site buildings - 230V 1 phase.
- Semi-permanent floodlighting - 230V 1 phase.
- Portable and hand-held tools - 110V (55V to earth)
- Site lighting - 110V 1 phase (55V to earth)
- Portable hand lamps (general) - 110V 1 phase (55V to earth)
- Portable hand lamps (confined or damp situations) - 25V 1 phase.

#### **3.15.3 Protection of Circuits**

Protection equipment shall be adequate to protect the system in accordance with the IEE Regulations and so arranged as to provide correct discrimination in operation.

#### **3.15.4 Testing and Inspection**

Testing and inspection shall be carried out as required under BS 7671 the IEE Regulations, Latest Edition.

### **3.15.5 Cables**

All cables used on site, other than installed in site offices etc., shall be of an armoured or mechanically protected type when used on systems operating at voltages in excess of 55 volt to earth.

### **3.15.6 Earthing**

The installation shall be solidly bonded to the Supply Authority's earth. In certain cases residual current devices may be necessary to comply with BS 7671, IEE Regulations Latest Edition, with particular reference to Section 604.

As soon as any part or the whole of the Contractor's temporary installation is no longer required for carrying out the Works, the Electrical Contractor shall disconnect and remove the same to the satisfaction of the Contract Administrator.

## **3.16 CARRIAGE OF GOODS**

The Electrical Contractor shall allow for the cost of all packing, carriage and delivery of goods, including off-loading, required upon the site to maintain the programme and shall include for the return of empty cases and the handling of materials not required on site. His/her Tender shall include for goods delivery by passenger train or other special transport as necessary to carry out the work in the specified time. The Electrical Contractor shall advise with his/her Tender if the delivery programme cannot be met for any item involved.

Delivery to site shall be in accordance with the agreed programme and the Electrical Contractor shall give three weeks notice of the actual delivery to the Contract Administrator.

## **3.17 TEST CERTIFICATES**

### **3.17.1 General**

Where testing specific to the project is required, ensure test certificates include:-

- Project title
- Details and dates of test
- Instruments used, serial numbers, calibration dates
- Signature of those witnessing test

### **3.17.2 Manufacturer's Test Certificates**

Insurance Company and Manufacturer's certificates of tests, at the specified duties, shall be held at the Manufacturer's works at the Electrical Contractors expense and test certificates shall be submitted for all plant and equipment to be incorporated into the Contract Works. No item of equipment shall be delivered to site before the Contract Administrator has given his/her approval of the test certificate.

Where no test procedures are given, the test shall be carried out in accordance with the appropriate current British Standard and subject to the Contract Administrator's approval.

Certificates shall be included in the record documents.

### **3.17.3 Electrical Contractor's Test Certificates**

The Electrical Contractor shall in accordance with the testing and commissioning section of the Specification forward to the Contract Administrator certified copies of results obtained from testing and commissioning on completion or on sectional completion as appropriate.

Certificates shall be included in the record documents.

## **3.18 USE OF INSTALLATION BY CONTRACTOR**

The Electrical Contractors shall be allowed to use the installation for testing, proving, and commissioning only, and when the following requirements have been fulfilled:-

- The Electrical Contractor has received written permission from the Contract Administrator to use the installation in accordance with the Contract Conditions and as set out in this Specification.
- The Electrical Contractor has given written advice of the date of testing, proving and commissioning etc., to the Contract Administrator.
- The Electrical Contractor has provided, at his/her own cost, unless stated to the contrary, all water, power, fuel, labour etc., necessary for the temporary operation of the plant including any temporary supplies for testing and commissioning.
- The Electrical Contractor has undertaken full responsibility and arranged adequate insurance cover for the period of said operation.
- The Electrical Contractor has arranged for a qualified and competent engineer to be in attendance on the plant and installation during the period of said operation.
- The Electrical Contractor has given written confirmation that the running of the plant prior to handing over shall in no way affect or invalidate the Electrical Contractor's guarantee, and Defects Liability Period which shall commence on the Certification of Practical Completion.

All costs arising from the six items listed above shall be borne by the Electrical Contractor.

Under no circumstances shall the plant be used for any purpose other than those listed above.

### **3.19 EARTHED EQUIPOTENTIAL BONDING**

Earthed equipotential bonding of all items of pipework, ductwork, equipment and other extraneous conductive parts shall be carried out in accordance with BS 7671 the Latest Edition of the IEE Regulations for Electrical Installations.

In order to facilitate the connection of bonding tape or cable all pipework, ductwork and items of plant and equipment shall be provided with bonding lugs. The size, location and detail of all bonding lugs shall be incorporated on to the Shop Drawings.

In general bonding lugs shall be provided at the following locations:-

- On all incoming gas, water and other services.
- On all pipework over 25 mm nominal bore within plant rooms and distribution ducts and risers.
- On all ductwork within plant rooms and distribution ducts and risers.
- At each side of any pipework or ductwork non-metallic joint or flexible connection, whether or not fitted with tie bars.
- On all non-electrical items of plant and equipment, e.g. tanks, cylinders, calorifiers, boilers, pressure vessels, flues, air handling units.

### **3.20 SUITABILITY OF MATERIALS AND PRODUCTS**

Use material and products which:-

are new unless specified otherwise are suitable for the services and conditions of use normally expected to apply after the installation is complete;

are able to withstand the testing and commissioning conditions specified;

do not initiate mould growth, support vermin, contain animal hair, contain crocidolite or support bacterial life;

do not involve the use of CFC's and HCFC's at any stage of manufacture, installation or subsequent operation except where specified;

are free from objectionable odours at the maximum or normal working conditions of operation;

do not suffer deterioration at the maximum or specified conditions of operation;

are capable of being applied to a base surface without causing damage or deterioration of the base;

are not a fire hazard, and do not evolve dense or toxic fumes when subjected to excessive heat, such as a fire;

when of similar type, are made by the same manufacturer;

whenever possible ensure products are manufactured and/or stocked under one of the following:

- BSI Kite Mark Scheme
- BSI Safety Mark Scheme
- From Firms of Assessed Capability to BS 5750
- From Stockists of Assessed Capability to BS5750

No materials generally known to be deleterious are to be used in, or incorporated into, any temporary or permanent part of the Works.

In particular use none of the following:-

- Asbestos Products
- Urea Formaldehyde

Check with manufacturers and/or suppliers of products and material that products contain no such deleterious materials. If any specified product contains such material request an alternative specification of product, manufacturer or supplier

### **3.21 HANDLING**

Offload and transport about the Works all materials and product as recommended by manufacturers.

### **3.22 STORAGE**

Store all material and products as recommended by manufacturers.

Provide sufficient, safe and secure storage for all materials and products.

Provide racks to prevent distortion for storage of conduits, pipes and similar materials.

Store all fittings, accessories and sundry items in clean bins or bagged and stowed in racks and maintained under suitable weatherproof cover.

### **3.23 PROTECTION OF CONTRACT WORKS**

Where the Main Contractor provides protection the Electrical Contractor shall check regularly the protection provided after installation of equipment and inform the Main Contractor if inadequate.

Install items such as grilles, diffusers, lighting fittings, switches accessories etc. as near to completion as practicable.

Only install filter media when the plant items concerned are being commissioned and tested.

Leave plant and equipment in a ready to paint condition where specified as part of the Works or to be carried out by others.

Paint parts liable to corrosion immediately after removal of any temporary protection.

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

Where the Electrical Contractor provides protection he/she shall provide adequate and safe protection for all material and products after installation.

Ensure all items are protected against ingress of water and dust, formation of condensation, extremes and rapid changes of temperature, building works and operations of others.

### **3.24 ROOM TERMINAL LOCATIONS**

The positions of all connection points, accessories, apparatus, equipment and other room terminals shown on the tender drawings are approximate and for guidance in the preparation of the tender.

Include for the determination on site, in collaboration with the Engineer and Electrical Contractor, of the finalised position of all such terminals.

Allow for the movement of all such terminals up to a radius of 2.0 m from the positions shown on the drawings.

Mounting heights indicated in tender documents are for tender purposes only. Confirm mounting heights with the Engineer before commencing work on site.

### **3.25 MAINTENANCE OF EXISTING SERVICES**

Fully maintain all existing services to existing premises during the progress of the Works.

Fully maintain the services to existing premises during the progress of the Works as listed in the “Specific Details” section.

Provide any additional work and materials necessary to maintain these services at all times during the duration of the Contract.

Any existing services disturbed by the Works are to be reinstated fully in accordance with the standards of quality defined in the specification and to the satisfaction of the Contract Administrator.

Make all connections to existing services out of normal working hours.

### **3.26 IDENTIFICATION OF PLANT AND EQUIPMENT**

The Electrical Contractor shall include for the complete identification of all plant and equipment etc., with white traffolyte labels having black lettering in general or red lettering where indicative of danger, risk or 400V, to a size, position and description as specified by the Contract Administrator.

The labels shall be fixed by chrome plated round headed screws where on a flat surface, or chromium plated "figure of eight" label attachments where secured to uneven objects.

All fused connection units, double pole switch accessories and any other accessories which are required under this specification, shall be engraved.

The accessory plate shall be engraved in either black or red, capital letters 5mm high detailing the appliance or equipment being supplied by the accessory.

### **3.27 CLEANING OF MATERIALS AND WORKS**

The Electrical Contractor shall thoroughly clean out the interior of each item of the installation and plant immediately after the execution of any work on that item, to the satisfaction of the Contract Administrator.

Immediately prior to Practical Completion of the Contract Works, the Electrical Contractor shall thoroughly clean down the works in an approved manner, and ensure the installation, including all plant, is free from dust, dirt, moisture and other foreign matter.

### **3.28 TESTING AND COMMISSIONING OF SERVICES**

Agree with the Main Contractor a programme for pre-commissioning checks, setting to work, commissioning and performance testing, and allow for all costs incurred.

Give not less than fourteen working days notice to the Main Contractor and Engineer and state any requirements for the attendance and co-operation of others.

Provide all necessary facilities to enable test to be witnessed and inspections carried out either on site or at manufacturer's works.

The Engineer will only witness test proceedings, confirm recorded results and determine if the specified requirements have been satisfied. If following test or inspection any plant or part thereof is shown to be defective or not conforming to the specification, the Engineer will reject such defective parts by written notice, within reasonable time, indicating area of dispute.

Appoint an "approved" engineer, to supervise the whole of the testing, commissioning, performance testing and instruction of client's staff.

Provide all specialised personnel (including manufacturer's representatives) and co-ordinate their activities.

Test all equipment, material and systems as detailed in Works Sections. If an inspection or test fails, repeat the procedure, until satisfactory results are obtained.

Complete all tests before any paint, cladding or similar material are applied or before services are concealed.

Ensure all requirements such as cleanliness, protection from harmful external and internal elements etc. are provided prior to commencement of commissioning.

Following satisfactory completion of testing and when the installations are in a safe and satisfactory condition, set to work, regulate and adjust, as necessary, to meet the specified design requirements.

Provide all necessary instruments and recorders to monitor systems during commissioning and performance testing.

Do not start performance testing, including system demonstration, system proving or environmental and capacity testing, until commissioning of the system is completed to the satisfaction of the Engineer.

Maintain on site full records of all commissioning and performance testing, cross referenced to system components and on completion of the Works include a copy in each Operating and Maintenance Manual.

Provide all certification documents for approval by the Engineer before any system is offered for final acceptance.

Gas, fuel oil, electricity and water for testing and commissioning will be provided as detailed in the Main Contract Documents.

### **3.29 RECORD DOCUMENTS**

Two weeks prior to Practical Completion, in addition to the requirements of the Preliminaries Document, the Electrical Contractor shall provide to the Contract Administrator for distribution two approved sets of the bound record documents comprising Record Drawings and Operating and Maintenance Manuals as described below, together with:-

Two sets of top quality paper prints of the Record Drawings.

In addition, at Practical Completion the Electrical Contractor shall provide one further set of prints together with two complete sets of Autocad disk files (Latest Edition) and PDF files to the Clients Specification.

The Record Documents shall comprise the following:-

#### **3.29.1 Record Drawings**

As defined earlier in this section.

The following specific requirements shall be included on electrical services record drawings:-

- The means whereby Regulation 413-02-04 is satisfied.
- Diagram complying with Regulation 514-09.
- The installed route lengths of cables.
- The measured earth fault loop impedance at each item of distribution and sub-distribution switchgear.

- The measured prospective short-circuit fault current at each item of distribution and sub-distribution switchgear.
- The measured maximum demand (current) and power factor at each item of distribution and sub-distribution switchgear. Any limitations to this item shall be stated e.g. lighting load only available on un-let offices.
- The measured volt drop at each item of distribution and sub-distribution switchgear and at items of fixed equipment and luminaires remote from distribution boards. Any limitations as in .06 above shall be noted.
- Trunking, conduit, stirrup and tray routes shall be identified with details of the circuits contained within them, i.e. circuit reference, number of cores/cables of each size installed.
- Available capacity of trunkings shall be noted along their length. This shall be either in terms of the IEE Regulations or taking account of the effects of cable grouping whichever is the more onerous condition, i.e. a trunking may have physical space for more cables, but the addition of cables would necessitate an increase in all the cable sizes because of the heating effects of cable grouping.

The following note shall be added to each Record Drawing:-

- "The Electrical installation is designed, installed and commissioned in accordance with the BS 7671, IEE Regulations latest edition.
- Prior to any additional/alteration works being carried out to this installation it is the responsibility of the person charged with the said modifications to make due reference to the installation design criteria and/or the Engineer responsible for the initial design of the installation.
- Failure to make due reference to the criteria will render the additional/alteration works in contravention of the latest edition IEE Regulations and, in addition, may well impair the safety of the existing installation.

### **3.29.2 Full Operating and Maintenance Instructions**

The Electrical Contractor shall provide a manual(s) to include all operating and maintenance instructions containing all information to enable the Client to operate and maintain the installations and equipment, comprising fully detailed sections including the following.

The arrangement of service manuals shall be prepared by the Electrical Contractor in the following manner:-

|                        |                                                                                                   |
|------------------------|---------------------------------------------------------------------------------------------------|
| Section 1              | Index                                                                                             |
| Section 2<br>Equipment | Full Description of the Design Intent, Systems and                                                |
| Section 3              | Emergency Measures and fault finding techniques                                                   |
| Section 4              | Schedule of routine and periodic maintenance.                                                     |
| Section 5              | Manufacturer's Literature including list of standard replacement parts and operating instructions |
| Section 6              | Equipment Schedules including manufacturers works/references numbers and contact details          |
| Section 7              | Testing & Commissioning Certificates                                                              |
| Section 8              | 'As Installed' Drawings                                                                           |

The documents shall be bound in stiff-backed ring binders and shall be A4 size, finished in black welded PVC with "pull open" two ring fitting at 80mm centres and of a capacity to suit the intended contents.

All the contents shall be mounted in clear PVC pockets sealed on three sides, open at the top and punched at 80mm centres.

The Contractor shall also provide an electronic PDF format copy. Within the electronic document each of the 8 N<sup>o</sup> sections, detailed above, shall be booked marked and hyperlinked to the contents list at section 1.

The Electrical Contractor shall include for all costs and expenses in this context and shall indicate the item separately in his/her Tender Summary.

The documents shall only include information relevant to the installations and shall not include other equipment or instructions in other languages.

In the event of the Electrical Contractor failing to comply with this Clause in the stipulated time for production etc., the Contract Administrator shall have the power to recommend the Contract Works as being unacceptable to hand over due to insufficient information being available to enable the plant to be operated and maintained in accordance with the Health and Safety at Work Act, and furthermore shall have the power to instruct the work to be carried out by others and deduct the resultant costs from the Contractors Final Account.

### 3.29.3 Building Log Book

To comply with Building Regulations the Electrical Contractor shall provide a building log book using CIBSE TM31 main template. The log book is intended to provide the building owner with the details of installed building services plant and controls, their method of operation and maintenance, and other details that collectively enable energy consumption to be monitored and controlled.

One paper copy and one electronic copy shall be handed to the client upon completion of the project.

#### **3.29.4 Manufacturers Test Certificates**

As defined earlier.

#### **3.29.5 Contractors Test and Commissioning Certificates**

As defined earlier.

### **3.30 TRAINING OF CLIENT STAFF**

The Electrical Contractor shall allow for the Person in Charge to instruct the Client's staff in operating, maintaining and servicing the entire plant. The Contract Administrator will give seven days written notice of his/her requirements for this period of instruction to commence.

The Electrical Contractor shall allow for instructions on specialist equipment or systems to be given by the manufacturers/suppliers.

### **3.31 DEFECTS LIABILITY PERIOD**

The Electrical Contractor shall be responsible for the repair/replacement of items installed under this contract which due to faults of materials or workmanship fail to provide satisfactory service during the 12 month period (unless defined otherwise in the Main Contract documentation) following the date of practical completion.

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**SECTION 4****LV SUPPLIES AND DISTRIBUTION EQUIPMENT****4.1 RATED VOLTAGE**

The rated voltage of all switchgear and distribution boards shall be not less than 500 volts AC between phases.

**4.2 SWITCH BOARD PANELS****4.2.1 General**

The switch board or switch panel assembly shall be suitable for connection to the supply system and shall be designed and constructed to withstand the thermal and mechanical stresses set up by short-circuit conditions from a source fault level.

The assembly shall be manufactured from high grade, machine folded/welded, zinc coated, sheet steel of not less than 2mm thickness and be provided with a 50mm high (minimum), removable rolled mild steel plinth.

The assembly shall be provided with arc-fault containment facilities to IEC 61641 or equivalent.

The assembly shall be capable of supporting the weight of a person walking on the enclosure without damage.

Doors shall be provided with neoprene gaskets and door mounted equipment shall be restricted to instruments, control switches and switch operating handles. Door handles shall have an integral cylinder lock and two keys shall be provided for each lock. Keys shall be fully labelled and handed to the Client at practical completion.

Each section of the assembly shall be divided into compartments on a modular basis, to ensure that future alteration and/or additions of equipment can be accomplished without difficulty (i.e. bolted removable divisions, not welded).

For switch boards, the assembly shall be readily extendible at either end with pre-drilled busbars and removable busbar chamber end panels.

Removable un-drilled gland plates not less than 3mm thick shall be provided. Gland plates for single core cables shall be non-magnetic.

Connections from the busbars to the live side of functional units shall be shrouded to IP 2X minimum, with warning labels.

Outgoing circuits shall be arranged and separated such that connections can be made and maintenance carried out on any piece of equipment, without disturbance to another.

Removal of any covers for cabling outgoing circuits shall not expose any live parts. An integral secondary barrier shall be provided.

Full segregation shall be maintained between circuits operating at different voltages. All terminals shall have clear covers marked with the operating voltage.

Suitable windows shall be provided at key locations for thermo graphic testing of bus bars. Each window shall be provided with a bolted metal cover.

The assembly shall include air circuit breakers, moulded case circuit breakers, fused-switch disconnectors, switch-fused disconnectors or disconnectors, as specified elsewhere. Unless otherwise stated, feeders shall be triple-pole with removable bolted link neutral. Cable boxes shall be manufactured to accept the incoming cable arrangement.

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

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

#### **4.2.2 Busbars**

The assembly busbar and dropper/riser system shall be housed in a separate earthed metal chamber, with the main busbar located at the top of the switchboard. Busbars and droppers shall be ASTA certified for the fault rating and continuous rating stated.

As a minimum, the neutral busbar shall have the same rating as the phase busbars. However, subject to confirmation from the CA the busbar may be uprated to cater for the potential presence of harmonic currents.

Where specified, the busbar system shall be arranged for the neutral earthing of the supply transformer to be made within the switchboard. Removable links shall be provided for testing purposes.

Busbars shall be manufactured from hard drawn, high conductivity copper.

Where specified, busbars shall be insulated throughout their length by PVC tape or sleeving with industry standard colours. Tape shall comply with BS EN 60454-3 and sleeving with BS EN 60684.

All busbar joint surfaces shall be tinned or plated and all joints shall be bolted with vibration resistant fixings.

Busbar supports shall be non-hygroscopic, anti-track and flame retardant. Busbar supports shall be strong enough to withstand, without damage, the forces set up by any thermal expansion and forces created by fault currents.

Access to busbars and connections shall only be possible by the use of tool and covers shall be fitted with engraved laminated labels with the legend 'BUSBARS' in 10mm (min) black lettering.

#### **4.2.3 Earthing**

A suitably rated copper earth bar in accordance with BS EN 60439-1 shall be provided throughout the length of the switchboard. It shall be pre-drilled to each end for future extension and removable end plates shall be provided.

The earth bar shall be drilled to accommodate all protective conductors and the incoming supply cable earth.

All protective conductors shall be connected to the earth bar by brass nuts and bolts, with flat and spring washers. All connections shall be labelled at their termination point at the earth bar.

A main earth termination point shall be provided inside each incomer compartment.

All equipment and metalwork, including gland plates, shall be connected to the switchboard earth bar.

All hinged doors and removable covers shall be bonded by separate flexible earth conductors.

An earth connection shall be made to each gland and/or armour clamp where cables terminate at the assembly.

The earth bar shall be manufactured from HDC Copper.

#### **4.2.4 Air Circuit Breakers (ACB)**

All air circuit breakers (ACB) shall be ASTA certified and in accordance with BS EN 60947-2. ACB's shall be horizontal, drawn-out type, with stored-energy, independent, quick make and break, trip-free operation, with anti-pump. ACB operating mechanisms shall be manual or motor loaded with manual loading facilities, spring stored energy type, as specified in Particular Specification. Trip circuits shall operate at 30 Volt DC.

Air circuit breakers shall have service, test and isolated positions and be capable of being locked in the OFF position. In the isolated position, all circuits shall be isolated. In the test position, only the control circuit shall be made.

Automatic, lockable safety shutters shall be provided to prevent access to live terminals in the disconnected or test positions. Interphase barriers shall be provided to prevent arc propagation.

Interlocks shall be provided to ensure that the circuit breaker is open during connection and disconnection.

A test block shall be provided at the unit front to allow secondary injection testing of all relays and tripping circuits without the disconnection of any wiring.

Air circuit breakers shall be complete with auxiliary contacts and terminals for the required controls and indications, together with all appropriate transformers and fuses.

Each ACB shall be provided with an operating handle for racking the ACB in and out for isolation, etc.

#### **4.2.5 Disconnectors, Switched Fuses and Fused Switches**

Switched fuses and fused switches shall be rated for fault-make, load-break, BS EN 60947-3 utilisation Category AC22 for distribution feeders and AC23 for motor feeders.

Switched fuses and fused switches shall be fitted with suitably rated BS 88 HRC fuse links.

Each feeder device shall be in a separate compartment with a hinged door interlocked with the disconnector, so that the door cannot be opened when the device is closed or locked open.

Positive drive ON/OFF indicators shall be provided.

All disconnectors, switched fuses and fused switches shall be clearly labelled.

### **4.3 MOULDED CASE CIRCUIT BREAKERS (MCCB)**

All MCCB's shall be to BS EN 60947-2 and of the current limiting type.

MCCB's shall be of the quick-make and break, independent, trip-free type with mechanical ON/OFF/TRIPPED indication.

For switchboard mounting MCCB's shall be the cubicle mounting type with door mounted padlockable, rotary type operating handle. They shall be of the fixed pattern with fully shrouded fixed contacts.

Interlocks shall be provided to prevent the opening of the front cover with the operating handle in the 'ON' position.

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

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

MCCB's shall be of a type suitable for the fitting of motorised operators or shut trip devices.

All MCCB's shall be clearly labelled.

#### 4.4 CONTACTORS

Contactors shall comply with BS EN 60947-4 and be rated AC3.

Contactors shall be of the multi-pole double-break, fully shrouded, block pattern, with replaceable main and auxiliary contacts. Operation shall be from a separate source. Each contactor shall incorporate auxiliary contacts and the control circuit shall operate at a voltage not exceeding the phase/neutral voltage. Where more than five triple-pole contactors are used, a separate control transformer shall be provided.

Where contactors are independently mounted, they shall be totally enclosed in a metal case with hinged and/or bolted on covers. Contactors mounted within a cubicle shall be housed within a separate compartment.

All contactor control wiring passing through an adjacent switchgear shall be maintained within an internally mounted metal duct/conduit.

#### 4.5 FUSES

Cartridge fuse-links shall comply with BS EN 60269-1 (BS88). Cartridge fuse-links shall have a utilisation Category of gG for general applications, including motor circuits. Category gM fuses shall only be used on motor circuits. Category 'a' breaking range fuses shall not be used.

Framework for the mounting of loose switchgear, distribution boards and similar equipment shall be of mild steel plate, section and bar or hot rolled hollow sections complying with BS EN 10210-2, or slotted angles complying with BS 4345.

Framework mounted outside a building shall be of galvanised mild steel plate, section and bar or hollow section, or galvanised slotted angles complying with BS 4345. Bolts, nuts and screws shall be galvanised or zing plated (electro-galvanised). Untreated areas of metal, e.g. cut ends, holes and areas damaged by welding, shall be given a coat of zinc rich paint.

#### 4.6 ENCLOSURES

Unless stated otherwise the enclosure protection shall be at least:

- i. Internally IP32
- ii. Externally IP65

Ferrous parts of indoor enclosures shall be adequately rust protected and shall be finished with an electrostatically applied, powder coated finish.

Outdoor enclosures shall be provided with a hot-dip galvanised coating complying with BS EN ISO 1460 or a sherardized coating complying with BS 4921.

#### 4.7 DISTRIBUTION BOARDS

All distribution boards shall be type-tested and comply with BS EN 60439-1 and BS EN 60439-3.

They shall be suitable for surface mounting, have lockable doors (supplied with two keys) and be controlled by an on-load integral disconnector. Keys shall be labelled and handed to the Client at practical completion.

All distribution boards shall be fitted with miniature circuit breakers and residual current devices as specified elsewhere. Where spare ways are provided they shall be fitted with blanking pieces.

All neutral and earth connections shall be made to bars within the distribution board, each connection having an individual terminal. The neutral shall have a removable link to facilitate testing.

The connections to the neutral and earth bars shall be made to correspond with the order of the phase connections.

All conductors terminating at distribution boards shall be appropriately marked with cable ring markers indicating the circuit number and where appropriate phase connection.

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

- i. Internally IP32
- ii. Externally IP65

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

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

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

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

#### **4.8 IDENTIFICATION OF SWITCHGEAR AND DISTRIBUTION BOARDS**

Identification and warning labels shall be in accordance with BS 5378 : Part 1.

Switchgear and distribution boards shall be permanently identified. Labels shall be of a laminated plastic material attached to the apparatus by screws.

Lettering shall be black on white labels and the wording shall be agreed with the Client.

The main control switch or circuit breaker shall be labelled, 'DISCONNECTOR' and numbered 1, 2, etc., if there are two or more incoming supplies. The characters shall be at least 10mm high and 1.5mm thick.

On all other labels the characters shall be at least 4mm high and 0.5mm thick.

A warning label shall be fixed to the front of the switchgear and distribution boards.

#### **4.9 MINIATURE CIRCUIT BREAKERS (MCB)**

Miniature circuit breakers (MCB) shall comply with BS EN 60898, and have a minimum rated short circuit capacity (Icn) of 10kA unless otherwise specified.

Three phase MCB shall trip all phases on any fault condition.

Provision shall be made to enable the operating mechanism to be padlocked in the 'OFF' position.

#### **4.10 RESIDUAL CURRENT DEVICES (RCD AND RCBO)**

Residual current devices (RCD) shall comply with BS EN 61008 (RCD) or BS EN 61009 (RCBO).

The units shall be double or triple pole as required and mounted enclosed within the distribution board panels or purpose made enclosure.

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

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

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

#### **4.11 LABELS AND DIAGRAMS**

All switchgear / fusegear / disconnectors and distribution units etc., shall be clearly marked with engraved laminated plastic labels, secured by screws to the cases, clearly indicating the service, voltage and phase of the circuit or apparatus controlled.

A diagram showing the details, rating and function of each switch, size and number of cores of all outgoing cables, location, size and rating of all distribution boards fed from that switchboard and the phase of each outgoing circuit shall be provided at each switchboard.

These diagrams shall be mounted in glazed frames or similar of an approved design and the layout and mounting shall be approved by the Engineer prior to installation.

#### **4.12 INSTRUMENTS**

Unless specified elsewhere, the main LV switchboard or panel board shall be provided with the following minimum instrumentation on the main incoming switch:

- One voltmeter with line voltage and phase voltage selector switch.
- One ammeter with line selector switch.

The instrumentation shall be flush mounted within the panel front of the switchboard, located immediately above the switches with which it is associated.

Current and voltage transformers shall be mounted within separate chambers within the switchboard.

Transformers shall conform to BS EN 60044.

All instruments shall conform to BS EN 60051 to DIN 43700 style, minimum size 72mm square.

Ancillary fuses shall be labelled with the functions and operating details including fuse type and rating. All auxiliary wiring shall be labelled by permanent slip on numbered ferrules. Terminal blocks and terminations shall be similarly identified.

#### **4.13 NOTICES AND LABELS**

An “electric shock treatment” notice is to be supplied and installed in each switchroom, along with a schematic diagram of the installation. Each notice shall be framed and mounted at locations to be agreed with the Engineer.

**SECTION 5****CONTAINMENT AND WIRING****5.1 CONTAINMENT****5.1.1 Cable Trays**

Cable trays shall be formed from perforated steel finished hot dipped galvanised after fabrication to BS EN ISO 1461.

Support shall be by means of steel brackets installed at intervals necessary to provide a rigid fixing and ensure that no undue deflection occurs in the complete installation. The brackets shall be hot dip galvanised prior to fixing. Dome headed bolts, nuts and washers of finish suitable to the tray shall be used between tray and brackets.

A minimum space between the building structure and tray of 50 mm shall be allowed.

Below are standard dimensions of cable tray.

| <b>Nominal Width</b> | <b>Minimum Height of Up Stand</b> | <b>Nominal Thickness of Sheet Steel</b> | <b>Application</b> |
|----------------------|-----------------------------------|-----------------------------------------|--------------------|
| 100 mm               | 12 mm                             | 1 mm                                    | Internal           |
| 150 mm               | 12 mm                             | 1 mm                                    | Internal           |
| 225 mm               | 12 mm                             | 1.5 mm                                  | Internal           |
| 300 mm               | 20 mm                             | 1.5 mm                                  | Internal           |
| 450 mm               | 20 mm                             | 1.5 mm                                  | Internal           |
| 600 mm               | 20 mm                             | 1.5 mm                                  | Internal           |
| 100 mm               | 12 mm                             | 2.5 mm                                  | External           |
| 150 mm               | 12 mm                             | 2.5 mm                                  | External           |
| 300 mm               | 20 mm                             | 2.5 mm                                  | External           |

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

Where cuts have been made the tray shall be painted with two coats of zinc rich paint.

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

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

All cables shall be securely fixed to traywork and the complete installations must be carried out in a neat and workmanlike manner without crossovers. A 25% reserve margin in size and weight shall be allowed for all cable trayworks. Cables shall be fixed to the tray using proprietary straps, saddles or cleats as appropriate, at intervals specified in BS7671 for the type and size of cable.

### **5.1.2 Cable Ladder Rack**

Cable ladder rack shall be of the hot dip galvanised extra heavy duty type to BS729. The rack shall be of proprietary manufacture and shall be a complete, continuous system with all manufacturers' bends, tees, couplers etc.

Supports shall be by means of steel channel and fixings to be of the same finish as the cable ladder rack. Supports shall be installed at centres of no greater than 1500 mm.

A minimum space between the building structure and cable ladder rack of 100 mm shall be allowed.

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

### **5.1.3 Cable Basket**

Cable basket shall be manufactured from electro plated zinc steel wire and shall be complete with all associated accessories.

Support shall be by means of steel brackets installed at intervals necessary to provide a rigid fixing and ensure that no undue deflection occurs in the complete installation. The brackets shall be hot dip galvanised prior to fixing.

Cuts in cable basket shall be carried out with the manufacturers recommended tools. Cut sections to create bends, tees etc. shall be bolted together such that the structural rigidity shall be the same as the manufactured section.

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

### **5.1.4 Cable Trunking**

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

Cable retaining strips shall be fitted at 750 mm intervals, unless trunking is installed with the cover on the top side.

Insulated cable support pins shall be fitted at intervals of 2 m in vertical runs of trunking and at the top of the vertical trunking.

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

#### **5.1.4.1 Sheet Steel Cable Trunking**

Sheet steel cable trunking shall conform to BS4678, Part 1, Class 3.

Fixings shall be arranged in pairs across the back of the trunking at 1 metre intervals.

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

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

All Tee pieces and bends shall be formed with similar means of connection and the inner radii area shall be such that cables will not be bent through a radius less than that prescribed in BS7671. Only bends and tees of approved pattern will be accepted.

All fixing screws within the trunking shall be of the round head type. Self tapping screws shall not be used.

All necessary accessories including long sleeve couplings, end pieces, bends, sets, tees, reducer branches, fillets, pinracks, cable retainers etc., shall be purpose made units rather than being fabricated on site.

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

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

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

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

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

Conduits shall be connected to the trunking by earthing sockets and male hexagon brass bushes.

Where conduits are taken off multi-compartment trunking they shall not pass through other compartments unless prior permission is obtained in writing from the Engineer.

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

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

Multi compartment trunking shall have welded internal fillets and properly manufactured cross-overs at junctions.

Wherever trunking passes through walls, vertical partitions etc., a fixed piece of trunking lid shall be fitted to the trunking extending 25 mm either side of the wall or other barrier, to allow removal of the adjacent lid without disturbing the building fabric. Care shall be taken to see that no orifice is left between the trunking and the building structure through which fire might spread. All holes shall be filled with fire barriers etc. to maintain the fire integrity of the structure.

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

Earth links of the appropriate size and type shall be installed outside the trunking at every jointing coupling, manufactured bend, tee, etc., throughout the entire trunking system.

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

Where multi-compartment trunking is specified, printed labels shall be fixed to each compartment side wall at 3 m intervals to note the use of the compartment.

#### **5.1.4.2 PVC and UPVC Trunking**

Unless stated otherwise the whole of the PVC/UPVC trunking installations shall be carried out with products manufactured to BS4678-4.

The trunking shall be fixed by means of round-headed screws at intervals not exceeding 1 metre. Fixing holes shall be slotted to allow for any subsequent expansion due to temperature variations. Insulated trunking shall not be installed where ambient temperatures are expected to exceed 60°C or fall below -5°C. Care shall be taken to ensure that the trunking is not deformed by fixings, particularly when trunking is fixed to an uneven surface. Packing pieces shall be introduced in order that the trunking shall be securely fixed, level and plumb without being deformed.

PVC/UPVC cable trunking shall be smooth inside and outside and free from imperfection.

PVC/UPVC cable trunking shall be of the high impact resisting heavy gauge type with well fitting lids of an approved type and size or as indicated in the Contract Documents.

PVC/UPVC trunking shall be fitted with manufacturer's standard tees, off-sets and other fittings where changes of direction occur.

Where trunking terminates, manufacturer's standard end plates and flares shall be fitted to connect to items of equipment.

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

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

Separate protective conductors shall be installed in the trunking with earth block/terminals at 5m intervals.

All joints, trunking and trunking covers shall fit closely and be free from gaps. Additional fixings shall be provided to the building structure 50 mm either side of the joint.

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

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

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

#### **5.1.5 Conduit and Conduit Facilities**

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

In no case will the use of proprietary bends, sets, elbows, inspection elbows or tees be permitted, unless permission has been allowed in writing from the Engineer to meet extraneous conditions.

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

All conduit boxes, couplings, draw-in boxes, etc., shall be of the same manufacture and quality as the conduit.

##### **5.1.5.1 Steel Conduit Systems**

###### **Conduits**

Steel conduit and accessories shall be heavy gauge galvanised screwed conduit, Class 4 to BS4568, BS EN 50086, BS EN 61386 and BS EN 60529.

###### **Fixing of Conduits**

All conduits must be firmly and rigidly fixed to be entirely without whip or movement. Spacerbar saddles, or strap saddles, must be used on the timbers in roof spaces and will be allowed when conduits are run on the underside of exposed unsealed floor or ceiling joists. Pipe hooks or crampets will not be allowed except for securing conduits in chases, or

screeds, when the top of the hook must be at least 10 mm below the finished surface of the walls, or 25 mm below the floor finish. Pipe hooks shall be galvanised.

All conduit drops in chases in plastered walls shall be painted with red oxide paint before plaster is applied.

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

All conduit drops in chases shall have a coupler inserted in the run 300mm from ceiling level.

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

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

### **Conduit Runs and Concealment**

The conduit installation routes shall be subject to approval from the Engineer prior to commencing the installation. Conduits shall be installed at least 150 mm from and preferably under hot water pipes and at least 50 mm from other service pipes and cables.

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

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

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

The installation of conduit boxes in floors shall generally be avoided but where it is essential and permission has been given in writing by the Engineer, the floor mounted boxes shall be fitted with brass covers

recessed to accommodate the floor finish. The covers shall seal the box against the ingress of moisture.

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

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

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

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

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

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

### **Locking Bushing and Coupling**

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

Every conduit connection to equipment, boxes, distribution boards, loop-in boxes, cable trunking etc., shall be made by means of a screwed coupling and male hexagonal headed smooth bore brass bush. The smooth bore bush shall be fitted to secure the conduit to the item connected via a purpose made clear hole only sufficiently large to permit the bush to be rotated, the hole to be closed by the bush and coupling where fitted. Paint must be removed from the surface of the item connected to allow it to be covered by the end of the coupling which shall be filed, clean and square, to ensure a good mechanical and electrical metal to metal joint.

Any exposed area of metal from which paint has been removed must be made good in a matching paint. Bushes shall be fitted and tightened by means of correctly fitting spanners. Mutilated bushes must not be fitted, and any bushes damaged whilst being fitted must be removed and replaced.

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

### **Continuity and Earthing**

The whole of the conduit installations shall be mechanically and electrically sound and continuous throughout their length in accordance with the BS7671.

### **Painting of Conduit**

Galvanised conduit which is slightly damaged shall be primed and painted with a metal based paint to match the colour finish of the conduit, where specified.

#### **5.1.5.2 PVC Conduit Systems**

All PVC conduits shall be heavy duty, high impact PVC and manufactured to comply BS4607, BS EN 50086, BS EN 61386 and BS6099.

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

Care must be taken to ensure that all joints are glued correctly.

Conduit systems shall be protected during storage and during installation by means of plastic plugs or plastic caps to prevent the entrance of

plaster or foreign matter. Protection shall also be afforded against mechanical damage.

Surface conduits shall be supported by spacer bar saddles which shall be fixed at maximum intervals of 1 m except for bends where saddles shall be positioned 200 mm on either side of the bend. Saddles shall include a sliding support tolerance for longitudinal expansion.

All saddles, tubes and boxes must be in perfect alignment to prevent warping when the installation is complete.

Expansion joints shall be installed where any length of conduit, inclusive of draw-in boxes etc., exceeds 6 m in length.

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

#### **5.1.5.3 Flexible Conduit**

Where metal conduit is specified, flexible conduit shall comply with the BS731.

Flexible conduit shall be interlocked steel tape type with a PVC sheath.

Flexible conduit shall be terminated using compression glands.

When PVC conduit is specified, reinforced flexible PVC conduit shall be employed, having a double wall and intermediate helical wire reinforcement.

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

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

#### **5.1.5.4 Painting of Supporting Steelwork Etc.**

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

## 5.2 WIRING

### 5.2.1 Wiring Grade Cables for Conduits and Trunking

All cables shall be 600/1000 volt grade, single core, stranded copper, LSOH insulated (6491B) to BS6004, BS6346 and BS7211, unless an alternative is specified. Prior to commencement of wiring the conduit system shall be swabbed to render it free from moisture and foreign matter.

No conductor with cross-sectional area of less than 1.5 mm<sup>2</sup> shall be used. The conduit installation shall be completed before wiring is undertaken.

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

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

Where cables are installed in cable trunking they shall be installed in compliance with BS7671. The space factor shall be 40% to permit 5% to remain for future wiring after the completion of the installation.

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

All cables shall be drawn in without the use of excessive force or the use of lubricants and the wiring shall be installed in such a manner that it is easily withdrawable.

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

The wiring of the installation must be done in strict accordance with the drawings, cable sizes and circuit details given in the Specification and schedules or drawings issued for the particular project. All wiring of multi-point final circuits must be carried out in the loop-in system and no joints or connectors other than those required for the connection of luminaires and others that may be particularly mentioned in the Specification will be allowed. On all A.C. supplies, care must be taken to ensure that both phase and neutral are contained in the same conduit.

The minimum length of spare cable generally to be left at each accessory shall be 150 mm per conductor, to enable terminations to be remade. Excessive cable length shall not be left at accessories.

Cables installed in trunking shall be grouped in their respective circuits and taped together and identified at regular intervals not greater than 2 m and at all junctions, conduit tap-offs etc.

In addition to phase identification, the core of cables connecting control gear, thermostats, valves etc. shall be fitted with identification sleeves bearing the same markings as the terminals of the apparatus to which they are connected.

### **5.2.2 Armoured Cables with PVC, XLPE or LSOH Insulation or Sheath**

XLPE/SWA/PVC cables shall be manufactured to BS5467.  
PVC/SWA/PVC cables shall be manufactured to BS6346.  
XLPE/SWA/LSOH cables shall be manufactured to BS6724.

All cables shall be delivered to site on cable drums with the maker's identification labels attached and these shall be handed to the Engineer upon demand. Cables shall be of BICC manufacture or equal and approved.

Cables shall only be handled when the temperature is above 0°C and in accordance with the manufacturer's recommendations.

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

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

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

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

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

All cables shall have the cores connected to bolted connections in bus-bars etc., by means of compression type terminations, made off by means of hydraulic compression tools and suitable die to suit size of cable.

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

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

### **5.2.3 Mineral Insulated Copper Sheathed (MICS) Cables**

#### **Cables**

Mineral insulated cables shall be manufactured to BS6207, light duty (500 V) or heavy duty (750 V), metric grade.

Accessories for mineral insulated cables be manufactured to BS6081 and shall be of the same manufacturing origin as the cable used.

For concealed installations and installations in plant and switchrooms, the LSF sheath shall be orange. For surface installations other than plant and switchrooms, the LSF sheath shall be white. The only exception to this requirement is for fire alarm circuits, where the LSF sheath shall be red for all types of installation.

#### **Method of Installation**

All persons employed shall be fully conversant with and highly skilled in the installation of MICS cables, and they shall have received an approved course of instruction in the installation and termination of all types of MICS cables. Details of training given to each individual, when so requested, shall be submitted to the Engineer for approval.

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

MICS cables shall be installed in accordance with the BS7671 and the manufacturer's recommendations.

Fixing centres for MICS cable shall be 300 mm horizontal and 450 mm vertical via LSF coated clips.

Where three or more cables are installed together on the surface, they shall be installed on cable tray.

Where MICS cables are installed in stud partitions or brick/blockwork walls, all vertical drops shall have, in the suspended ceiling void, a loop of one complete turn allowed for the re-making off of the termination, should it be so required at a future date.

The MICS cable shall be run in conduit, thus being rewirable.

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

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

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

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

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

Where a cable is required in excess of the manufacturer's maximum manufactured length the cable shall be extended by means of a factory made cable joint. The joint shall be readily accessible and marked on record drawings etc. Cables shall not otherwise be jointed. All adjacent cables shall be run in the same horizontal or vertical straight lines, diagonal runs are not permitted.

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

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

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

### **Cable Terminations**

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

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

All tails shall be of sufficient length to remake broken connections.

The system shall be wired on the loop-in principle.

### **Testing MICS Cables**

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

Nothing less than a reading of 1000 Megohm must be obtained between the conductors or between any conductor and the cable sheath, all conductors being disconnected from any apparatus. Any re-sealing or replacement necessary shall be carried out without any additional expense to the Contract.

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

Nothing less than 1000 Megohm insulation readings will be accepted in respect of tests on individual sections of cable.

#### **5.2.4 Soft Skin Fire Performance Cable**

Soft skin fire performance cables are those types capable of continuing to operate when exposed to fire. All soft skin cables shall comply with BS7629, BS EN 50200 and IEC 331.

Cables shall be installed in accordance with the manufacturers recommendations. Cables shall be drawn from cable drums to prevent kinking and shall be dressed by hand only.

Cables shall be fixed using suitable single hole or "Universal" fixing bands, fixing centres shall be in accordance with BS7671.

No cable joints will be allowed.

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

#### **5.2.5 LSOH Insulated and Sheathed Cables**

Generally LSOH insulated and sheathed cables (6242B) shall be run in ceiling and floor spaces and in galvanised steel conduit in walls.

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

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

The cables shall be installed so as to give maximum rewirability commensurate with the specified method of installation. Cables installed in ceiling spaces shall be accessible through removable ceiling tiles or ceiling access traps and cables run in ceiling spaces shall not be embedded in the building fabric.

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

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

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

In order to afford a withdrawing facility, not more than 14 single, 8 twin, or 5 three core 1.5 mm<sup>2</sup> cables or their equivalent are to be supported within the confines of one run of stirrups.

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

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

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

Cables shall not share a common run of stirrups with any other type of cable.

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

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

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

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

Cables run on fair-faced brickwork shall be protected by means of heavy duty high impact PVC conduit securely connected to the accessory box as described in Clause 4.03. The other end of the conduit shall be suitably bushed.

Where cables converge and run to distribution boards they shall be supported on galvanised steel cable basket bonded to the distribution boards. Cable entries to distribution boards shall be via gland terminations which secure the cable sheath to the distribution board.

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

Final connections, fluorescent luminaires shall be made by means of flexible cords of the same cross-sectional area as the final sub-circuit cables.

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

Surface installation cables shall be fixed by means of 'Hiatt' or 'Tower' type clips.

Where approval is given in writing by the Architect, multi-runs on fair faced brickwork may be secured to prepared soft-wood battens, the latter being secured by plastic plugs and screws, otherwise they shall be enclosed in PVC conduit as described earlier in this Clause.

Where cables are run under floors and in roof spaces they shall be passed through holes drilled in the neutral axis of the joists where possible, but in no case shall the holes be less than 50 mm from the top or bottom surface of any joist. NOTCHING OF JOISTS WILL NOT BE PERMITTED.

#### **5.2.6 Flexible Cords and Cables**

All flexible cords shall be to BS6141 300/300 Volt or 300/500 Volt insulated and conductor cross section of not less than 0.5mm<sup>2</sup>.

For connections to terminals of lamp holders and heaters, cores shall be glass fibre insulated glass braid/varnish sheathed for a surface temperature of 150°C to BS6500.

For application where the temperatures does not exceed 60°C, cords shall have PVC insulation and sheath.

### **5.3 GENERAL**

### 5.3.1 Building Expansion Joints

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

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

- A sufficient loop of cable must be allowed between fixings on cables fixed directly to the building structure.
- All conduits in air must be joined by a 150 mm minimum length of flexible conduit, linking conduit and adaptable boxes and be suitably looped to accommodate the maximum variation in the building structure. A minimum protective conductor of 4.00 mm<sup>2</sup> shall link the conduit section.
- All cable trunking crossing an expansion joint shall be linked by flexible section being a minimum of 250 mm in length or greater to accept the maximum building variation. The two fixed sections of trunking shall be linked with a 25 mm x 3 mm flexible braided copper earth tape.
- Cable trays must be stopped at each side of the expansion joint, with a minimum gap of 150 mm. Sufficient lengths of cable shall be provided on all cables crossing this gap to allow for the maximum building movement. The cable tray sections shall be connected by two 25 mm x 3 mm flexible braided copper earth tapes.

### 5.3.2 Supports and Fixings

Fixings shall be made by one or more of the following methods detailed overleaf, according to the nature of the equipment to be fixed, the material in which the fixing is to be made and the local environment.

Holes for all fixings involving the use of plugs and inserts shall be drilled, the use of hammer-driven tools will not be permitted, except where written permission has been obtained.

In all cases, fixings in brickwork and masonry shall be made in the brick or masonry and not in the joint.

Fixings made by any method other than those detailed here will not be permitted without the written approval of the Engineer.

Particular importance must be made to the type of supports and brackets for pipework and associated equipment. The materials, construction, method of fixing, practicability and appearance of the brackets must be carefully considered.

Full and proper care shall be exercised in the positioning and marking out of all brackets and supports. Brackets and supports shall be set out so that they do not obstruct the access to valves, flanges or fittings requiring maintenance.

All fastenings and fixings to the constructional and fabric elements of the building shall be included.

No fixings whatsoever will be allowed into any external cladding panels or to the inside of any double skin roof decking. All supports in the latter instance shall be taken from the purlins.

On precast, prestressed and hollow floor constructions, metal plate and rod hanger supports with associated drilling of the structure and secondary spanning steelwork shall be employed subject to the written approval of the Architect.

Structural steelwork shall not be drilled either for the passage of pipes or the attachment of brackets, nor shall steelwork be welded to, without written permission of the Architect.

On hollow wall construction and light partitions, fixing of the spring clip or toggle type shall be used.

Main walls and partition walls etc., where conduits etc., pass through sleeves, shall not be considered as supports.

Expanded bolt fixings used in concrete floors and blockwork walls shall be of a maximum diameter of 12mm and to a maximum depth of 100mm.

Expanded bolt fixings are not acceptable within the underground walkway duct and inserts will be provided in this area for all fixings.

| <b><u>Equipment to be</u></b>                                                                                                                                                                                                  | <b><u>Material</u></b> | <b><u>Environment</u></b> | <b><u>Fixing</u></b>                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|--------------------------------------------------------------------------------|
| <b><u>Fixed</u></b>                                                                                                                                                                                                            |                        |                           |                                                                                |
| Lightweight Equipment not subject to movement, excessive vibration, shock or heavy handling, i.e. conduit, small cable clips and saddles, normal luminaires, small fuseboards and switchfuses, lighting switches, sockets etc. | Good brickwork masonry | Clean, dry                | Proprietary fibre or plastic plugs, woodscrews.<br>Dry = steel<br>Damp = brass |
| - ditto -                                                                                                                                                                                                                      | - ditto -              | Clean, high               | Proprietary                                                                    |

|           |                                                            |                                                    |                                                                                                                               |
|-----------|------------------------------------------------------------|----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
|           |                                                            | temperature<br>or corrosive,<br>any<br>temperature | bronze plugs,<br>corrosion<br>resistant<br>screws.                                                                            |
| - ditto - | Brickwork<br>masonry with<br>ragged or<br>irregular holes. | Any condition                                      | Proprietary<br>plugging<br>compound and<br>woodscrews<br>Dry = steel<br>Damp = brass<br>Corrosive =<br>corrosion<br>resistant |

| <u>Equipment to be<br/>Fixed</u>                                                                                                                                                                                                                                         | <u>Material</u>                                                                                                                                                                                                    | <u>Environment</u> | <u>Fixing</u>                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------------|
| - ditto -                                                                                                                                                                                                                                                                | Good<br>timber<br>blockboard<br>and plywood<br>exceeding<br>12.5 mm<br>thick                                                                                                                                       | Clean              | Woodscrews<br>Dry = steel<br>Damp = brass                                                 |
| Lightweight<br>Equipment not<br>subject to<br>movement,<br>excessive<br>vibration, shock or<br>heavy handling,<br>i.e. conduit, small<br>cable clips and<br>saddles, normal<br>luminaires, small<br>fuseboards and<br>switchfuses,<br>lighting switches,<br>sockets etc. | Sheet and<br>Cellular<br>material of <u>high</u><br>strength per unit<br>area, e.g. sheet<br>steel sheet<br>aluminium,<br>concrete blocks,<br>clay blocks,<br>plywood less<br>than 12.5 mm<br>thick chip-<br>board | Any<br>condition   | Threaded brass,<br>Neoprene insert<br>plated gravity<br>toggles, plated<br>spring toggles |
| Heavyweight<br>Equipment or<br>Equipment subject<br>to excessive<br>vibration, shock or<br>heavy handling, e.g.<br>cable cleats,<br>brackets for cable<br>tray and hangers,<br>fuseboards and<br>other than small<br>sizes, heavy                                        | Very strong<br>brickwork,<br>dense concrete                                                                                                                                                                        | Dry                | Expansion bolts<br>or self drill<br>anchors                                               |

luminaires,  
control panels,  
motors, contactors

- ditto -

- ditto -

Damp and/or  
corrosive

Galvanised or  
cadmium plated  
expansion bolts

- ditto -

Normal strength  
brickwork  
masonry and  
concrete

Dry

Expansion bolts  
or self drill  
anchors

| <b><u>Equipment to be Fixed</u></b>                                                                                                                                                                                              | <b><u>Material</u></b>                                                      | <b><u>Environment</u></b> | <b><u>Fixing</u></b>                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Heavyweight Equipment or Equipment subject to excessive vibration, shock or heavy handling, e.g. cable tray and hangers, fuseboards and switchfuses other than small sizes, heavy luminaires, control panels, motors, contactors | Normal strength brickwork masonry and concrete                              | Damp and/or corrosive     | Galvanised or cadmium plated expansion bolts                                                                                                          |
| - ditto -                                                                                                                                                                                                                        | Poor brick-work masonry or concrete in which it is difficult to drill holes | Dry                       | Grout-in Sockets or bolts, which may be plated through the wall with written approval                                                                 |
| - ditto -                                                                                                                                                                                                                        | - ditto -                                                                   | Wet and/or corrosive      | Galvanised or cadmium plated bolts with proprietary caulking anchors<br><br>M.S. Brackets, which may be plated through the wall with written approval |

| <u>Equipment to be</u><br><u>Fixed</u>                                                                                                                                                                                                                     | <u>Material</u>                            | <u>Environment</u> | <u>Fixing</u>                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Heavyweight Equipment or Equipment subject to excessive vibration, shock or heavy handling, e.g. cable cleats, brackets for cable tray and hangers, fuseboards and switchfuses other than small sizes, heavy luminaires control panels, motors, contactors | Any material of low strength per unit area |                    | M.S. Brackets and/or plates to spread the load. All brackets to be painted red lead primer and finishing coat.<br><br>Bolts and screws to be galvanised cadmium plated or normal to suit the conditions |
| Any fixing                                                                                                                                                                                                                                                 | Structural steelwork                       | Any condition      | Proprietary clamps and/or clips. Finish of clamps and bolts etc. to suit the conditions. All brackets to be painted red primer and finishing coat                                                       |

**N.B.** Structural steelwork must not be drilled or welded to without the written permission of the Engineer.

### 5.3.3 Miscellaneous Three Phase and Single Phase Points

- Where single phase and three phase power is required for miscellaneous supplies and heating and ventilating equipment, the supply and installation of all motor starters, isolators, room thermostats, stop buttons, plugs and sockets and other such control and connection equipment shall be carried out unless specifically stated otherwise.
- All other equipment such as pumps, compressors, valves, pipe thermostats and sensing equipment etc., as scheduled on the Drawings shall be wired to and connected in accordance with the Specification.

### **5.3.4 Termination at Fixed Equipment**

#### **Apparatus Served from Surface Mounted Final Control Equipment**

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

Flexible conduit shall connect the conduit box with the apparatus in accordance with Clause 4.03 with particular emphasis on the correct method of earthing as required by BS7671.

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

Every item of equipment shall be provided with terminals of adequate size to permit the connection of the conductors specified.

#### **Apparatus Served from Flush Mounted Final Control Equipment**

A conduit recessed into the building fabric shall link the final flush mounted control equipment to a conduit termination (end) box recessed adjacent the apparatus. An extension box with conduit spout outlet shall be fixed to the terminal box using the fixing lugs provided, a break joint ring being fitted between the two. The screws securing the extension box shall not form part of the earth path, a separate earth being obtained from the recessed conduit box.

#### **Insulated and Sheathed Cable Installations**

Where LSOH insulated and sheathed multicore cables are used to serve an item of electrical apparatus they shall terminate adjacent to the apparatus in a suitable connection unit and/or isolating switch as specified.

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

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

### **5.3.5 Buried Cables and Markers**

All cables laid in the ground shall have the minimum cover as detailed.

In open ground, under pathways and pavements, lawns and planted areas etc., as follows.

|                      |        |
|----------------------|--------|
| Communication cables | 600 mm |
|----------------------|--------|

|                        |        |
|------------------------|--------|
| Street lighting cables | 600 mm |
|------------------------|--------|

|                                         |        |
|-----------------------------------------|--------|
| Power cables not exceeding<br>650 volts | 600 mm |
|-----------------------------------------|--------|

|                                                                       |        |
|-----------------------------------------------------------------------|--------|
| Power cables exceeding 650<br>volts but not exceeding 11,000<br>volts | 800 mm |
|-----------------------------------------------------------------------|--------|

Auxiliary cables associated with main cables shall be laid at the same depth as the main cables.

Low voltage, high voltage and communication cable routes shall be separated by a minimum distance of 600mm.

Under roadways, the minimum cover to the top of ducts shall be as follows.

|                                       |        |
|---------------------------------------|--------|
| All cables not exceeding<br>650 volts | 750 mm |
|---------------------------------------|--------|

|                                                                       |         |
|-----------------------------------------------------------------------|---------|
| Power cables exceeding 650<br>volts but not exceeding 11,000<br>volts | 1000 mm |
|-----------------------------------------------------------------------|---------|

Cables shall be laid on a bed of sand 100 mm deep, surrounded by sand to a minimum cover of 100 mm. The cable shall be covered by 300 mm of hand placed, selected back-fill with all large pieces of hard-core removed, well rammed. One or more continuous strips of plastic marker tape shall be run above this layer so as to adequately cover the cables. The tape shall be clearly and indelibly marked "DANGER ELECTRIC CABLES".

The trench shall be back-filled, properly consolidated and the ground reinstated. For installations in wet ground or on steeply sloping sites, approval shall be obtained from the Engineer for the methods to be employed. For installations in existing soft landscaped areas, the excavation shall be back-filled and consolidated to within 150 mm of the surface in grassed areas, or 400 mm shall be back-filled with sub-soil material as specified. The remaining 150 mm, or 400 mm shall be back-filled with sufficient clean, friable top soil to ensure that the finished level marries in with the existing ground level. The top soil shall be brought to a suitable tilth for germination of seed and all stones over 25 mm diameter and all perennial weeds removed.

Wherever cables are to be installed under roads, through foundations, walls or under concreted areas, they shall be enclosed in pipe ducts.

A minimum of 100% spare ducts shall be installed. Draw-in pits shall be provided in accordance with the following:-

At each significant change of direction.

- At intervals not exceeding 20 m in straight runs.
- Where otherwise required to facilitate drawing in.

Where, for any reason, the minimum specified cover cannot be provided then the cables shall be run in cable ducts which shall be surrounded and covered with mass concrete.

Each run of cable(s) shall be installed and covered with sand, as specified, in one continuous operation so as to be completed within one working day. Trenches shall be completed, as specified, within 72 hours of the commencement of installation of the cables. Where particular difficulty is foreseen in meeting this requirement, approval shall be obtained from the Architect for the methods to be employed.

Cables shall only be installed when the temperature is above 0°C and has been above this temperature for at least the previous 24 hours.

Cable markers shall be installed to indicate the position of underground cable(s). Cable markers should be installed in accordance with the following:

- At each side of each road crossing.
- At every change of direction.
- At each joint authorised in writing.
- At intervals not exceeding 45 m on straight runs.

Cable markers shall be of concrete with an engraved plastic label, with the words Electricity Cables, with an indication of the direction of the cables.

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

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

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

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**SECTION 6****LUMINAIRES AND ACCESSORIES****6.1 LUMINAIRES****6.1.1 General**

All luminaires shall be suitable for the environment that they are to be installed.

The luminaire shall be cleaned free of dust, dirt and other deleterious matter after completion of the installation. Where dirt, dust, corrosion or other conditions cause imperfections in the luminaires, they shall be replaced at no cost.

Luminaires, diffusers, attachments or glassware etc., shall be properly stored prior to final erection.

Switch start control gear shall not be used.

Exterior and vapour proof luminaires shall be installed with suitable gaskets on all openings to ensure the integrity of the installation. All fixings and supports in these situations shall be zinc plated, brass or stainless steel. Reflectors and louvres shall only be installed when all dirty trade is completed and the Electrical Contractor shall take care not to get fingerprints, marks etc. on the reflective surface.

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

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

Normally visible luminaire support shall be suspension wire or conduit. All fluorescent luminaires shall be solidly mounted with all assembly nuts, bolts and accessories made tight to prevent vibrations and noise. Antivibration packing shall be fitted where necessary. Luminaires mounted direct to trunking shall be fixed by means of manufacturer's recommended fixing assemblies.

Unless stated otherwise all luminaire supports shall be fixed to the building primary structure. Luminaires shall not be supported from suspended ceiling unless detailed. All mounting and fixing arrangements shall be submitted for approval prior to installation.

**6.2 PLUG IN CEILING ROSES AND MODULAR WIRING SYSTEMS**

All luminaires recessed or semi recessed into the suspended ceilings shall be connected by means of plug in ceiling roses. Plug in ceiling roses shall be mounted on a circular conduit box and shall comprise a three pin or four pin 2 amp socket and plug

with a coarse screw moulded plug retaining cover, connected via a suitable flexible cord.

Four pin plug in ceiling roses shall be utilised with integral emergency lighting facilities.

Modular wiring systems shall be in compliance with BS7671.

Modular systems shall be wired utilising cables suitably rated to run in containment with general wiring and shall have a LSF outer sheath. Where systems utilise marshalling boxes cables between items shall be supported so as to not lay on the back of ceilings.

Modular systems shall be factory assembled with no terminating of plugs/sockets etc. on site.

### **6.3 LAMPS**

All luminaires shall be supplied with lamps of the type and size specified.

All lamps shall be by leading brand manufacturers and shall be new.

Where lamps are to be dimmed they shall be "burnt in" at full output prior to any dimming function in accordance with the lamp manufacturers recommendations.

Fluorescent lamps shall be to BS EN 60081 and BS1853 : Part 2 with amendments.

LED luminaires shall be L70 compliant, have a full 5 year, 50,000 hours unlimited warranty, with no restrictions on switching or annual usage.

### **6.4 FLEXIBLE CABLES AND CORDS**

All flexible cables and cords shall comply with BS6500 and BS6004. Cables shall be 300/500V grade LSF insulated and sheathed as appropriate.

The minimum cross section area of flexible cords shall be 0.75mm<sup>2</sup>.

### **6.5 LIGHTING SWITCHES**

All lighting switches shall have interiors of the AC quick make/slow break pattern, generally rated at 20A and manufactured in accordance with BS EN 60669 where relevant.

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

The physical "layout" arrangement of switches in ganged boxes shall be similar in plan to the lighting points which they control. Switches not so arranged shall be engraved in an approved manner to indicate the circuits controlled, but in any case all switch plates of six gang and above shall be suitably engraved to indicate each switch function.

All door swings shall be verified prior to commencing the installation on site and cord and wall switches shall be positioned adjacent to the closing edge of the door. Wall

switches shall be located 150 mm to the edge of the mounting box, from the door architrave.

The cords of all ceiling switches shall be of sufficient length (without joints) to reach a point 1.5 metres from floor level unless otherwise specified. Cords of excessive length shall be shortened to this height.

Where cord operated "Pull" type ceiling switches are specified to be used at door position they shall be located on the ceiling in such a manner that the cord will hang free approximately 75 mm any wall face and also be clear of the door movement.

All lighting switches shall be labelled with their circuit reference.

## **6.6 SOCKET OUTLETS**

All 13 Amp socket outlets shall comply with BS 1363 and unless specified otherwise shall be switched.

All 13 Amp socket outlets shall be of the dual earth terminal type.

All 13 Amp socket outlets shall be labelled with their circuit reference.

## **6.7 FUSED CONNECTION UNITS**

All fused connection units shall comply with BS5733 and unless specified otherwise shall be double pole switched and incorporate a BS1362 fuse.

Front plates shall be engraved to indicate the equipment served.

All fused connection units shall be labelled with their circuit reference.

## SECTION 7

### EARTHING

#### 7.1 EARTHING

##### 7.1.1 General

The whole of the metallic portion of the installation other than current carrying parts, shall be electrically and mechanically bonded to the consumer's main earth terminal and also, if applicable, to the lightning protection system or other points specified.

The installation shall be effectively earthed in accordance with the following:-

- BS 7671.
- British Standard Code of Practice : Earthing : BS7430
- British Standard Code of Practice: The Protection of Structures against Lightning : BS EN 62305.
- British Standard Construction of Electrical Equipment for the Protection Against Electric Shock : BS2754.
- Supply Authority Requirements
- Electricity Supply Regulations.

All protective conductors shall, where possible, be enclosed within metal trunking or conduit serving switchgear, distribution boards etc., so as to provide mechanical protection.

Earth continuity between separate items of switchgear, distribution boards etc., mounted adjacent to one another shall be effected by means of high conductivity continuous copper tape, or LSF sheathed cable coloured green and yellow connecting all items to the earth terminal.

All items of switchgear, accessories, luminaires, conduits, and the outer sheaths of MICS cables, the armouring of all XLPE/SWA/LSF cables, together with all other items of electrical plant and equipment, shall be effectively earthed by means of a protective conductor.

The armouring of plastic sheathed cables shall terminate in a suitable compression gland fitted with a purpose made earth tag. A suitable protective conductor shall connect the earth tag to the apparatus earthing terminal.

The armouring of metal sheathed cables shall be securely clamped to the gland at the cable termination with a purpose made bolted clamp. A suitably sized protective conductor shall be installed to connect the armour clamp or gland to the apparatus earthing terminal.

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

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

### **7.1.2 Main Earth Terminal**

Main earth bars shall be mounted on suitable fixing insulators, constructed from 50mm x 6 mm flat tinned copper section, rated in accordance with BS7430.

Space connections to the earth bars shall be at 75mm centres and shall have space for 4 No. future connections.

Disconnecting test links shall be provided to allow periodic testing of a live installation.

All main earthing conductors shall be identified at each end with a unique reference.

### **7.1.3 Mains Equipotential Bonding**

Main pipes, other service pipes and ducting, risers of heating and air conditioning systems and exposed metallic parts of the building structure shall be connected to the main earthing terminal by means of main equipotential bonding conductors, using single core cables with LSF insulated coloured green/yellow.

A 50 mm section of each main pipe, at positions close to their entry into the building, shall be cleaned and made smooth and a copper earthing clamp fitted.

The copper earthing clamp shall be a proprietary type or shall be fabricated from high conductivity copper strip, minimum size 40 mm x 4 mm which shall encircle the cleaned sections of the pipe. 40 mm x 10 mm brass bolts shall pass through 10 mm holes drilled in the end return sections of each clamp and a brass bolt, washer and nut shall tighten the clamp on to the pipe. Connections to duct risers shall generally be made at flanges where at least two locknuttet set screws shall secure each connection.

Connection to exposed metallic parts of the building shall generally be made where sections are bolted together in which case extended bolts capable of fulfilling their structural function and accommodating the connection shall be used, a locking nut shall secure the connection to the extended bolt.

A permanent label, indelibly marked with the words 'SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE' in legible type not less than 4.75 mm high, shall be permanently fixed at the points of connection.

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

#### **7.1.4 Supplementary Earth Bonding**

Supplementary earth bonding shall comply with BS7671, utilising 4mm<sup>2</sup> LSF/CU cables from local electrical earths. Cables shall be contained in conduit to a location immediately adjacent the bond position and shall exit by either:

- Stuffing gland – above ceilings or in plantrooms
- Flush flex outlet plate – below ceilings

Supplementary bonding shall be required as below:

- Cross bond ladder rack, cable trays, cable baskets and trunkings
- Kitchen equipment such as stainless steel worktops and hoods
- Cross bond between hot, cold and waste pipes to wash hand basins and sinks.
- Ceiling tile grids

#### **7.1.5 Dedicated Earth**

Dedicated earth systems shall be derived from the main earth bar with connection made through a disconnecting test link. A white engraved link with the legend “Dedicated Earth” (along with its specific application) in 25mm orange lettering shall be provided in a prominent location above the test link.

Dedicated earth cables shall be cream coloured LSF insulated single core cables.

#### **7.1.6 Earthing Electrodes and Pits**

Earth electrodes shall be copper clad steel with all drive type head, connection and cable clamps.

Earth rods shall be protected by purpose made enclosures that are accessible for testing and maintenance purposes.

Where an earth rod is internal to a building, the enclosure can be formed in the floor structure with a load bearing cover. It shall be of propriety manufactured sealed type, to prevent water ingress. The rod shall pass through a 75mm hardening mastic compound and a sealing gland assembly to prevent the ingress of water.

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## SECTION 8

### INSPECTION, TESTING AND COMMISSIONING

#### 8.1 GENERAL

The whole of the work shall be carried out in strict accordance with the BS 7671, the Electricity (Factories Act) Special Regulations 1908 and 1944, the Electricity Supply Regulations 1937, and any other relevant local, statutory or government authority.

#### 8.2 VISUAL INSPECTION

Visual inspections shall be made to verify that:

- The installation conforms to the design specification and drawings.
- Compliant with all relevant British Standards Statutory Requirements and BS7671
- Not damaged, clean, new and correctly installed

The Electrical Contractor and the Engineer shall carry out joint visual inspections through the course of the installation at the stages listed below:

- Between first and second fix.
- Between second and third fix.
- Between third fix and testing.
- After testing and prior to validation.

Any remedial works noted shall be completed prior to the next stage of inspection.

#### 8.3 TESTING IN COMPLIANCE WITH BS7671

The electrical installation shall be inspected, tested and verified in accordance with BS7671.

It should be noted that electronic components may sustain serious damage as a result of certain accepted electrical installation test procedures. Conductors and other circuit components shall be tested prior to them being connected to electronic components. Electronic equipment shall be tested in accordance with the manufacturer's instructions.

The presence of electronic components shall be noted clearly on the circuit cards and in operating and maintenance manuals with an indication that testing procedures may result in damage.

Where any part of the installation is to be concealed within the building fabric tests shall be made to ensure that the installation is satisfactory prior to concealment.

A record of the results of each test shall be kept on site. Such records shall include details of sections tested, remedial measures taken, sections replaced etc.

All tests shall be executed within the programme of building works.

All labour and test instruments shall be allowed for carrying out the works. The instruments shall be correctly calibrated and certified for the limits of accuracy required and shall be operated by competent persons, trained in the use of instruments.

Copies of the calibration certificates shall be provided with the test results.

In the event of any test indicating failure to comply, that test and those preceding, the results of which may have been influenced by the fault indicated, shall be repeated after the fault has been rectified.

#### **8.4 FACTORY PROVING TESTS AND TRIALS**

All test certification associated with factory built assemblies, purpose built panels etc. shall be provided prior to dispatch to site.

The Engineer shall be afforded the opportunity to inspect and witness test all equipment prior to dispatch to site.

#### **8.5 COMMISSIONING**

Commissioning shall be carried out to verify the correct operation of the whole installation including equipment etc. and to ensure that this is operating in accordance with the specified conditions, this shall include but not be limited to:

- Locations and functioning of all luminaires, switches, socket outlets and fixed equipment.
- Isolation of all circuits shall be tested and proven.
- Rotation and operation of motors.
- Emergency lighting tested to BS5266, ensuring output is maintained for the prescribed time period with battery re-charge accomplished in the specified time.
- Check and record illumination levels for all areas.
- Commissioning and functional testing of the fire alarm system shall be carried out by the Specialist equipment manufacturer, all in accordance with BS5839.

#### **8.6 DOCUMENTATION**

Upon completion of all tests and commissioning, a copy of detailed Certificates shall be submitted to show that the equipment, materials, installations etc. have been tested and commissioned as detailed above. The certificates shall be duly completed and signed, shall be submitted to the Engineer within 14 days of the results being obtained. The results of the tests and details of completion for the Electrical Test, shall be detailed on the Test and Completion Certificates respectively, issued by the National Inspection Council for Electrical Installation Contracting.

In addition all manufacturer's certificates of tests at the specified duties carried out at the manufacturer's works shall also be submitted in triplicate as detailed above.

All test certificates shall be incorporated within the Operating and Maintenance Manuals.

A notice to the effect that the installation should be periodically inspected, shall be secured to the main switchgear. The notice shall read as follows:

**IMPORTANT**

This installation should be periodically inspected and tested, and a report on its condition obtained, as prescribed in BS7671.

Date of last inspection:

Recommended date of next inspection:

**8.7 TREATMENT - ELECTRIC SHOCK**

In all Main Switch Rooms and/or sub-stations, a notice shall be provided and fixed in a conspicuous place, giving full instructions for the method of treating persons suffering from electrical shock, in accordance with the Electricity (Factories Act) Special Regulations, Reg No 29.

## SECTION 9

### LABELLING AND IDENTIFICATION

#### 9.1 GENERAL

Supply and install all necessary labelling and identification to all equipment, materials, cables, components, terminations and systems of the electrical services installation.

All signs and labels shall be displayed in accordance with BS5378, BS5499, BS7671 and as agreed with the Engineer.

#### 9.2 LABEL TYPES

The following principal colour co-ordination of signs/labels shall apply:

|                                             |                                                                                            |
|---------------------------------------------|--------------------------------------------------------------------------------------------|
| Warning                                     | Yellow background with Black lettering                                                     |
| Mandatory                                   | Blue background with White lettering                                                       |
| General                                     | Information White background with Black lettering                                          |
| Emergency                                   | Green background with White lettering                                                      |
| Prohibition                                 | White background with Red lettering                                                        |
| Fire Fighting                               | Red background with White lettering<br>(except extinguishers that have particular colours) |
| Equipment/Services<br>Locations with Others | Orange bands of tape or where required routed in<br>common Orange colour                   |

#### 9.3 WARNING NOTICES

All items of equipment or enclosure within which voltages exceeds 250 volts or separate enclosures or items of equipment that allow simultaneous contact with live parts exceeding 230 volts shall be so arranged that before access may be gained a warning of the maximum voltage present shall be clearly visible i.e. 'DANGER 500 VOLTS'.

On unit construction switchgear the label shall be centrally placed and preferably on the busbar section. The number of labels shall be determined by the size of the switchboard but at least one label every two metres length of switchboard shall be provided.

Each switchboard shall have the primary warning triangle sign denoting "Caution, Risk of Electric Shock".

Where a disconnecter leaves any part of equipment or enclosure "live" when in the OFF position a warning notice shall be used indicating that the equipment is not totally isolated and giving instructions for achieving further isolation.

Warning labels shall be fixed to high-voltage cables or their protective covering at 1.5 metres (max) intervals with lettering 10mm high in Red on a White background.

#### 9.4 GENERAL INFORMATION/IDENTIFICATION LABELS

- a. All electrical equipment shall be labelled to ensure correct identification and give essential operating functions that relate to each other. The labels shall have a White background and Black lettering.
- b. The main incoming switch shall state:

- Main Disconnector
  - Rating
  - Phase
  - Voltage
  - Incoming cable size in mm<sup>2</sup> and cable type system earthing
- c. Individual switch fuse, MCCB, disconnector shall state:
- The circuit which it controls with a general description of type of load
  - Rating
  - Phase
  - Outgoing cable size in mm<sup>2</sup> and cable type
- d. The main bus bar/main panel construction shall also state:
- The British Standards to which it complies
  - Fault Rating
  - Classification Reference
  - IP Rating
- e. All distribution boards shall have external labels that state:
- Voltage
  - Maximum rating of protective devices uses
  - Type of load connected
- f. All distribution boards shall have internal labels that state:
- Main cable size in mm<sup>2</sup>
  - Phase colour indication
  - Circuit number\*
  - Description of circuit\*
  - Circuit protective device ratings\*
  - Actual circuit current\*
  - Circuit cable\*
  - Equipment vulnerable to test\*
- \* This applies to all final circuits and the labels/circuit charts shall be completed in clear printing in Black ink on a White background.
- g. The individual phases shall be identified as L1, L2 and L3 with their phase colours of Brown, Black and Grey respectively.
- h. Where a distribution arrangement incorporates contactors, time switches, relays, indicator lights and push buttons each of these shall be labelled and indicate its function i.e. ON/OFF/AUTO together with what it controls i.e. "LIGHTING", "OVERRIDE SWITCH", "TIME SWITCH FOR EXTERNAL LIGHTING".
- i. These labels shall conform to a White background with Black lettering.
- j. Local switchgear/disconnectors and control gear shall have individual labels that shall be Black lettering on a White background. These labels shall indicate:

- Equipment Title
  - Current Rating, Phase, Voltage
  - Circuit Reference
- k. The ON/OFF functions shall be clearly indicated using an appropriate label where the operating positions are not clearly indicated on the equipment itself.
- l. Where socket outlets are not RCD protected and are intended for the connection of a specific piece of equipment they shall be labelled to indicate that intended use.
- m. All junction boxes that form a marshalling point and junction point for fire alarm system, security systems and communication systems shall have a label with Black lettering and White background.
- n. These labels shall indicate:
- The wiring system enclosed
  - Voltage
  - Circuit(s) reference

## 9.5 EMERGENCY LABELS

- a. Where an item of equipment and/or switchgear is designated for emergency operation, the labelling shall be White lettering on a Green background.
- b. This labelling shall clearly indicate the item of equipment/function it performs together with the emergency action required to be undertaken.

## 9.6 PROHIBITION LABELS

Where an item of equipment and/or switchgear is designated for prohibited use:

‘Danger switch off when not in use’  
‘Do not switch off’  
‘Emergency stop’

This labelling shall be Red lettering on a White background.

## 9.7 FIRE FIGHTING LABELS

Where a particular item of equipment and/or switchgear is designated for firefighting use e.g. a fire alarm switch on a main switchgear panel this shall be clearly and differently indicated with a label with White lettering on a Red background.

## 9.8 LABELLING MATERIAL

- a. The material shall be a composite plastic component with three layers of rigid plastic (040 ABS) materials. The letter colour being the centre element of the composite and when engraved the composite shall then expose the colour.

- b. The method shall be as commonly referred to as 'TRAFFOLYTE'.
- c. All lettering shall be upper case in capitals and generally the height of lettering that shall be used shall be as follows:
  - 6mm for identification labels
  - 12mm for warning notices
  - 12mm for the principle wording of an emergency sign
  - 6mm for the secondary wording of an emergency sign
- d. The fixing used for all labels shall be either bolted with gripping washer or riveted with space washers behind each rivet.
- e. Two fixings shall be provided for labels with a height up to 25mm. Labels higher than this shall have four fixings, one in each corner of the label.

## 9.9 LABELLING FOR HV SWITCHGEAR

- a. Each main switch panel shall have a general label located centrally on the switchboard stating the following information:
  - Manufacturers name
  - Switchboard designation
  - System voltage, phases, frequency
  - System fault level
  - Busbar rating
- b. All feeders switches shall have permanent labels giving the following information:
  - Feeder designation
  - Feeder cable size
  - Transformer connection e.g. Transformer 'A'
- c. All incoming switches shall have permanent labels giving the following information:
  - Incomer Designation and Source of the Supply
  - Incoming Cable Size
- d. All current and voltage transformers shall have permanent labels giving the following information:
  - Designation/Identification
  - Transformation Ratio
- e. All protective devices shall have permanent labels giving the following information:
  - Designation/Identification
  - Type of Protection
- f. All busbars shall have the required safety labelling.

**EQUANS  
MANCHESTER ROYAL INFIRMARY  
NELSON STREET SUB STATION  
LIFE CYCLE UPGRADE – LC1839**

**SUMMARY OF TENDER FOR  
ELECTRICAL SERVICES**

|              |                                     |            |
|--------------|-------------------------------------|------------|
| 1.           | General Conditions/Preliminaries    | £          |
| 2.           | Temporary Works (Generator Hire)    | £          |
| 3.           | Bespoke New LV Switchboard          | £          |
| 4.           | Sub Main Cables/Tails Wiring        | £          |
| 5.           | Removals                            | £          |
| 6.           | Ladder Racking                      | £          |
| 7.           | Fire Precautions                    | £          |
| 8.           | Small Power                         | £          |
| 9.           | Lighting/Emergency Lighting         | £          |
| 10.          | Fire Alarms                         | £          |
| 11.          | Structured Cabling                  | £          |
| 12.          | BMS                                 | £          |
| 13.          | Builderswork                        | £          |
| 14.          | Earthing                            | £          |
| 15.          | Lightning Protection                | £          |
| 16.          | Testing and Commissioning           | £          |
| 17.          | As Fitted Drawings and Manuals      | £          |
| 18.          | P.S. Power Factor Connection        | £10,000.00 |
| 19.          | P.S. Isochronous Generator Governor | £ 5,000.00 |
| 20.          | P.S. Neutral Paralleling Contactor  | £ 8,000.00 |
| 21.          | Contingencies                       | £10,000.00 |
| <b>Total</b> |                                     | <u>£</u>   |

**N.B.** Costs to include main contractors discount where required.

For and behalf of \_\_\_\_\_

\_\_\_\_\_

Signed: \_\_\_\_\_

Date: \_\_\_\_\_

**To be returned with tender**

**EQUANS  
MANCHESTER ROYAL INFIRMARY  
NELSON STREET SUB STATION  
LIFE CYCLE UPGRADE – LC1839**

**SCHEDULE OF DAY WORKS  
FOR ELECTRICAL SERVICES**

Dayworks percentages in accordance with the RICS/BEC definitions are:

|           |   |
|-----------|---|
| Labour    | % |
| Materials | % |
| Plant     | % |

For and behalf of \_\_\_\_\_

\_\_\_\_\_

Signed: \_\_\_\_\_

Date: \_\_\_\_\_

**To be returned with tender**