# 73 Maygrove Road

# Mechanical and Electrical Services Performance Specification

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# Specification Revision Sheet

Each time revised pages are issued, as detailed below, please replace the pages in the appropriate Section of your copy of the Specification Reference C8611. All amendments are typed in **Bold.**

| Section | Title | Description of Alteration/Revision | Rev | Date of Revision |
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# Section ME1.00

# Preliminaries and General Description

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# ME1.00 Preliminaries

In the event of any contradiction between the services specific preliminaries and the main contract preliminaries the Services Contractor shall seek clarification in writing from the Employer's Representative before proceeding.

The following specification, together with all associated drawings, is provided to the Services Contractor to indicate the Employer's Requirement in terms of the performance design and installation method to be complied with and/or adopted for the mechanical and electrical services contract.

These preliminaries are specific to the mechanical and electrical services works but shall also be read in conjunction with the main contract preliminaries which they augment.

It should be noted that whilst certain sections of the mechanical and electrical services specifications are notionally separated for convenience of use and reference they shall be read as a single document. The specification and accompanying services drawings shall be read as one and in the event of conflicting information between either specification or drawing shall be raised in writing during tender and clarification sought and confirmed in writing before proceeding. Neither document nor drawings shall be read in isolation.

This separation is achieved by the prefix M (mechanical), E (electrical), ME (mechanical and electrical) at the commencement of each section and on each page number. In addition a separate section is included in Section 2.00 which covers the sprinkler installation. This section of the works is detailed as a package due to the specialist nature of the sub-contract.

Any person or party using the specifications shall consider the specification as a single document. It is necessary therefore to be familiar with the 'single document' particularly with regard to multi serviced items such as fume cupboards, safety cabinets, fan coil units, air handling plant and the like.

## 1.1 Definitions

Throughout this specification various terms are used which refer to specific companies and individuals and the following definitions shall apply:

'The Services Contractor' and 'The Services Subcontractor' shall mean the company appointed to execute the Contract Works as they relate to the mechanical and electrical services described in this and associated documents.

'The Employer' shall mean Room & Studios London, 73 Maygrove Road, London NW6 2EG.

'The Main Contractor' or 'The Principal Contractor' shall mean the company or organisation appointed to execute and manage the Main Contract Works as defined in the Main Contract Documents.

'The Architect' shall mean Create Design, Wigglesworth House, 69 Southwark Bridge Road, London, SE1 9HH.

'The Services Engineer' shall mean mgpartnership, 1 Katherine Mews, Godstone Road, Whyteleafe, Surrey, CR3 0ED.

'The Structural Engineer' shall mean XXXXX

'The Specialist Company' shall be that company or organisation named in the Specification to carry out specific areas of work described therein. The Specialist Company shall be bound by the Main Contract Terms and Conditions.

'The Employer's Representative' shall mean that person employed by or appointed by The Employer from time to time.

'The Local Authority' shall mean London Borough of Camden.

'Provision' or 'Provide' shall mean design (if applicable), procure, supply, transport, deliver, receive, check, off load, inspect, place in position, install, set to work, test and commission, demonstrate, handover and provide Operating and Maintenance Instructions and Record Drawings.

## 1.2 To Whom it May Concern

The requirements of the Health and Safety at Work etc Act 1974 and subsequent amendments thereto are brought to the attention of all those who design, install, operate or maintain the plant and equipment required by this specification and/or drawings forming a part of this specification or tender documents or who are required to enter the areas covered by the specification or depicted on any related drawings.

The Services Contractor, being the design developer, installer and co-ordinator, erector and supplier of the works required by this specification shall comply with all those duties laid upon him in these capacities.

The Services Contractor shall be responsible for providing all plant rooms and plant with the necessary notices, warnings and/or instructions. These shall cover maintenance, working operating and access or egress thereto or therefrom. For example, all plant rooms shall have a notice permanently secured to all doors stating "No Admittance to Unauthorised Personnel" in letters 50mm high followed by:

"Health and Safety at Work Act 1974 - Persons entering these premises must comply with all safety regulations under the above Act".

All plant, systems and plant rooms shall be laid out and installed to comply with the Health and Safety at Work etc Act. All precautions necessary to protect personnel from injury due to collision with pipes, ducts, hangers and supports shall be taken. This shall include the protection or wrapping of all sharp edges and the identification by means of yellow and black markings of all protruding objects likely to cause injury.

It shall be the duty of any person who erects or installs any article for use at work in any premises where that article is to be used by persons at work to ensure, so far as is reasonably practicable, that nothing about the way in which the article is erected or installed makes it unsafe or a risk to health at any time.

At all times the Services Contractor shall employ a person to attend to the health and safety matters associated with project works.

## 1.3 Construction (Design and Management) Regulations 2016 (CDM Regulations)

The CDM co-ordinator, appointed by the Employer, will make available, as soon as practicable, the health and safety plan to the main contractor.

The health and safety plan shall then be taken over by the successful main contractor and developed into a working document to be made available to all.

The Services Contractor has a major responsibility for health and safety during the contract and in summary his duties are as follows:

1. Assist the main contractor to develop the safety plan into a working document and implement same.

2. Ensure co-operation between all his subcontractors and that they and others employees comply with the safety plan.

3. Ensure safe working practices on site.

4. Take reasonable steps to ensure that only authorised persons are allowed on the site.

5. Promptly provide the CDM co-ordinator with any information reasonably known to be required for the safety file.

The main contractor and his Services Contractor shall be familiar with both the CDM Regulations and the Approved Code of Practice and allow for all items therein.

## 1.4 Provision of Everything Necessary

The Services Contractor shall be held by the acceptance of his tender to understand the scheme design principles as a whole and in detail. Using this information the Services Contractor shall install the works understanding that he is responsible for the satisfactory working of the installation on completion and its maintainability. The specification and the tender drawings are to be used jointly and anything not specifically mentioned in either, but necessary for the fulfilment of the guarantees and requirements called for in the contract, or necessary for the proposed working of the systems to the satisfaction of the Employer's Representative shall be provided under the contract.

The Services Contractor shall ensure that his tender includes for him to install the design intent in his preferred installation method including the fit and final detailing that will occur. The Services Contractor shall include for any works to join new systems to existing systems including any modification necessary to install the new components.

## 1.5 Introduction

A description of the project is contained within the main contract preliminaries.

It shall be the duty and responsibility of the Services Contractor appointed for the execution of the mechanical and electrical services Installations to provide the services described and specified hereunder. Where a system is outlined or described the contractor shall be deemed to have included for the complete system together with all parts and components necessary to comply with all the relevant Laws, Regulations, Codes and British Standard Specifications unless specifically excluded by this specification.

## 1.6 The Contract Details

The contract details are not contained within this specification which only details the quality and required performance of the works. Reference shall be made by the Services Contractor to the main contract documents

## 1.7 General Description of the Project

The project shall consist of the formation of a new four-storey block housing 4 No. apartments. Each apartment shall be provided with dedicated services and new utility connections as per the tender drawings.

## 1.8 Water Services for Domestic or Food Production Purposes

All works on domestic water services shall be undertaken in accordance with the Water Supply (Water Fittings) Regulations 1999.

The contractor carrying out the works shall be approved and registered with WIAPS (Water Industry Approved Plumber Scheme) or an alternative scheme authorised by the local water supplier in the region where the works are to be undertaken.

Registration with an alternative organisation recognised by the government (CIPHE/APHC/ SNIPEF) may be acceptable but approval shall be sought by the local water supplier.

Should the contractor not be registered with an Approved Contractor Scheme, then the contractor shall make the necessary arrangements to comply with the local water undertaker's requirements. This shall include, but not be limited to, notification in accordance with Regulation 5 of the Water Regulations, attendance during inspections of the domestic water services and any other legislative or local water undertaker's requirements.

If the contractor is registered with an Approved Contractor Scheme, then where required the contractor shall provide notification in accordance with Regulation 5 and issue on completion a contractor's certificate in accordance with Regulation 6.

All works on any domestic unvented hot water storage system shall be undertaken by appropriately qualified personnel only as stated in Approved Document G of the Building Regulations. Copies of the contractor's competency certification shall be held on site within the health and safety plan for record.

All materials and fittings used on domestic water services must be approved for use on UK water supply systems and be approved products within the Water Regulations Advisory Scheme (WRAS) Water Fittings and Materials Directory.

The installation conditions detailed within the directory must be followed such that the fitting and system complies with the Water Supply (Water Fittings) Regulations 1999.

## 1.9 Site Visits During Tender Period

The tenderer shall visit the site during the tender period by arrangement with the Employer's Representative at Rooms & Studios.

During the site visit the Services Contractor shall familiarise himself with all aspects of the day-to-day site operation which might affect his contract works and tender. In particular problems of access, site security, provision of a user liaison officer shall be addressed and all necessary allowance made by the Services Contractor in his tender price.

## 1.10 Works Within and around the Building

The Services Contractor shall be aware that the Employer shall have full enjoyment of the building and as such shall not suffer a noise nuisance or loss of any facility because of the Services Contractor's works.

The main contractor shall provide a competent person to act as user liaison officer. This person shall meet at regular intervals with the Employer to rectify any of his working methods that restrict or adversely affect the Employer's operations.

The Employer's normal working hours are 08.00 hours to 18.00 hours weekdays and 08.00 hours to 13.00 hours Saturday. The main contractor's user liaison officer shall work closely with the Employer and ensure all information regarding activities and the time of their execution is available.

Should any damage be caused by the Services Contractor within or to the existing building this shall be put right by the Services Contractor at his cost and to the Employer's satisfaction.

The Services Contractor shall not use the passenger lifts at any time.

## 1.11 Method Statements

The Services Contractor shall prepare and present to the Employer's Representative risk assessments and method statements for the various areas of the contract works and for any other specialist areas as requested by the Employer's Representative.

These method statements shall be prepared in due time and shall show all disruption that may occur and what steps the Services Contractor is taking to limit this. The method statement shall include the health and safety steps the Services Contractor will be taking, how the works will be supervised, the levels of protection being taken and the expected duration of the works

## 1.12 Publicity

It is a condition of the invitation to tender that the Services Contractor shall not release any publicity or information in any form relating to the project, to the press, technical journals or any other agency, organisation or individual.

The tenderer shall return with his tender submission all tender documentation issued to him if requested in writing to do so.

## 1.13 Approvals by Local Authorities, Building Control Officer and Statutory Undertakings

The Services Contractor shall include for and carry out all necessary works to demonstrate compliance with all bye-laws, building regulations (and any other supporting documentation that the regulations refer to as guideline

documentation) and national statutes as applicable to the location, building and works installed by him.

No additional costs will be allowed for any further requirements of these authorities after contract award or the issuing of a Letter of Intent.

## 1.14 Local Notices and Fees

The Services Contractor shall give all necessary notices to all local authorities, statutory undertakings etc and pay all fees legally demandable and shall include for the same in his tender submission.

## 1.15 Site Engineers and Supervision

The Services Contractor shall advise, at the time of his tender submission, the staff he wishes to appoint to execute the contract works. This shall take the form of an organisational 'family' tree which shall clearly demonstrate and identify the staff and management organisation of his team.

The Services Contractor shall appoint a site engineer specifically responsible for the project works who shall be on site at all times during the construction installation and commissioning periods. This engineer shall be fully experienced and qualified in the type and extent of the Services to be provided and shall have sufficient authority to deal immediately with normal site occurrences without having to refer to more senior personnel within the Services Contractor's organisation. The Services Contractor shall give a telephone number where he may be contacted outside his working hours in case of emergencies.

The Services Contractor shall be required to have a responsible authorised representative in attendance at any site meetings to which his attendance is requested and will be deemed to have allowed for this in arriving at his tender price.

## 1.16 Co-Operating and Accommodating Other Trades

The Services Contractor shall note that the project works includes many items by various subcontractors of the Services Contractor's choice. He shall organise and agree his working method so as to ensure all such works are executed to give a single project to the desired standard. The Services Contractor shall be entirely responsible for the organisation and instruction of his subcontractors and suppliers.

## 1.17 Programme and Planning

Throughout the course of the execution of the contract the Services Contractor shall maintain on site all necessary labour to satisfy the requirements of the contract programme and sequence agreed with the Employer's Representative.

A detailed programme of the mechanical and electrical services drawing production, procurement, installation, testing, commissioning, handover and demonstration works shall be prepared and agreed in conjunction with the Employer's Representative. Such a programme shall be prepared on the basis of critical path analysis and shall clearly demonstrate all activities in detail. In addition the programme shall be agreed within 7 days of contract award or the issuing of a letter of intent.

**At the time of tender** the Services Contractor shall present an abbreviated programme in block form demonstrating his proposed sequence of works from contract award to contract completion.

## 1.18 Builders' Work and Sub-Surfaces

Before commencing his work the Services Contractor shall satisfy himself as to the suitability of the sub-floor, wall and/or other surface on/to which he is to fix or lay his work. As regards the suitability of the structure to carry the weight of the plant or equipment he shall allow temporary and permanent strengthening and support as necessary.

## 1.19 Delivery of Materials

The Services Contractor shall note that he shall be entirely responsible for the offloading and hoisting into position of all materials and plant and he shall give reasonable advance notice of such deliveries offloading and placing in position so that the Employer's Representative can be aware of such deliveries. In all instances delivery times shall be agreed with the Employer's Representative and the Services Contractor shall include for such deliveries to be made outside the working hours of the building's users.

The Services Contractor shall note the vehicle size restrictions are enforced to the site, both in terms of length and height. These restrictions shall be obtained from the client's representative and appropriate arrangements made.

The Services Contractor shall note that these may require sectional delivery of plant and re-assembly as necessary and costs in this respect shall be included within the tender offer.

In all such cases the Services Contractor shall arrange for suitably qualified attendance to receive such goods and ensure their good condition both before and after unloading and hoisting. This shall include their protection both during unloading/hoisting and after placing to their point of use.

## 1.20 Damage from Freezing

The Services Contractor shall allow for and take all necessary precautions for the prevention of damage to plant and equipment due to damage from freezing before practical completion. The Services Contractor shall make good any such damage at no cost to the Employer and to the entire satisfaction of the Employer's Representative.

## 1.21 Design, Installation, Working Drawings and Responsibilities

The Services Contractor shall produce and present to the Employer's Representative for review installation and working drawings for the complete mechanical services installation, electrical services installation and associated builders' work.

The production of such drawings shall be completed against a detailed programme that shall be produced by the Services Contractor and shall be submitted to the Employer's Representative and agreed.

The Services Contractor shall present his working and installation drawings for review. These drawings shall be presented at a scale of not less than 1:50 for all general arrangement type drawings and at a scale of not less than 1:20 for all plant room and detail drawings. All drawings presented for review shall be fully co-ordinated by the Services Contractor with all disciplines so affected by his work. Uncoordinated drawings and layouts shall not be submitted.

The information given in the attached specification and shown on the listed drawings is the design intent, and detail the schemes that are to be installed. The Services Contractor shall be deemed to have fully understood the requirements of the design and shall use this design intent information together with his site survey information, to produce his co-ordinated installation drawings.

These drawings shall be prepared by the Services Contractor using the services of a co-ordination draughts person and the drawings shall be prepared in plan and section detailed fully with dimensions and invert levels to show his proposals for the execution of the works. The drawings shall prove the fit of all services one to another, to the structure, to any existing items and to all architectural detail.

The Services Contractor shall note that the Employer's Representative shall require at least one week in order to complete his review procedure and return drawings to the contractor and the above mentioned programme shall make all due allowance for the requirement. Additionally, the drawing and design programme shall reflect the agreed contract programme requirements.

The Services Contractor shall not assume that his drawings will achieve 'No Comment' status at the first issue and shall therefore incorporate sufficient time within his drawing and design development programme for subsequent issues to be made as necessary to achieve a 'No Comment' status.

Drawings issued to the client team for comment Will be reviewed and returned with one of the following status letters.

'A' status – means that there are no further comments and the work may proceed in accordance with the specification.

'B' status - means that subject to the comments made any related procurement process may commence in accordance with the specification but that the drawing or documents shall be amended and resubmitted to achieve an 'A' status. Under no circumstances shall installation work proceed on site without an 'A' status drawing.

'C' status - means that work shall not proceed and that the document shall be re submitted for further review

Once 'No Comment' status has been achieved these drawings should be made available for inclusion in the safety file prior to issue of record drawings to the CDM co-ordinator.

## 1.22 Manufacturer's Requirements

The contractor shall ensure all items are installed in accordance with the manufacturer's written requirements and recommendations. Before any plant is procured, technical details of such plant shall be issued for consideration by the Employer's agent. This shall be in the way of a technical submittal and shall give:

(i) Details of off-site testing
(ii) Specification compliance and specific annotation if not compliant
(iii) The product's compatibility with the project, structure, ceiling type, colour of finishes and all other contract works

## 1.23 Sealing of Services

During the course of the works no open ends of pipework, ductwork or valves, conduit and trunking shall be allowed. All material delivered to site shall therefore be properly and adequately sealed against the ingress of air, water, dust, dirt or other material.

## 1.24 Benchmark and Hold Point Procedures

The Services Contractor shall provide a 'benchmark' procedure for all aspects of the services. This is to agree, before the main installation commences the standard of workmanship and its correlation with the specification. As the installation of services is commenced he shall offer a typical part of the installation for inspection by the Employer's Representative in order to ensure that the specified requirements are satisfied.

The benchmarking inspection procedure shall be managed by the Services Contractor who shall give the Employer's Representative at least 7 days' notice of an inspection requirement. The contract programme shall allow for this period.

The Services Contractor shall inspect both his own and his specialist suppliers' work as they proceed and issue inspection reports detailing his findings. These reports shall be submitted to the Employer's Representative.

Before any works are to be covered by following trades, this following work shall not proceed until the Services Contractor is satisfied the work to be covered is installed in accordance with the specification and drawings. When the Services Contractor is so satisfied he shall offer the installed works to the Employer's Representative for his own inspection. The Services Contractor shall not proceed with the following trades until such time as the Employer's Representative is satisfied with the installed works.

The Services Contractor shall detail these hold points on his programme and specific quality plan for each trade and they shall occur as a minimum prior to the installation of the following:

1. Raised floors
2. Floor coverings
3. Wall coverings
4. Concealment of any services
5. Thermal insulation
6. False ceilings

The Services Contractor shall develop his own 'intention to cover up the works' audit system.

The Services Contractor shall ensure that his own and his specialist suppliers commissioning works proceed in a phased manner and he is satisfied that each stage is complete before proceeding to the next stage. When the Services Contractor is satisfied that a specific stage is complete he shall offer the completed stage to the Employer's Representative. The following stage shall not commence until such time as the Employer's Representative is satisfied with the completion of the previous stage.

The Services Contractor shall detail these hold points on his commissioning programme and they shall occur at the following times:

1. At the end of static completion
2. At the end of pre-commissioning
3. At the end of commissioning
4. At the end of performance testing

The Services Contractor shall develop his own 'authority to proceed' to the next stage audit system.

# Section ME2.00

# The Design of the Mechanical and Electrical Services

# Index

# ME2.00 The Design of the Mechanical & Electrical Services

## 2.1 Introduction

The following is an excerpt from Section 6 of the Health and safety at Work Act 1974 as amended by the Consumer Protection Act and is inserted here as a reminder to the Designer of his obligations.

"It shall be the duty of any person who designs, manufactures, imports or supplies any article for use at work to ensure, so far as is reasonably practicable, that the article is so designed and constructed that it will be safe and without risks to health at all times when it is being set, used, cleaned or maintained by a person at work.

It shall be the duty of any person who undertakes the design or manufacture of any article for use at work to carry out or arrange for the carrying out of any necessary research with a view to discovery and, so far as is reasonably practicable, the elimination or minimisation of any risks to health and safety to which the design or article may give rise."

**END OF EXCERPT**

Throughout the design of the Mechanical and Electrical Services, the Contractor shall make available to the Employer's Agent his design file demonstrating his fundamental design and performance criteria, building and plant load calculations, plant, duct, pipe and equipment selections, lighting calculations, cable sizing, conduit and wireway equipment and material selections. A programme of meetings, probably weekly, shall be arranged by the Contractor with the Employer's Agent, the purpose of which shall be to review the progress of the Contractor's design, both in terms of a technical appraisal and programme.

The Design File referred to above shall form the basis of the design data Section required to be included in the Operating and Maintenance Instructions.

### 2.1.1 Maintenance of Plant and Equipment

The Designer shall allow for all necessary facilities to permit the safe and easy maintenance of the systems he provides.

In particular, he shall ensure that all pipe and duct mounted components and assemblies are provided with flanged connections, unions or other acceptable means of disconnection. 'Acceptable means of disconnection and access for maintenance' shall mean acceptable to the Employer's Agent.

The Designer shall take care that all disconnection and isolation facilities are positioned such that they are easily and safely accessible for maintenance purposes and that individual components, plant equipment etc can be removed without the need to remove other non-associated services.

All services support, design, locations and interfaces within the existing building fabric and structure shall be verified with and approved by the structural engineer prior to the services installation

## 2.2 General Description

This specification shall be read in conjunction with the Contract Particulars and Standards of Materials and Workmanship Specification for Electrical and Mechanical Services, the Contract drawings and Preliminaries.

The Services Contractor shall include in his tender for the provision of the design, supply, installation and setting to operate all plant, equipment and materials necessary to provide a complete and fully operational services installation as described within these documents and as indicated on the tender drawings.

It shall be the Services Contractor's responsibility to ensure that all services described herein are fully tested and commissioned as described and to the full satisfaction of the Services Consultant.

The Services Contractor shall liaise with all other Contractors and other related trades in respect of co-ordination and integration of the services.

## 2.3 Building Description

The project consists of the creation of a new multi-storey apartment block over four floors containing 4 No. apartments and lower ground floor refuse and bike storage area.

Access to the upper floors shall be via new openings formed in the adjacent communal staircase.

## 2.4 Services Description

The Services Contractor shall complete the works described within this specification and may be requested to return to site to make final connections to ancillary equipment. This work shall be considered separately but cost allowance shall be made within the tender submission to complete these works as part of this tender bid.

The works shall consist of the provision of anew metered water and 230V 100A rated UKPN utility power supply terminating within each apartment.

A new landlord's power supply shall be installed for the refuse, bike store and external lighting.

All apartments shall utilise electricity for power medium to generate both hot water and heating systems.

## 2.5 Incoming Services

The Services Contractor shall liaise with the statutory suppliers to provide new incoming water and electricity connections to each apartment. The Services Contractor shall liaise with each authority to ensure that the supplies are installed, complete with meters at the appropriate time within the construction programme. The Services Contractor shall commence negotiations with the authority at the commencement of the project and highlight any problems at the earliest time.

The 5 No. power supplies shall be derived from the legacy UKPN Ryefield distribution board remotely accessed at the rear of the car park. The works shall include all necessary cabling and containment modifications within the switch cupboard, along with the required trenching and cable ducts needed to manage the 230V 100A 50 Hz supplies to the block.

Each apartment block shall also be provided with a uniquely metered 28mm mains water service.

## 2.6 Regulations, Codes of Practice, Bye-Laws and Design Notes

The following is a list of regulations, codes of practice, bye-laws, and design data shall be observed and complied with by the Contractor who shall confirm that his Tender Price makes all necessary allowance for such observation and compliance. The document indicated is deemed to include all associated addendums/revisions as of the time of tender.

1. Government Statutory Regulations and Laws.

2. All Building Regulations, Local Authority and Statutory Undertaking Regulations and Bye-Laws as applicable to the building concerned.

3. British Standard Codes of Practice.

4. European and British Standard Specifications.

5. CIBSE Guides: Volume A (Design Data), Volume B (Installation and Equipment Data), Volume C (Reference Data), Volume F (Energy Efficiency), Volume G (Public Health), Volume H ( Building Control), Volume J (Weather Solar and Illuminance), Volume K (Electricity in Buildings)

6. DW 144, DW 143.

7. CIBSE Commissioning Codes (unless otherwise detailed in this Specification)

8. BSRIA Publications with particular reference to Commissioning.

9. The Institute of Plumbing Data Book – Latest Edition.

10. Thames Water Regulations and Recommendations.

11. The Water Supply (Water Fittings) Regulations 1999.

12. Pressure System and Transportable Gas Container Regulations 1989.

13. CIBSE Technical Memoranda – TM13 – Minimising the risk of Legionnaires' Disease.

14. HSC Document L8 – Legionnaires Disease – The Control of Legionella Bacteria in Water Systems – Approved Code of Practice and Guidance.

15. BS 7671 – Wiring Regulations – 17th Edition.

16. Electricity at Work Regulation (1989).

17. BS 8300 – Design of Buildings and their approaches to meet the needs of disabled people – Code of Practice.

18. BSEN 12056:2 and 3- Gravity Drainage Systems Inside Buildings

19. BS 6700 2006 – Water Services Design for Domestic Use

20. BS 806:2 2005 – Specification for Installations Conveying Water for Human Consumption Inside Buildings

21. Building Regulations Part G

22. BS EN 378-3: 2016 Refrigerating Systems and Heat Pumps – Safety and Environmental Requirements

## 2.7 Extent of Works

The Services Contractor shall supply, install, test, commission and set to work the new discrete installations as appropriate to satisfy performance objectives, as defined in the specification, tender drawings and Client requirements.

## 2.8 Electric Underfloor Heating and Towel Rails

All rooms as indicated on the tender drawings shall be provided with underfloor electric heating which shall be controlled individually by a wall mounted controller. The controller shall have the provision to control both the time of operation and the temperature setting within the area. The installation shall be designed and installed to the supplier's recommendations under the selected finishes.

Each bathroom shall include an electric towel rail as listed within the Architect's schedule of equipment and shall have an integral timeclock control facility fitted to the towel rail and temperature regulation facility.

## 2.9 Heat Pump Installation (Apartment)

Each apartment shall be provided with an external multi-split heat pump providing heating and cooling separately to the designated floors and areas as indicated on the layout drawings.

The external units shall be housed in purpose-built acoustic enclosures to meet the requirements of the Local Authority and in accordance with the Acoustic Consultant's recommendations.

Pipework shall be run within a purpose-built plastic containment system with access branches being located at points adjacent to pipework joints and shall enter the apartment via purpose-built puddle flanges to prevent water ingress.

The installation shall be tested following completion for water ingress. Access to all joints shall be proved.

The pipework connecting the indoor cassette units to the condensing units shall be suitably insulated.

Indoor cassette units located within individual areas shall be concealed within semi-recessed boxing which shall encompass the unit.

Indoor cassette units installed where required shall meet the following design criteria within the rooms:

| | | |
|---|---|---|
| NR levels: | Bedrooms | NR25 night-time<br>NR30 daytime |
| | Living Rooms | NR30 |

Condensate pipework shall be gravity wherever possible and run to fall to the nearest vertical foul drainage stack complete with self-sealing waste valves. Where pumps are required, these shall be Peristaltic type, low noise and located for ease of maintenance.

The control system shall enable individual time/temperature adjustment and speed control within each room. Wall mounted controllers shall be provided and placed in the location agreed with the Architect.

Indoor cassette units located within individual areas shall be interlocked with the electric underfloor heating where they are located within the same zone to prevent simultaneous heating and cooling.

Upon completion of the installation, the Services Contractor shall test the system in heating and cooling modes and shall record the air volume rates and associated noise levels of each unit within each room.

All condensate drains shall be tested by discharging water continuously into the indoor cassette unit condensate trays to ensure that all condensate clears the unit promptly.

The condensing units shall be supplied by Mitsubishi or equal and approved.

All indoor cassette units shall be supplied by Mitsubishi or equal and approved and shall be located in the rooms indicated on the Services Consultant's general arrangement drawings, but listed as follows:

| | |
|---|---|
| Lower Ground Floor: | Kitchen/Living/Dining<br>Master Bedroom |
| Ground Floor: | Kitchen/Living/Dining<br>Master Bedroom |
| First Floor: | Kitchen/Living/Dining<br>Master Bedroom |
| Second Floor: | Kitchen/Living/Dining<br>Master Bedroom |

The outdoor condenser units shall be located as shown on the services drawing and shall be installed on anti-vibration mountings to minimise the transmission of noise to the building structure.

The indoor cassette units shall be located as shown on the service drawings and shall be selected at low speed setting and shall be installed with anti-vibration supports to prevent noise transfer to the ceiling joists. The Services Contractor shall ensure that adequate access is available for maintenance to the indoor cassette unit, valves and control devices. An adequate return air path shall be maintained to allow air from the room served to return to the dedicated indoor cassette unit.

The pipework installation shall be installed in accordance with the manufacturer's instructions and shall be concealed within the false ceiling. All pipework shall be adequately insulated to prevent condensation occurring. No sections of pipework or connections shall remain exposed unless located above a drip tray.

All pipe supports shall maintain the continuity of the insulation vapour barrier.

Each indoor cassette unit shall have the facility to alter the fan speed setting from low speed to high speed from an easily accessible fan selector switch.

Refrigerant pipework shall be installed to the manufacturer's recommendations and joints shall be kept to a minimum. Where joints occur, access panels shall be fitted to be able to check for leaks in accordance with F Gas Regulations.

## 2.10 Central Extract Systems

A central extract system shall be provided to each apartment which shall discharge at high level to the nearest external position and shall terminate with an external weather louvre or air brick.

The extract fan unit shall be as Messrs Nuaire MEVDC Range, provided with both discharge connection and multi outlet ducts to ventilate all bathrooms, toilets, kitchen and airing cupboard, all as indicated on the tender drawings. UPVC rectangular ductwork shall be provided to each zone with local extract via a ceiling mounted grille.

The fan unit shall run continuously on low speed, with boost interface control where indicated.

The Services Contractor shall terminate the duct with a suitable louvre and this shall be co-ordinated with the Main Contractor to provide a weatherproof installation and achieve/comply with the Architect's RAL colour.

All toilets and bathrooms shall be provided with local boost feature operated by the light switch and shall signal the fan unit to go to high speed.

The kitchen extract unit shall be fitted with a flat plastic duct connection which shall discharge through the external wall via an air brick. The duct shall be fully concealed either within the ceiling or the top of the kitchen furniture.

The kitchen supplier shall provide an integral hob extract fan and the Sub-Contractor shall connect the extract duct to the hob unit.

## 2.11 Domestic Water Services

The building has a basement, ground, first, second and third floor levels.

A new mains water service shall be provided to the basement and ground floor levels by the local water undertaker, Thames Water. The Contractor shall liaise with the Water Authority to provide these supplies. The incoming supply shall be extended into each apartment to serve the various appliances.

Connections to dishwashers and washing machines shall incorporate a type EC double check valve.

All pipework and fittings shall be WRAS approved for use in drinking water systems. Copper pipework and fittings shall be used and these shall be brazed or soldered type.

The Services Contractor shall make all allowances necessary to comply with the local Water Authority requirements. This shall include but not be limited to attendance during inspections of the domestic water services within the apartment.

The Services Contractor carrying out the work shall be approved and registered with Thames Water's own approved Contractors scheme. The Services Contractor shall make all allowances to arrange and agree all necessary inspections with Thames Water and to ensure that these inspections are carried out.

All electric hot water heaters shall have an unvented type installation and therefore unvented system safety kits shall be supplied and fitted by the manufacturer and as detailed on the tender drawings.

The Services Contractor shall hold the necessary certificates proving competency when installing unvented hot water systems. This shall be identified on the works Method Statement. The installation of unvented hot water services requires that the installer notifies the Local Building Control Authority of the proposed installation and shall comply with Section G3 of the Building Regulations.

An electric water conditioning unit shall be fitted to the incoming mains water to each apartment adjacent to the electric hot water heaters to prevent scale build-up.

All hot water pipework within ceiling voids and ducts shall be fitted with hot water temperature maintenance tape, as Raychem or equal and approved.

Surge arrestors shall be installed on an incoming mains supplies to each apartment.

## 2.12 Drainage

Soil and waste water above ground shall be conveyed from the apartments via a complete new sound attenuated drainage system as shown on the Tender drawings.

Pipework and fittings for the vertical stack pipework shall be as the Friaphon pipework system from Durapipe. MUPVC for all branch connections.

Pipework shall be installed in accordance with BS EN 12056:2 local Building Control requirements and in strict accordance with manufacturer's recommendations.

# 2.13 Electrical Services

## 2.13.1 Scope of works

The Services Contractor shall allow for the design, development, procurement, installation, test and commission of the complete electrical services based on this specification and accompanying layouts and typical services arrangement drawings. All works shall be executed in accordance with BS 7671 and other cross-related documents referenced therein.

The Services Contractor shall be responsible for all dialogue and liaison with the utility service providers to ensure the timely provision of services in accordance with the overall programme constraints.

All works shall be executed by NICEIC registered electrical sub-contractors and Part P certified electricians.

Method Statements shall be provided for all elements of the works.

## 2.13.2 Extent of Works

The Services Contractor shall design, supply, install, test, commission and set-to-work the installations as appropriate to satisfy the objectives as defined in the specifications and client requirements.

The descriptions included in this document generally describe the extent and nature of the works but does not attempt to give a detailed description of the work and moreover, does not absolve the Services Contractor from his responsibility to visit the site and carefully consider the implications of the Tender package of information and make himself aware of all governing factors which may affect the content and programme of works, and method of construction.

The works undertaken by the Services Contractor shall comprise of the design, installation, test and commissioning of the complete electrical services to each apartment, along with any communal and external areas.

The Services Contractor shall be wholly responsible for obtaining approval by relevant authorities, provision, installation, testing, commissioning and general setting to work of all necessary equipment to complete the installation as described herein, including provision of Health and Safety Plan and File, Operating and Maintenance Manuals etc., in accordance with the Standard Specifications and generally as indicated on the drawings.

Items which are described in the Specification but which are not indicated on the drawings, and vice versa, shall be deemed to be included. Items excluded from the Specification and the drawings but which are required to ensure a complete installation to achieve performance objectives and Statutory Authority requirements shall be deemed to be included.

# 2.14 Incoming Mains Supplies

## 2.14.1 General

For the purpose of tender it shall be assumed that each apartment will be served from a distribution board located within the demise via individual supply authorities' meter. The Services Contractor shall allow full liaisons with the Regional Electricity Company (the Supply Authority) to provide the main incoming supply to the building and be compliant with the necessary requirements. The incoming supplies shall be sleeved, ducted entries into the block and routed on cable traywork to each consumer location. The Services Contractor shall also procure and arrange for fitment of the shipper's metering, the installation of which must coincide with the programme and works completed.

## 2.14.2 Sub Main Distribution

The Services Contractor should allow for separate XLPE/SWA/LSF 3C cables to be installed from the remote meter position at the rear of the car park to each apartment consumer unit. An auxiliary landlord's power supply shall also be provided.

Cabling shall be managed on traywork or fixed direct to the structure using cable cleats, not PVC tie-wraps.

Presentation of connections between the DNO (District Network Operator) service head and meter shall be carried out in accordance with UK Power Networks standard service head connection arrangements, obtainable from UK Power Networks website. The Services Contractor shall also be responsible for the liaison and arrangement of the meter/shipper provider who shall be notified to the Contractor during the construction works by the Client's Representative.

## 2.14.3 Apartment Distribution Arrangement

| | |
|---|---|
| 4 No. Apartments | The Services Contractor shall allow a metalclad consumer unit in each apartment, complete with MCB's and a 100A main switch.<br><br>All circuits shall be provided with individual RCBO devices. No group RCD shall be employed. |
| 1 x Landlord | The Services Contractor should allow for a 230V supply complete with MCB's to control the Landlords services fed from a separate DNO meter located within the legacy switchroom.<br><br>All 230V internal field cabling shall be LSF/SC cabling within galvanised conduit or fixed. Each circuit, where indicated, shall be protected by integral Type B RCBO devices. External cabling to lighting shall be carried out in LSF/SC in galvanised conduits. |

2.14.3.1 Typical Apartment Distribution Board Arrangements

(See also drawings).

Circuit 1: Small power ring circuit kitchen (32A MCB) LSF twin and earth cable – 6242B – RCBO (allow for 2.5mm$^2$ cable, validate during your design the required size).

Circuit 2: Bathroom lighting and power (20A MCB) LSF twin and earth cable – 6242B – RCBO (allow for 2.5mm$^2$ cable, validate during your design the required size).

Circuit 3/4/5: Small power ring circuit all rooms (except kitchen and bathrooms) (20A MCB) LSF twin and earth cable – 6242B – RCBO (allow for 2.5mm$^2$ cable, validate during your design the required size).

Circuit 6/7/8: Lighting (except bathroom) (10A MCB) LSF twin and earth cable 6242B – RCBO (allow for 1.5mm$^2$ cable, validate during your design the required size).

Circuit 9: Future security, boiler controls (16A MCB) LSF twin and earth cable 6242B – RCBO (allow for 2.5mm$^2$ cable, validate during your design the required size).

Circuit 10: Fire Alarm (16A MCB) LSF twin and earth cable 6242B – RCBO (allow for 2.5mm$^2$ cable, validate during your design the required size).

Circuit 11: Electric cooker (45A MCB) LSF twin and earth cable 6242B – RCBO (allow for 10mm$^2$ cable, validate during your design the required size).

Circuit 12/B: Underfloor heating (20A MCB) LSF twin and earth cable 6242B (allow for 2.5mm$^2$ cable, validate during your design the required size).

Circuit 13: Air source heat pumps (32A MCB) XYPE/SWA LSF multicore cable.

Circuit 14: Electric water heater (20A MCB) LSF twin and earth cable 6242B RCBO (allow for 4.0mm$^2$ cable, XXXX design the required size.

6A RCBO lighting - wired via XLPE/SWA/LSF
20A RCBO condensing unit - wired via XLPE/SWA/LSF
20A RCBO 13A socket outlets - wired via XLPE/SWA/LSF

Plus 15% spare ways.

## 2.14.4 Landlord's Distribution System

The Services Contractor shall provide a dedicated metered 230V distribution system to facilitate the landlord's services.

The distribution board shall provide 230V services and supplies for the lighting and power supplies to the amplifier, door entry unit and Cat 5 booster set.

## 2.15 Lighting

### 2.15.1 Apartment General Lighting Installation

Architectural positioning may supersede indicative positions and will be client initiated.

All lighting will be conventionally switched as indicated, complete with dimming facilities as indicated on the lighting layouts.

All switch plate accessories shall generally be in accordance with the Architect's schedule. For tender purpose, these shall be brushed stainless steel in the lounge, dining room and master bedrooms, white plastic in all other areas.

Switch boxes are to be 35mm deep. The Services Contractor shall note that external walls may not allow boxes to penetrate the insulation vapour barrier and all boxes shall be shallow type. Switch boxes on internal walls should not be mounted back to back.

Luminaires will be as indicated on the drawings with a mixture of Pendant's and LED recessed downlighters. All luminaires are to meet the requirements within the area there installed. All recessed lights shall be fitted with LPC approved fire hoods, where required within the selected construction of the apartments. IP rated luminaires shall be provided in bathrooms and shower rooms.

No light switch shall be installed within a bathroom except for pull cord operated switches compliant with BS 3676, however switches shall be external to the area.

Wiring shall be contained within the fabric of the building and shall be protected wherever damage may occur or danger may arise. Suitable protection to be installed to BS 7671. All lighting circuits shall be protected by 10A rated Type C MCB's incorporating an integral 100mA/ms residual current device.

### 2.15.2 External Lighting Installation – Landlord's

The Services Contractor should allow for external lighting. These should be connected to the landlord's distribution board with time clock control, with override dusk/dawn photocell sensor.

## 2.16 General Power Installations

Generally small power socket outlets and Fused Connection Unit's shall be installed as detailed on the tender drawings.

General socket outlets shall be provided flushed into walls in the positions indicated on drawings. All setting out and mounting heights shall be agreed with the Architect.

Power within the Kitchen is to be in accordance with the Architects Kitchen layout and details on the drawing.

The Services Contractor should refer to the Mechanical services drawings to ensure connections are allowed to all Mechanical equipment.

The fans shall operate in conjunction with the lighting.

Electric underfloor heating and towel rail units shall be on dedicated circuits. Wiring shall include for the associated wall mounted thermostatic controller.

All switch plate accessories will generally be in accordance with the Client's interior schedule. However, for the purpose of Tender, brushed stainless steel shall be provided within the dining rooms, living rooms and master bedrooms, white plastic shall be provided elsewhere.

All socket outlets will be positioned 450mm above floor level or as indicated elsewhere and fused connection units shall be mounted at an approved height immediately adjacent to the apparatus being served unless otherwise specified.

The Services Contractor shall also allow for making final connections to all kitchen appliances and discrete equipment using heat resistant cables.

Circuits shall be arranged as per detailed on the tender drawings using 600/1000V LSF double insulated twin and earth 6242B cabling.

Protection shall be via suitably rated Type C RCBO devices, as indicated on the drawings. Each device shall be fitted with a 30 mA/ms trip function.

All cabling shall be fixed at regular intervals in accordance with manufacturers recommendations, using proprietary screwed fixings and not PVC ties. Vertically installed cabling shall be drawn within a uPVC conduit wireway.

Provide the following minimum quantity of socket outlets, unless otherwise indicated:

| | |
|---|---|
| Lounges | 5 x 2 gang |
| Bedrooms | 3 x 2 gang |
| Halls | 1 x 2 gang |
| Kitchens | 4 x 2 gang (in addition to equipment power) |
| Dining Rooms | 4 x 2 gang |
| Study | 3 x 2 gang |

## 2.17 Fire Alarm Installation

Within each apartment, the Services Contractor shall install a LD2 BS5839 Part 6 approved fire detection system using mains rated LDCB LPS approved smoke detectors.

These detectors shall be located within all circulation spaces that form part of the escape route from the apartment and living/kitchen area and accommodation areas.

Each device shall have integral battery pack and integral audible and visual alarm for battery failure output.

The fire alarm installation shall include for an interface connection to a fire curtain control panel. This shall operate on the instigation of any alarm from any smoke detector.

Wiring shall be carried out using suitably sized 4C 2.5mm2 LSF twin and earth 6492B cabling.

## 2.18 Door Access System / Intercom

The Services Contractor shall install a monochrome video entry door intercom system providing video entry control between handset devices located internally.

The installation shall be installed and tested by an approved agent/installer for the selected system and not by the electrical Services Contractor.

## 2.19 Earthing Network & Equipotential Bonding

### 2.19.1 General

All works associated with the provision of an earthing network shall be carried out by the Services Contractor to comply with BS 7671.

Where armoured cables are installed, the armouring shall be supplemented with a separate core for the protective conductor which should be sleeved green/yellow to identify its use.

Cable calculations to be provided by Services Contractor to verify each armoured cable size and CPC.

### 2.19.2 Supplementary Bonding Conductor

Supplementary bonding conductors shall be provided to bond exposed conductive parts to other exposed conductive parts, extraneous conductive parts to other conductive parts. (BS 7671).

The supplementary bonding conductors shall be sized in accordance with BS 7671 and shall generally be a minimum of 2.5mm².

Cross bonding of water services and extraneous metal work to be installed.

### 2.19.3 Warning Labels

Traffolyte labels inscribed 'Safety Electrical Connection - Do Not Remove' shall be engraved, in upper case characters, not less than 4.75mm high, shall be permanently fixed immediately adjacent to all main earth connections.

## 2.20 Cable Support Systems

All cables shall be supported independently from other services with protected from mechanical damage were necessary.

## 2.21 Test Certificates

The Services Contractor shall upon completion of all testing and upon their acceptance, provide the following certificates confirming the completion of installations:

- NIC/EIC Test and Completion Certificate Part P compliant
- Fire Alarm Certificate in accordance with BS5839 (BAFE compliant)

## 2.22 Intruder Alarm System

The Services Contractor shall provide a dedicated switched fused connection unit adjacent to the apartment consumer unit for the future fitment of a NACOSS approved intruder system.

## 2.23 Telecommunications

Liaise with British Telecom and arrange for the incoming telephone lines in accordance with the programme.

Arrange for the following telephone lines:

2 telephone lines per apartment installed to and terminated at the telephone outlet in each apartment and provide suitable wireways and BT approved service entries.

Provide telephone points wired using BT compliant cable and taken back to a grey terminal box identified with a label.

Provide internet connections to each apartment with separate internet cable for future subscription by the resident. Terminate the cabling with suitable junction boxes in a convenient location such as the living room and be taken back to convenient access chamber for connection by the internet provider.

Provide a PVC conduit to the entry port from the telephone outlets with draw wires for a future smart cable installation. Ensure there are no more than two right angle bends in the conduit.

All cabling shall be CW1308/CW1308 plus earth (BT approved) with LSOH sheathing.

All faceplates shall be type BT Master typically BT-6 plate finish brushed stainless steel.

# Section M4.00

# Mechanical Services Installation Method and Materials Specification

# Index

# M4.00 Materials and Standards of Workmanship

## 4.1 Ductwork

### 4.1.1 Comfort Conditioning and Ventilation Systems

All ductwork systems shall be designed, fabricated, installed and pressure tested in accordance with the latest edition of HVCA Specification DW144 and all amendments and addendums current as of the issue date indicated on the front of this Specification.

Ductwork shall be constructed from galvanised sheet steel.

All ductwork support systems shall be designed, fabricated and installed in accordance with DW144 as previously detailed.

Access doors of the specified standard above shall also be provided upstream of all volume control dampers, fire dampers, turning vanes and other duct line devices to enable the mechanism operation to be viewed.

Designers Information

| | | |
|---|---|---|
| 1. | Pressure Classification: | Medium Pressure Class B. |
| 2. | Air Leakage Limit: | 0.61 l/s per $m^2$ duct surface |
| 3. | Positive Pressure | 650 Pa. |
| 4. | Negative Pressure: | 400 Pa. |
| 5. | Material: | Hot dipped galvanised sheet steel as DW144. |
| 6. | Inspection/Servicing Access Openings: | Level 1. |
| 7. | Periodic cleaning frequency: | 5 years (anticipated). |

8. Pressure testing of the completed ductwork systems shall be carried out.

9. Special Supports:

   The Services Contractor shall be required to drill the roof cladding structure and shall use the specified fixings

10. Scale: Not less than 1:50 (except Plant Rooms).

    Plant Rooms not less than 1:20

11. Other Requirements:

    The ductwork and supports shall be externally painted in all locations outside the plantroom as follows:

a) Degreased and cleaned - 1 coat calcium plumbate primer.

b) 2 coats white eggshell - RAL 9010. Roller applied.

Most ductwork shall be exposed to view and therefore special attention shall be paid by the Sub-Contractor to ensuring that all excess sealant is carefully and neatly presented. In addition all supports shall be plumb and neatly presented with no excess thread exposed through fixings (2 threads showing max).

12. For the purposes of satisfying HVCA standard DW/TM2 all ductwork for this project shall be classified as 'Advanced' level of cleanliness.

13. Access doors shall be of robust design and shall be of the self-sealing, quick release double insulated type and shall be of the largest possible size dictated by the maximum dimension of the ductwork.

14. Access doors for the purpose of cleaning the internal surfaces of the ductwork shall be provided at least every 10m of straight duct length. The access door specification detailed above shall apply.

4.1.2 Flexible Ductwork - Circular (and Rectangular - where specified)

Flexible ductwork shall only be used where shown on the drawings and/or to provide final connections onto grille boxes, diffusers, plenums and other final terminal devices.

The length of any flexible duct shall not exceed 300mm and any lateral offset shall not exceed 25mm. The use of flexible ducts to overcome inaccurate setting out and installation shall not be allowed.

Where the fixed, rigid steel ductwork is thermally insulated the flexible ductwork shall be of the pre-insulated type, incorporating a vapour barrier.

The cut ends of the thermal insulation shall be sealed using 50mm wide adhesive foil tape.

All flexible ductwork shall be of the 'Flextract 2008' type for uninsulated situations or 'Flextract 2008K' pre-insulated type for situations requiring pre-insulation.

Flextract is a product manufactured by Flexible Ducting Ltd, Cloberfield, Milngavie, Glasgow, G62 7LW, telephone 0141 956 4551.

Flexible ducting shall be securely fastened to rigid steel spigots using worm drive hose clips.

4.1.3 Fume Extract Systems

All extract ductwork associated with the fume cupboard and bio-safety cabinet extract systems shall be manufactured in grey UPVC.

The manufacture, installation and testing of UPVC ductwork shall be in accordance with HVCA Specification DW151.

Fan casings and impellers shall be of fully welded construction and shall incorporate flanged inspection access doors and threaded drain connections.

Flexible connections shall be provided on both sides of the fan casing and shall be constructed from PVC.

All sound attenuators shall be of fully welded construction from 4.5mm thick UPVC sheet complete with internal pads filled with Rockwool (32kg/$m^3$) wrapped in clear Melinex sheet.

## 4.2 Pipework

### 4.2.1 General

All pipework shall be designed, fabricated, installed and pressure tested in accordance with the particular service requirements as defined in this Specification. Additionally all Black Mild Steel pipework shall be painted 1 coat **grey** zinc phosphate after it has been successfully pressure tested.

Pipework shall be installed to allow the proper installation of the specified thickness of thermal insulation including due allowance for valve, flange and union insulated boxes.

All pipework shall be installed to achieve a uniform and square appearance and where practicable be parallel to both the structure and to other services, all vertical pipework shall be plumb. The installed alignment shall include for the requirements of venting and draining. All pipework shall be installed to ensure that the longest possible length of tube is used between fittings. The over use of sockets or butt welds shall not be accepted.

All pipework shall be installed with the provision for future maintenance, dismantling and with sufficient access for true manipulation. **Joints shall not be concealed within the thickness of a wall or floor.**

Break joints for dismantling purposes shall be installed at twelve metre or less centres in agreed locations.

Purpose made fittings shall be employed at all times. Offsets shall be formed by use of an efficient bending machine. All changes of direction so formed shall be made with a minimum of loss of local wall thickness and with the diameter maintained. Crinkled and scored work shall not be accepted.

All pipework shall be straight, clean, round in cross section, free from cracks, surface flaws, laminations and other defects and free from rust and scale. During delivery and prior to installation all pipework shall be stored in purpose made racks with the ends capped.

All cuts from standard lengths of pipe shall have all burrs and swarf removed, the ends shall be trimmed square and shall be thoroughly cleaned before erection.

During the course of cutting, screwing and manipulation of the pipework and fittings care shall be taken to ensure that the surfaces are not damaged. Wrench marks on the pipework, fittings and pipeline accessories shall not be accepted and items so damaged shall be replaced.

During the installation open ends of all pipework shall be sealed with suitable purpose made caps, ie plugs or plastic covers only. Wood, rag, adhesive tape or paper plugs shall not be used. If the pipework ends are not sealed to the above detail the pipework shall be dismantled for as far as considered necessary by the Clients Engineering Representative and then cleaned internally. This work shall be carried out without cost to the Client and without detriment to the project construction programme including the removing, cleaning and replacing of the sections of pipework.

Attention is drawn to the clause on testing in this Specification and to the current IEE Regulations (BS 7671) on earthing, and the need for suitable earthing points.

Particular attention is drawn to the requirements of the Pressure Systems Safety Regulations 2000 (PSSR) and the Pressure Equipment Regulations 1999 detailed in Section 1 of this Specification.

For ease of reference the following abbreviated Specification of pipework materials is included.

| Service | Pipe Material |
|---|---|
| Steam (up to and including 100mm dia) | Heavyweight Black Mild Steel Tube to BS 1387 |
| Condensate | Copper tube 15mm to 54mm O.D. inclusive to BS EN 1057: 1996 (formerly BS 2871 part 1 table X). |
| Low Temperature Hot Water | Heavyweight Black Mild Steel Tube to BS 1387. Screwed joints up to 50mm dia, welded joints 65mm dia and above. |
| Domestic Hot and Cold Water (including Drinking Water) | Copper tube 15mm to 54mm O.D. inclusive to BS EN 1057: 1996 (formerly BS 2871 part 1 table X). |
| Overflow and Warning Pipes | Copper tube 15mm to 54mm O.D. inclusive to BS EN 1057: 1996 (formerly BS 2871 part 1 table X). |
| Chilled Water | Heavyweight Black Mild Steel Tube to BS 1387. Screwed joints up to 50mm dia welded joints 65mm dia and above. |
| Cooling Coil Condensate and Humidifier Drains | Copper tube 15mm to 54mm O.D. inclusive to BS EN 1057: 1996 (formerly BS 2871 part 1 table X). |
| Water System Drains, Safety Valve Discharges | As Main Pipe System Pipe Specification. |
| Vacuum | Heavyweight galvanised mild steel tube to BS 1387 where exposed (screwed joints). Phosphorus deoxidised (non arsenical) copper alloy CU-DHP copper tube 15-54mm O.D. to BS EN 1057: degreased in accordance with HTM 2022, and High Duty fittings. |

| | |
|---|---|
| Piped Gases | Phosphorus deoxidised (non arsenical) copper alloy CU-DHP copper tube 15-54mm O.D. to BS EN 1057: degreased in accordance with HTM 2022, and High Duty fittings. |
| Bottled Gases | Phosphorus deoxidised (non arsenical) copper alloy CU-DHP copper tube 15-54mm O.D. to BS EN 1057: degreased in accordance with HTM 2022, and High Duty fittings. |
| Laboratory Waste Drainage Pipework | Polypropylene pipework solvent welded mechanical joints as manufactured by 'Vulcathene' or equal and approved. |
| Domestic Soil and Waste Pipework | Copper tube 15mm to 54mm O.D. inclusive to BS EN 1057: 1996 (formerly BS 2871 part 1 table X). Cast iron to Pr EN 877 with flexible joints to BS 6087 above 54mm. |
| Rainwater Drainage from Building Roof | Cast iron to Pr EN 877 with flexible joints to BS 6087. |
| Exhaust hood drains | Galvanised heavyweight tube to BS1387. |
| Dry Risers | Galvanised heavyweight tube to BS1387. |

## 4.2.2 Welded Joints

### 4.2.2.1 Welding

The following welding requirements shall be complied with regardless of whether the welding is carried out on or off site.

The jointing of carbon steel shall be carried out to BS 2971 Class II for Arc Welding and BS 2640 Class II for Gas Welding. Where branch pipes are permitted by this Specification to be welded to the main pipe, the standard of welding shall be as that specified for butt welds. All welds failing to meet these standards shall be cut out and re-made without cost to the Employer.

All welds shall be executed by Class I Welder Craftsmen only in accordance with BS 4871 Part I.

All welds shall bear a mark to identify the welder responsible and a record shall be kept of the work and its location together with copies of each welder's certification. These shall be included in the Operating and Maintenance Manuals. All welding identification shall be clearly visible after painting. All marks shall be in the form of stamped tags tack-welded on to the pipe adjacent to the weld. Tagging of welds shall take place at the time the weld is completed and not subsequently. Welds not tagged and identified the day of completion of the weld shall be deemed unidentifiable and, therefore, unacceptable. Such welds shall be cut out and re-welded.

Where requested to be tested welds shall be tested by an Independent weld testing company, and the Employer's Representative, and all other interested parties shall be fully informed of the Testing, the Health and Safety at Work Act etc requirements, and the programme implications.

All welds on all pipework shall be carried out to BS 2971 Class II and BS 2640 Class II.

The first ten welds on each pipe size shall be subjected to a non destructive test (NDT).

Butt welds shall be examined using, where practical, an ultrasonic method.

Welds on flanges shall be examined using magnetic particle procedures which may be carried out during normal working hours.

A copy of the relevant British Standards shall be kept on site at all times and further copies shall be displayed on site for reference by welder craftsmen.

Where welding of other materials is required such as stainless steel etc, the work shall be in accordance with the foregoing but to the relevant British Standard Specification.

Where on-site welding of pipework is carried out, the methods to be applied shall be as follows:

| Pipework Size | Methodology |
|---|---|
| Up to and including 50mm diameter: | Oxyacetylene or tungsten inert gas. |
| Above 50mm diameter: | Manual metal arc. |

Where welding is carried out off-site in prefabrication workshops, the On-Site methodology shall apply and in addition metal inert gas welding may be employed where the Independent Test Authority is satisfied with all procedures and supervision.

4.2.2.2 Fittings

With the exception of joints made between straight lengths of pipe, only purpose made butt-welding fittings shall be used. All fittings shall comply with the "British Standard for Butt-Welding Pipe Fittings for Pressure Purposes", BS 1965. These shall have bevelled edges. All fittings shall be clean and rust free.

Swept tees and elbows only shall be used.

Only factory made reducers may be used except on pipe sizes of 50mm and under when off-site prefabricated swaged reducers may be used to reduce a maximum of two pipe sizes only, eg. from 50mm to 25mm diameter. Only eccentric reducers may be used on horizontal pipework.

Where the pipework configuration is such as to require reducing Tees and proof is shown at the time of Tender that such manufactured Tees are not commercially available, the following shall apply:

i. Mains and Branches of two or less pipe sizes difference shall utilise an equal tee fitting coupled to a reducing fitting.

ii. Branches diameter of 40mm or less and more than two pipe sizes smaller than the Main may be set-in in accordance with BS 2971: 1991 fig 16(b), "shaped tube to suit bore of main pipe" or set-on in accordance with BS 2971: 1991 fig 10, provided that all such connections are prefabricated off-site and the holes in the main are drilled and properly prepared.

iii. Branches of 50mm diameter and above and more than two sizes smaller than the main may be made using manufactured easy sweep branches set in accordance with BS 2971: 1991 fig 13 or BS 2640 fig 4. The hole in the main pipe shall be cut by machining to the precise dimensions required and the edges properly prepared.

iv. Branches where the direction of flow may be required to change by design shall utilise equal tee fittings coupled to a reducing fitting.

**The following practices shall not be allowed:**

**i. Gussetted Bends of the segmented or the cut and shut type.**

**ii. The use of backing rings, sleeve welds and window welds.**

**iii. The use of welded socket or sleeve joints.**

4.2.2.3 Flanges

All flanges shall have flat faces unless otherwise specified.

Where welding is carried out off-site to provide pre-fabricated pipework, flanges shall be of the weld neck type butt-welded on to the pipe.

All flange welds shall be magnetically particle tested. All flanges shall be welded on so that the plane of the flange face is at right angles to the longitudinal axis of the pipe. Flange faces on branch pipes shall not be closer to the main pipe than one half of the outside diameter of the flange or 100mm, whichever is the greater.

4.2.2.4 Preparation of Pipe Ends

All pipe ends shall be machine cut where practical. They shall be square ended and prepared, bevelled and cleaned by grinding and filling to the standards, tolerances and dimensions laid down in the relevant British Standard.

4.2.2.5 Tolerances for Internal Diameters

The pipes and fittings to be joined shall have the same internal diameters within the tolerances set down in the relevant British Standard given above.

4.2.2.6 Headers

Where header pipes, that is large diameter pipes of 150mm diameter or more on primary circuits with multiple branches serving different secondary systems, are employed in plantrooms with the branches in close proximity to each other, for example the returns of different heating or chilled water system return pipes to the primary ring main, the branches shall be set-on as described in BS 2971: 1991 fig 10.

4.2.2.7 Welding Proximity

Attention is drawn to the requirements of the British Standards on Welding in respect of the proximity of welds. The toes of adjacent butt welds shall be no closer than four times the nominal thickness of the pipe. Where welding in closer proximity to that specified above is required the specific guidance from the Independent Test Authorityas to the minimum distance permissible between welds and the standard of welding shall be obtained in writing.

4.2.2.8 Positioning of Welder

Where possible welding shall be carried out in the “down hand” position and the pipe shall be turned to accomplish this.

4.2.2.9 Alignment

All pipes and fittings shall be accurately aligned and be within the tolerances set down in relevant British Standard given above.

4.2.2.10 Filler Metal

All electrodes for arc welding shall be properly stored in accordance with the manufacturer's instructions. The electrodes used shall be the best for their purpose, that is, the appropriate electrode shall be used for the formation of roots, first fill or the fill and cap. For metal arc welding the electrodes shall comply with the British Standard 2971.

Prior to the commencement of work, a schedule of materials, their purposes, sizes, fluxes and other relevant information shall be submitted to the test authority, for approval.

4.2.2.11 Preheating

At ambient temperatures below 5°C pipe ends and fittings shall be heated to at least hand warmth for a distance not less than 150mm on either side of the joint.

4.2.2.12 Cleaning During Welding

All slag and foreign matter shall be removed at the end of each pass prior to the deposition of the next pass. Care shall be exercised to avoid over-grinding.

4.2.2.13 Welds

Weld reinforcement shall be uniform, without undercut and shall merge smoothly into the pipe or fitting surface. All welds, gas or arc, shall comply with the fault limitations set down in the relevant British Standard.

4.2.2.14 Brazing

All brazing shall comply with the requirements of British Standard 1723.

4.2.3 Screwed Joints

4.2.3.1 General

Screwed joints may be used where the pipework material specification allows. At least one of the mating components shall be taper threaded except where brass valves or fittings with paralleled threads are employed. When selecting brass valves or fittings preference shall be given to taper threaded fittings except where parallel threads are required for a specific purpose designated by British Standards, the Local Water Authority or Gas Supply Authority as relevant. Excess quantities of jointing material shall be cleaned from the threaded joint before pressure testing.

Screwed joints in pipework shall be to British Standard 806, BS 21, BS 1387 but "long screws" shall be prohibited.

Screwed joints shall take up the full wrenching allowance ie: the length of externally threaded pipe encased by the internally threaded fitting shall be equal to the gauge length + the positive tolerance on the internal thread + the wrenching allowance. Reference shall be made to Figure 3 and 4 together with Table 2M of BS 21: 1973, or the latest equivalents thereof.

4.2.3.2 Unions

All unions shall be "Navy" pattern with bronze to bronze spherical faces and seats. Unions shall not be used where their temperature and pressure ratings are exceeded. "**Railroad" pattern unions (bronze/iron) are prohibited.**

4.2.4 Copper Pipe Joints

4.2.4.1 Copper Pipe Joints (Except for Potable Water Services)

Compression fittings shall not be used unless written authority is given by the Employer's Representative.

Where joints are made using pipe fittings as specified the pipe ends shall be cut square using a rotating pipe cutter. No hacksaw cutting shall be permitted. The pipe ends shall be free from all burrs.

Whichever type of jointing system is used, purpose made fittings shall be utilised and pipe ends shall penetrate the fitting to the full depth intended by the manufacturer, i.e. shall be butted to the internal shoulder provided in the fitting.

Failure to comply with these requirements shall result in joint and fitting being condemned as failures.

The foregoing applies to both capillary and compression joints.

Where compression fittings are allowed the Site Supervisor shall carry out a quality control audit to check that **all** joints have their capnuts properly and firmly screwed into position in accordance with the manufacturer's instructions. The use of jointing pastes in conjunction with compression fittings is prohibited.

Over and above the Independent Testing specified for capillary joints the Employers' Representative shall inspect, choosing at random, 10% of all compression joints. Each joint chosen shall be undone and the pipe separated from the fitting for the inspector's view. Subject to the Site Inspector passing the joint as satisfactory, the joint shall be remade.

4.2.4.2 Copper Pipework Joints - Drinking Water

For methods of Jointing of Pipework reference shall be made to British Standard 6700, Section 3 published in 1997 plus subsequent amendments or later additions as applicable.

Attention is drawn to the possible hazards to health from Lead Solders. Only lead free solders approved by the Water Research Centre shall be used.

Unless approval is obtained from the Architect in writing to a specific solder, all joints shall be made using Yorkshire Potable Solder Fittings with soft lead free solder only.

Attention is drawn to problems with by-products of certain fluxes promoting bacteriological growth and health problems associated with metals such as lead. No soldered joint shall be used unless approval is obtained to the materials used in the making of such a joint. Fluxes, solders and Capillary Fittings shall not be used unless specific clearance of the particular types are given in writing by the Local Water Authority.

Joints utilising hemp and jointing compound shall not be allowed. No material, which supports microbiological growth or provides nutriment to microbiological organisms shall be permitted.

On completion of a section of pipework, the section must be thoroughly flushed through to remove all flux residue and entirely in accordance with the manufacturer's recommendations.

4.2.5 Fixings and Supports

The installation shall be supported by and secured to the primary base building fabric and not to any secondary or cosmetic surfaces such as false ceilings or moveable partition walls. Where curtain walling or glass/aluminium cladding is employed, the services shall be supported independently from these elements.

Where pipework supports and brackets are welded only welders certified for pipework jointing as specified herein shall be employed.

Pipework shall be supported so as to permit free movement due to expansion and contraction and to prevent the transmission of noise and vibration. Where expansion occurs, brackets and guides shall be of the type to allow this movement. 'U' bolts and mezzanine rings shall not be allowed to accommodate expansion movement. All joints and changes in direction shall be supported. Generally spacing shall be as specified in the tables given.

Vertical pipework shall be properly supported so that branches do not carry the weight of the pipe.

All cold water and chilled water pipes, supports and brackets shall be insulated from the pipe with a suitable load bearing non-conducting material. Where it can be shown that condensation will not occur on the brackets securing domestic cold water services then standard brackets may be used for domestic cold water services only provided that the installation and vapour sealing encapsulates the brackets.

4.2.5.1 Supports for Mild Steel Pipework

| Size of Pipe (Metric Equivalent) | {Intervals for Horizontal Runs} | | Intervals for Vertical Runs |
|---|---|---|---|
| | Un-Insulated | Insulated | Un-Insulated or Insulated |
| mm | m | m | m |
| 15 | 1.8 | 1.8 | 2.4 |
| 20 | 2.4 | 2.4 | 3.0 |
| 25 | 2.4 | 2.4 | 3.0 |
| 32 | 2.7 | 2.4 | 3.0 |
| 40 | 3.0 | 2.4 | 3.7 |
| 50 | 3.0 | 2.4 | 3.7 |
| 65 | 3.7 | 3.0 | 4.6 |
| 80 | 3.7 | 3.0 | 4.6 |
| 100 | 4.0 | 3.0 | 4.6 |
| 125 | 4.5 | 3.7 | 5.5 |
| 150 | 5.5 | 4.5 | 5.5 |
| 200 | 8.5 | 6.0 | 8.5 |
| 250 | 9.0 | 6.5 | 9.0 |
| 300 | 10.0 | 7.0 | 10.0 |

4.2.5.2 Supports for Copper Pipework

| Size of Tube | {Intervals for Horizontal Runs} | | Intervals for Vertical Runs |
|---|---|---|---|
| | Un-Insulated | Insulated | Un-Insulated or Insulated |
| mm | m | m | m |
| 15 | 1.2 | 1.2 | 1.8 |
| 22 | 1.2 | 1.2 | 1.8 |
| 28 | 1.8 | 1.5 | 2.4 |
| 35 | 2.4 | 1.8 | 3.0 |
| 42 | 2.4 | 1.8 | 3.0 |
| 54 | 2.7 | 1.8 | 3.0 |
| 67 | 3.0 | 2.4 | 3.7 |
| 76.1 | 3.0 | 2.4 | 3.7 |
| 108 | 3.0 | 2.4 | 3.7 |
| 133 | 3.7 | 3.0 | 3.7 |
| 159 | 4.5 | 3.7 | 3.7 |

4.2.5.3 Vulcathene (Polypropylene Pipes)

| Size (mm diameter) | Horizontal (m) | Vertical (m) |
|---|---|---|
| 38 | 1.2 | 1.5 |
| 51 | 1.4 | 1.5 |
| 76 | 1.5 | 1.5 |
| 102 | 1.8 | 1.5 |

All horizontal run pipework from fixtures served by HWSF shall be additionally supported by a continuous 20g galvanised sheet steel (½ round) cradle.

4.2.5.4 ABS Pipes

| Size (mm diameter) | Horizontal (m) (20°C) | Horizontal (m) (50°C) | Vertical (m) |
|---|---|---|---|
| 12 | 0.8 | 0.4 | ) |
| 16 | 0.8 | 0.5 | ) |
| 20 | 0.9 | 0.7 | ) |
| 25 | 1.0 | 0.7 | ) As Horizontal |
| 32 | 1.1 | 0.7 | ) |
| 40 | 1.1 | 0.8 | ) |
| 50 | 1.2 | 0.9 | ) |

4.2.5.5 PVC Pipes

| Size (mm diameter) | Horizontal (m) (20°C) | Horizontal (m) (50°C) | Vertical (m) |
|---|---|---|---|
| 12 | 0.7 | | 0.3 |
| 16 | 0.7 | | 0.3 |
| 20 | 0.8 | | 0.4 |
| 25 | 0.9 | | 0.4 |
| 32 | 1.0 | | 0.5 |
| 40 | 1.1 | | 0.6 |
| 50 | 1.2 | | 0.7 |
| 63 | 1.4 | | 0.8 |
| 75 | 1.5 | | 0.9 |
| 100 | 1.5 | | 0.9 |

4.2.6 Valves for Control and for Isolation

All necessary approvals from the Water Undertaker shall be obtained for all fittings.

All valves shall bear the British Standards Kite Mark or the equivalent EN standards mark except where a particular valve type is specified for which there is no current British or EN Standard.

No valve shall be used in circumstances, which are outside the temperature and pressure ratings for the valve or in applications for which it is not suitable.

Attention is drawn to the approved list of suppliers/manufacturers in this specification.

4.2.6.1 Isolation Valves for Water Services

4.2.6.1.1 General

Isolating valves shall be provided at all branch connections to/from the rising main distribution pipework. In addition local isolation valves adjacent to all heating and cooling coils, heat exchangers, vessels, calorifiers, tanks and domestic water service draw off points shall be provided.

Gate valves will only be allowed if required to meet the Water Undertaker's regulations when every other alternative valve has been considered.

Under no circumstances shall lubricated plug valves be used or any other valve, which requires a lubricant applied under pressure.

Under no circumstances shall compression fittings or patent mechanical couplings be used on the pressure generating side of isolating valves.

4.2.6.1.2 Valves of 50mm Diameter or Less

Valves of 50mm diameter and below shall be ball type where temperature and pressure ratings and service allows. All ball valves shall be lever operated and the levers shall be on an extended spindle to allow proper insulation of the valve. All ball valves on cold water services, on chilled water services, on hot water services and heating services shall be of A-metal, non-dezincifiable brass or bronze and shall have seats made of a material suitable for the temperature and conditions of service. Nitrile or butyl nitrile seats shall not be allowed on services where the temperature is in excess of $50^{o}$C.

4.2.6.1.3 Valves Greater than 50mm Diameter

All valves unless specified otherwise, shall be of the butterfly type, wrench operated up to and including 100m and gear operated over 100mm. All valves shall be designed to give 100% shut off. These valves shall only apply up to their pressure and temperature rating. All plant and equipment shall be easily removable and to facilitate this, pipe line “stall pieces” shall be provided between the valve and the plant or equipment wherever “wafer” type valves are employed. Where “wafer” lugged valves are used they shall be supplied fully lugged all the way round the circumference in accordance with British Standards, complete with threaded holes and half length bolts supplied by the manufacturer and the whole assembly shall be certified as suitable for the temperature and pressure rating of the valve. PN16 shall be the minimum pressure rating that shall be acceptable.

For cold water and chilled water services where the temperature of the service cannot ever rise above $50^{0}$C the valve disc shall be nylon coated SG iron or cast iron and the valve seat shall be black nitrile unless the water treatment used has a detrimental effect in which case EPDM shall be used as an alternative.

For all hot water services and heating services the valve disc shall be electroless nickel coated SG iron or cast iron and the valve sear shall be EPDM suitable for a temperature rating of not less than $120^{0}$C. Valve shafts shall be of stainless steel.

4.2.6.1.4 Valves for the Isolation of Pressure Gauges

All pressure gauges shall be fitted with isolating valves of A-metal, DZR brass or bronze of the needle globe type.

4.2.6.1.5 Balancing and Regulating Valves for Water Services

For balancing and regulation, double regulating, fixed orifice and variable orifice valves shall be used as shown on the Drawings within their stated temperature and pressure limitations. These shall be of A-metal or bronze up

to and including 50mm. For sizes 65mm to 150mm these shall be of cast iron with bonnets and discs of A-metal, bronze or stainless steel.

All valves shall have a characterised fixed or variable orifice disc/port combination and shall be supplied with graphs of the characteristics, which are suitable for the determination of the flow rate from pressure differential readings. The manufacturer shall state in writing the range of accuracy of the valves for the purpose of determining flow rate together with the limits within which the stated accuracy is applicable. The manufacturer shall also define that part of the characteristic, which provides an accuracy of ±5% (plus or minus five percent) or better.

Fixed and variable orifice double regulating valves used both for regulation and flow measurement shall be selected to ensure that the pressure drop signal is not less than 1.0 kPa and that the valve setting exceeds 50% of the total valve opening at the design flow.

High pressure loss valves may only be used where higher pressure loss is necessary and only after permission of the Employer's Representative has been obtained in writing.

All regulating valves shall have indicating setting collars and adjustable stops. All regulating valves shall have pressure differential tappings and manomenter connection points on either side of the seat arranged above the horizontal.

The only exception to this shall be for regulating valves in series with the by-pass port of three-way control valves where regulating valves with pressure tappings are incorporated into the system and the total flow can be measured whether through coil or through the by-pass. In this case, the regulating valve on the by-pass must be suitable for its purpose and shall otherwise comply with the specification above. Gate valves shall not be used.

Where flow measuring balancing valves are installed due account shall be made of the minimum upstream and downstream straight pipe lengths required for accurate flow measurement and the manufacturers' recommendations shall be obtained. Due account shall be given to the greater importance of the flow-on condition and valves shall be installed in a manner which minimises the turbulence on to the valve. In general, valves for terminal units shall be on the flow to the unit while valves on main sub-circuits shall be on the return to the vertical main. All valves shall be installed in straight pipe runs, which provide not less than 10 pipe diameters upstream and 5 pipe diameters downstream of straight pipe unless the manufacturer's written recommendation allows a lesser distance.

4.2.6.1.6 Thermostatic Radiator Valves

Reference shall be made to the Controls Section of this Specification.

4.2.6.1.7 Valves for Gas and Vacuum Services

Isolating valves on gas service shall be ball valves with double seals and non blow-out stems. For flow trimming only globe valves may be used. All valves shall be approved by the Gas Board.

Where the size of the service is such that ball valves are impractical then written consent shall be obtained from the Architect to the use of other types of valves.

4.2.6.1.8 Isolation Valves for Steam and Condensate Services

All isolation valves for steam services shall be flanged or suitable for flanged connection as the steam service is all welded.

Up to and including 50mm diameter sizes the isolation valves shall be of the bronze flanged globe type suitable for operation on steam at a pressure of 10 bar g.

Such valves shall be of the renewable disc type and shall all be one of the following:

Hattersley Fig 13 - Bailey 1408/51

For 65mm diameter sizes and above the steam service isolation valves shall be of the lugged, butterfly type, lever operation as manufactured by Keystone or T Omoe.

For such valves of 80mm diameter and above the valves shall be gearbox operated.

Isolation valves for condensate services of 50mm diameter and less, services shall be of the ball valve type as manufactured by Worcester Controls Limited, Fig/Model AW44.

For condensate service isolation valves of 65mm diameter and above, they shall be cast iron flanged with gun metal trim, solid wedge and non-rising stem and shall be as Hattersley Newman Hender Fig 541 or equal and approved.

All valves on the steam and condensate services of a particular size range shall be of the same manufacturer and type.

4.2.6.1.9 Valves for Drain and Draw-Off Points

The valves for all drain or draw-off points shall comply with the specification for isolating valves except that Butterfly valves shall not be used.

4.2.7 Non-Return Valves

4.2.7.1 General

Where automatic change-over of Duty and Stand-By Pumps is specified, non-return valves in all pump discharge pipework shall be provided. Where high head pressures (above 700 kPa) apply, then the recoil type shall be installed. The type of non-return valve shall be selected in conjunction with the manufacturer of the pump and shall be selected to operate in the fully open position.

Where required elsewhere the non-return valve selected shall suit the application.

4.2.7.2 Domestic Water Services

Where specified double check valve assemblies shall be provided on domestic water services. Each double check valve assembly shall include the provision of an up stream isolating valve and test point and shall be manufactured and installed in accordance with the Water Research Council test standards. Material and methods of construction shall be in accordance with British Standard 6282.

4.2.8 Safety Valves for Pressure Relief

4.2.8.1 General

Statutory requirements take precedence over all other considerations. All Safety Valves shall be terminated with a vertical waste pipe of the same diameter as the valve discharging directly over a tundish piped to drain.

Each safety valve shall have the lift pressure as determined by the manufacturer clearly and permanently marked on the body of the valve. Any adjustment mechanism shall be locked to prevent alteration by any person other than the manufacturer.

4.2.8.2 Calorifiers (Unvented)

These shall be as NABIC figure 500T high lift temperature and pressure relief.

4.2.8.3 Steam

For steam systems the safety valves shall comply with the relevant British Standard and HM Factory Inspectorate's Technical Data Note 34. Pressure relief valve discharges shall terminate in an exhaust hood with drain pipe. All exhaust hoods shall be of identical appearance from a single manufacturer. The drain pipe shall terminate over a gully.

4.2.9 Strainers and Filters

Pipeline strainers to the following items of plant and specification shall be supplied and installed as follows:

a) Each subsidiary circuit pumped off the primary ring main. This shall be duplex in the common return pipework immediately before entry into the ring main.

b) All pressure reducing valves.

c) All spray taps where specified.
All strainers shall be installed in a manner as to afford easy and direct access for strainer basket removal and cleaning.

d) Isolating valves shall be provided on either side of the strainers adjacent to them (within 300mm).

e) The pressure drop across the strainer assembly when the basket is clean shall not exceed 15.0 kPa.

f) Each strainer shall be fitted with pressure tappings (BINDA type) on the inlet and outlet suitable for connection to a portable differential pressure gauge.

g) Each strainer shall be fitted with a stainless steel basket with a mesh suitable to prevent the passage of and facilitate the removal of particle matter as follows:

| | Location | Particle Size |
|---|---|---|
| i) | All plant and pumps other than those specified hereunder. | 250 microns |
| ii) | Plantroom primary ring mains. | 500 microns |
| iii) | Subsidiary circuits. | 500 microns |

4.2.10 Antivibration Couplings and Flexible Connections

Antivibration couplings or Flexible connections shall be provided as specified to prevent the transmission of noise and/or vibration and, in addition, reference shall be made to other parts of this Specification, which require their use in association with specific items of plant.

Flexible connections shall be of EPDM or of stainless steel as specified. Flexible connections shall be selected to operate within the manufacturer's temperature and pressure ratings with due allowance made for shock loadings. All flexible couplings shall be of a quality such that after 10 years service under the "in-service" operating conditions, the residual burst pressure shall be 3 (three) times the working pressure.

The EPDM shall be reinforced and where the operating temperature is:

i. $60^{o}C$ to $100^{o}C$

The flexible carcass shall be steel wire mesh reinforced throughout to prevent catastrophic failure. These rubber flexible connections shall have a minimum design life of 10 years, continuously operating at $100^{o}C$ and then have a minimum burst pressure of 30 bar g in compliance with the minimum requirements of DIN 4809: Part 1. A Compliant Certificate shall be provided prior to the placing of an order.

The flexible connection shall be fully traceable and into the flexible carcass shall be moulded the manufacturer, country of origin, type and batch number, serial number, easily recognisable colour flashes and the date of manufacture.

ii. Below 60°C:

The reinforcement shall be of high tensile synthetic fibre.

iii. For temperatures above 100°C flexible connection shall not be manufactured from rubber, but shall be of thick wall spirally wound multi-ply construction stainless steel to provide the required noise and vibration reduction. The flexible shall be provided with Van Stone ends and swivel flanges. This type of flexible connection being for installations where the pump is on "solid" AV mounts, with the overall length not exceeding 130mm.

All flexible connections of EPDM shall have wire reinforced ends.

Where the installation pressure exceeds 1.5 bar, flexible connections shall incorporate tie bars complete with flexible washers beneath the tie bolt heads.

No EPDM flexible connection shall have been manufactured more than twelve months prior to commissioning.

All flexible connections shall bear the manufacturer's date of manufacture indelibly marked upon them.

Flexible connections shall not be used to connect mis-aligned pipe ends or connections.

All pipework shall be suitably anchored and guided in conformity with the manufacturer's recommendations.

No EPDM flexible connection shall be installed in a position which is likely to bring it into contact with oil or grease.

All flexible connections shall be stored on site in clean, dry oil free conditions.

To ensure correct installation and alignment, the Contractor shall have the manufacturer visit the site after installation and submit a Certificate of Conformity which shall be included in the Record documentation.

**Flexible joints/hoses containing EPDM shall not be used on domestic water services. Tap tails shall be hard piped.**

4.2.11 Expansion and Contraction

4.2.11.1 General

Due account of Expansion and Contractions shall be made in the design and installation of pipework and all necessary anchors shall be detailed on the drawings. The pipework shall be so installed as to avoid non-axial stressing of pipework joints.

4.2.11.2 Expansion Bellows

Expansion Bellows with associated guides and anchors shall be provided wherever contraction or expansion of a piped system requires them. The installation shall, as far as possible, absorb the expansion movement by natural sets and flexibility only where this is not possible shall expansion bellows be utilised.

Sufficient guides shall be provided to ensure that alignment of the bellows is correct at all times. Proper access requirements necessary for periodic inspection and replacement of the bellows shall be provided and notified to the Employer's Representative.

A schedule of all expansion bellows detailing type, manufacturer, linear expansion or contraction absorbed, cold draw shall be prepared and submitted to the Employer's Representative.

Where bellows are positioned such that failure may be hazardous due to either the hydraulic pressure or temperature then they shall be provided with an external sleeve, which shall be easily removable to allow inspection of the bellows.

All bellows shall have a working life of not less than 5,000 full length cycles.

4.2.12 Venting - Air Separators, Air Bottles and Automatic Air Vents

4.2.12.1 General

A sufficient number of air separators, air bottles, automatic air vents and vents shall be installed in water conveying pipework systems to ensure that on filling these systems they are freed from air and other gases quickly and easily and that any air or gas subsequently entering the system is removed from the system. The installation of these items and equipment shall include but not be restricted to the following:

1. The top of every riser or dropper pipe shall be fitted with an air bottle.

2. The high point(s) (or the position of lowest pressure) in each pipework system shall have an air separator(s) installed immediately after the highest bend(s) where an air bottle is required as well.

3. All Heating and Cooling Coils shall be fitted with air vents unless the pipework is so arranged that the coil is self venting.

4. All heating and air conditioning terminal units incorporating heating or cooling coils shall be fitted with air venting facilities. Where terminal units are floor mounted or at low level every unit shall have an air bottle on the branch pipework to the coil. Piping to units may be arranged so that one air bottle serves a pair of units.

Where changes in pipe size occur in horizontal runs eccentric fittings shall be used to facilitate venting.

4.2.12.2 Air Separators

Air separators shall consist of a section of pipework not less than 600mm long in which the velocity of the water passing through shall be not more than 0.2 m/s. Entry and Exit connections shall be eccentrically positioned in axial lines with the bottom of the Separator. Alternatively Air Purgers factory made by an Approved Manufacturer may be used. These shall be of cast iron or bronze and shall be sized at one pipework size larger than the full bore pipe size and shall be fitted with eccentric reducers.

Every separator shall be fitted with an Automatic Air Vent.

4.2.12.3 Air Bottles

Air Bottles shall be of diameter not less than the diameter of the section of pipe in the system to which they connect. They shall not be less than 600mm high. The top of every air bottle shall be fitted with an automatic air vent, except where the air bottle forms a part of the pipework serving a terminal unit or pair of terminal units when a key operated air vent shall be substituted.

4.2.12.4 Automatic Air Vents

All Automatic Air Vents (AAVs), constructed of brass or gun metal with internal check valve, shall be installed complete with a hand controlled lock-shield valve in the pipework connecting the AAV to the system it serves. The valve shall be located so that it is accessible from floor level. The discharge outlet from all AAVs shall be piped to within 300mm of the floor level and terminated in a splay cut end, all discharges shall be labelled with traffolyte label.

4.2.13 Dirt Pockets

Where any piping system rises up or drops down a vertical distance of 5.0 metres or more, a full bore dirt pocket shall be provided at the bottom. For pipes up to 200mm diameter, the dirt pocket shall be at least 5 (five) diameters' distance of pipe and for pipes over 200mm diameter 3 (three) diameters' distance of pipe. For pipes up to and including 50mm diameter, a 25mm valved hose union shall be provided. For pipes over 50mm and up to 100mm diameter a 50mm valved hose union shall be provided in the dirt pocket for draining down purposes. For pipes over 100mm diameter a 100mm diameter isolating valve shall be installed coupled with a patent mechanical coupling to a reducer followed by a 50mm valved hose union.

Dirt pockets on steam services shall be provided with a trap set as shown on the Drawings.

Excluded from this provision are:

a) Cold Water Distribution Pipework and Drinking Water Systems
b) Hot Water Service Distribution

4.2.14 Hose Unions

All hose unions, unless otherwise specified, shall be standardised at either 15mm or 25mm diameter.

4.2.15 Water Sampling Draw-Offs

Water sampling draw offs shall be installed with the minimum length of connecting pipework terminating with a drain cock or isolating valve complete with a brass nozzle suitable for sterilisation by “flaming” with a blow torch and so arranged as to avoid damage to the valve and other adjacent equipment during the application of heat.

Sampling Draw-Offs shall be provided at locations as follows:

a) On the HWS flow as close to the calorifier or storage vessel as possible.
b) On the HWS return as close to the calorifier or storage vessel as possible.
c) On the flow from all cold water storage tanks as close to the tank as is possible.

4.2.16 Public Health Services

4.2.16.1 Suspended Pipework - (Drainage and Rainwater)

All drainage pipework suspended at high level within the Basement areas shall be installed in cast iron to Pr EN877 and shall have flexible joints manufactured to BS 6087. Each coupling shall be complete with an electrical continuity connector.

4.2.16.2 Brackets

All cast iron pipework where installed at high level suspended from the underside of the concrete slab shall be supported at distances of not greater than 1.8m.

Where fittings are located within the horizontal pipe run additional brackets shall be installed to ensure adequate support to all branch runs and positioned adequately to take the weight of pipework and contents.

The cast iron manufacturers hanging brackets or purpose made mild steel brackets shall be used for suspended pipework with 12mm drop rods.

Where pipeline ancillaries such as gullies require support, purpose made channel supports shall be provided to adequately support the base of the gully or trap.
All ferrous material shall be painted two coats of primer.

4.2.16.3 Pipework Access

Access shall be provided with the use of fittings or rodding points where indicated on the drawings or at any changes of direction, bends, branches, etc, in order to provide a fully roddable drainage system.

Access fittings shall be so located so as to allow the insertion of any cleaning equipment or testing apparatus and for the removal of any blockages.

Every care shall be taken to ensure that the access point is not situated in such a manner that nuisance or danger from spillage may occur.

4.2.16.4 Drain and Head of Drain Vents

Air admittance valves shall not be utilised.

All drainage and interceptor vents shall be installed to roof level and terminate with a wire balloon.

Where the service penetrates the roof finishes, it shall be weatherproofed with a lead work or device as listed below.

Where vents pass through asphalt roof finishes the contractor shall include for a roof connection as Timesaver No. GT72.

Where vents pass through a felt or membrane roof finish, the Contractor shall include for a roof connection as Timesaver No. GT99.

The termination of all vents shall accord with Codes of Practice and shall be not less than 900mm above any openable window and if within 3m horizontal distance.

4.2.16.5 Lead Caulked Joints

Where traditional spigot and socket joints are required on intercepting traps or other pipeline ancillaries they shall be made as follows:

a. The spigot and socket having been located squarely together shall have two rings of tarred yarn tamped well into the open joint.

b. The joint shall then be poured with molten lead utilising a caulking ring and correct thickness tools ensuring that the complete joint shall contain no less than half the socket depth of lead thickness.

The C.I. drain coupling at the foot of each stack pipe shall be placed just above the structural floor slab level.

A pipe strap support out of 40mm x 4mm galvanised mild steel strip, shaped to contours of the coupling and with tails long enough to span the hole in the structural slab shall be fixed to coupling of the drain so that the structural slab will support the drain at this point. The tails of the strap shall extend 150mm beyond the edges of the hole in the slab.

Vertical and horizontal cast iron pipework shall be fixed strictly in accordance with the recommendations of Glynwed Foundries Limited in respect of fixing bracket locations, spacings and type.

All pipes, fittings and fixings shall be painted at site after testing as follows:

a. Pipework - one coat of bituminous black paint solution.

b. Mild steel fixings - one coat of primer after wire brush cleaning, followed with one coat black bituminous paint.

Full details of all brackets shall be submitted to the Employer's Representative prior to commencement of the installation work.

4.2.16.6 Traps

All traps to sanitary fittings shall be of the deep seal type.

Traps shall be easily removable from sanitary fittings and branch pipe incorporating a union type fitting.

4.2.16.7 Connections to WC Pans

The Contractor shall include for 'Multikwik' type WC pan connections where connecting between branch soil pipes and the WC pan spigot.

The correct type of connector shall be used to provide a fall to the branch soil pipe from the horizontal outlet of the WC pan.

4.2.16.8 WC Overflows

The WC overflows shall be installed as indicated on the contract drawings, the service shall be installed in copper tube 15mm to 54mm O.D. inclusive to BS EN 1057: 1996 (formerly BS 2871 part 1 table X).

The WC overflows shall discharge at the locations given on the Tender drawings. The overflow shall have a traffolyte label indicating the origin of the flow.

## 4.3 Cold Water Storage Tanks, Break Tanks & Feed Expansion Tanks

All tanks shall be heavy duty PVC or glass reinforced plastic resistant to ultraviolet degradation with heavy duty covers manufactured of the same material. All tanks shall be adequately braced and stiffened. Where tanks are of the sectional type, the manufacturer shall erect and test the installation. All tanks shall be approved by the Local Water Undertaker, and where fire fighting systems are fed, by the Loss Prevention Council. All CWS tanks shall be suitable for the storage of potable water and shall have all vents and overflows suitably screened. All tanks shall be inherently self-draining.

Where sectional tanks are used their covers shall be internally flanged and bolted while their sides and bases shall be externally flanged and bolted. All covers shall include a heavy duty hinged and lockable access door. Where the top of any tank is 2.0m or more above the finished floor level it shall have adjacent to its access door a suitably hooped cat-ladder. Where any tank is greater than 1.5m in depth it shall be provided internally with a GRP access ladder immediately adjacent to the access door.

All water capacities of 2,500litres and above shall be contained within not less than two tanks, or a single tank suitably sub-divided to facilitate cleaning and maintenance of each half while the other half is kept in service.

All nuts and bolts shall be of stainless steel.

All internal ties shall be of stainless steel.

The construction of all tanks shall be such as to remain water tight while operating over an ambient temperature range of not less than $50^0$K. Any joint sealant used shall fully recover from any compression applied by the expansion of the tank materials over this range over a life span of at least 25 years. All tanks shall be designed and installed in a manner to give a tank life of not less than 50 years.

Where tanks incorporate integral insulation that insulation shall be CFC free.

The storage of all water shall be split between two or more tanks, or in sub-divided tanks so as to permit maintenance and cleaning whilst the storage is kept in service. All tanks and sub-divided tanks shall be piped in a manner, which shall permit series draw-through together with the necessary bypass arrangements to permit maintenance to be carried out on any one of the tanks while maintaining the service in use.

### 4.3.1 Float Valves

All float valves shall be of the fully adjustable type in the vertical plane.

Float valves shall be positioned at the opposite end of the tank to the draw-off connections to maximise circulation.

### 4.3.2 Discharge Pipe Termination

All pipes discharging with ends open to the atmosphere whether external to the building or within the building shall be terminated with a splay cut end with the splay facing away from the surface to which the pipe is fixed.

## 4.4 Thermal Insulation

### 4.4.1 Introduction

All insulation shall be provided in accordance with BS 5970 and 5422.

Thermal insulation shall be provided to pipework, vessels, tanks, valves, fittings and plant as follows:

1. Calorifiers and Heat Exchangers and Receivers (where provided).
2. Hot or potentially hot pipework in plantrooms and service voids (e.g. Safety Valve Discharges, etc).
3. All heating and hot water pipework including cold feed and vent pipework and valves.
4. All domestic hot water supply and secondary circulating pipework.
5. All drinking water mains.
6. All cold water services (and shall be vapour sealed).
7. All water chillers and chilled water pipework, including pumps and pump line ancillaries (and shall be vapour sealed).
8. All comfort conditioning and supply air ventilation ducting. (All supply ductwork shall be vapour sealed).
9. Steam and condensate pipework.
10. Condensate pipes from cooling coils up to the main drain connection.

### 4.4.2 Insulation Installation

No thermal insulation whatsoever shall be applied until the pipes, ducts, vessels, calorifiers, tanks etc of a particular service have been successfully pressure tested, and such tests witnessed by the Employer's Representative and painted as specified.

Any insulation that gets wet or is damaged prior to Practical Completion shall be removed in its entirety and replaced at no cost to the Employer.

To facilitate the testing of insulation thicknesses provision shall be made for the cost of cutting away and making good one section of insulation of every size and thickness on each service. Where thicknesses do not conform to that specified the affected parts of the installation shall be replaced at no cost to the project.

Sectional insulation shall be carefully fixed using aluminium bands at 600mm centres to ensure that all circumferential and longitudinal joints are closed tight. All insulation shall have a 50mm overlap between circumferential joints. Vapour/moisture barriers shall be provided every 6 metres of pipe length.

This barrier shall take the form of a silicon mastic seal between adjacent lengths of insulation.

All insulation work shall be carried out by a specialist company. The specialist company shall be approved by the thermal insulation material manufacturer and he shall be a member of the Thermal Insulation Contractor's Association, Kenway House, 388 High Road, Ilford, Essex, IG1 1TL.

The name of the insulation sub-contractor and written confirmation that he is a member of the Thermal Insulation Contractor's Association shall be submitted to the Employer's Representative prior to allowing insulation to commence.

4.4.3 Suitable Materials

Before any insulation system is installed written approval to the scheme and materials shall be obtained from the Local Authority.

No fibres of the insulation material shall have a diameter of less than 3.0 microns.

Mineral Wool or Rockwool insulation materials shall be used throughout unless otherwise specified and all fibres shall be stabilised to prevent migration.

4.4.4 Pipework Insulation

4.4.4.1 Plant Rooms, Internal Ducts, Shafts

All pipework including unions and plant shall be insulated. The insulation shall be reinforced aluminium foil wrapped. No open ends of insulation shall be left and the complete installation shall be fully encapsulated.

4.4.4.2 Occupied Zones

Except for chilled water, pipework, where exposed to view within occupied areas of pipework shall not be insulated.

4.4.4.3 Pipework Brackets and Supports

All chilled water pipe brackets and supports shall be insulated from contact with the pipework by means of a suitable hard wood block or dense foam block to prevent the conduction of heat and formation condensation on the brackets. The vapour barrier shall be continuous through all supports and brackets and a sheet metal sleeve shall be provided at all support locations to facilitate the fixing of the vapour barrier. Additionally all steam pipe supports shall include a calcium silicate block at the support point of the same thickness as the pipe insulation. Dense foam blocks shall only be used on services where the pipe wall temperature will not exceed $50^{o}$C.

4.4.4.4 Flanges, Valves, Strainers and Pump Impellers and Ancillary Items

All valves, strainers, pump impeller casings, flanges etc on chilled and cold water services shall be insulated using purpose made valve and strainer sections. The boxes shall be formed of an injection moulded phenolic foam material to the profile of the plant and equipment being insulated. The boxes shall wherever possible be of a maximum 2 sections and shall be securely fastened in position using nylon straps or some other fastening method. The foam material shall be of a type not expanded using CFC's or HCFC's and the material shall be acceptable to the Fire Officer and Local Authority. Boxes in external locations shall, before installation, be painted 1 coat primer, 1 coat undercoat and 1 coat gloss (White).

For steam, LTHW and all other service valves, flanges, fittings, etc shall be insulated using glass cloth encapsulated Rockwool mats secured by hooks and eyes or 2 section aluminium boxes lined with Rockwool matting and fastened using quick release latch type tension buckles secured with Velcro straps.

Where boxes and mats abutt adjacent pipe sections they shall overlap the pipe insulation by at least 50mm and shall in the case of chilled water and cold water be sealed to prevent the ingress of ambient air or be sealed to the adjacent insulation with a removable vapour seal band overlapping at least 30mm to the valve box and pipe insulation.

4.4.4.5 Minimum Insulation Thickness

All thicknesses are based on 'Rockwool' with a maximum thermal conductivity in the range 0.03-0.043 W/mK and density 112 kg/m$^3$.

Full data sheets for other material which does not satisfy the above minimum criteria shall be submitted to the Employer's Representative. The thickness of the pipe material shall not be changed without the written authority of the Employer's Representative.

4.4.4.5.1 Chilled Water Systems

| Pipe Bore (mm dia) | Thickness (mm) |
|---|---|
| 15 | 38 |
| 20 | 38 |
| 25 | 38 |
| 32 | 38 |
| 40 | 38 |
| 50 | 50 |
| 65 | 50 |
| 80 | 50 |
| 100 | 50 |
| 150 | 50 |

4.4.4.5.2 Hot and Cold Water Services, Rainwater, Condensate Drains

| Pipe Bore (mm dia) | Thickness (mm) |
|---|---|
| 15 | 25 |
| 20 | 25 |
| 25 | 25 |
| 32 | 25 |
| 40 | 25 |
| 50 | 25 |
| 65 | 25 |
| 80 | 25 |

4.4.4.5.3 Chilled Water Vessels

(Density = 48 kg/$m^3$)

50mm thick.

4.4.4.5.4 Heating Calorifiers, Hot Water Storage Tanks, Condensate Receivers etc

(Density = 48 kg/$m^3$)

50mm thick.

4.4.4.5.5 LTHW Heating

| Pipe Bore (mm dia) | Thickness (mm) |
|---|---|
| 15 | 25 |
| 20 | 25 |
| 25 | 25 |
| 35 | 25 |
| 40 | 25 |
| 50 | 38 |
| 65 | 38 |
| 80 | 38 |
| 100 | 38 |
| 150 | 50 |

4.4.4.5.6 Steam and Condensate Pipework

| Pipe Bore (mm dia) | Thickness (mm) |
|---|---|
| 15 | 25 |
| 20 | 25 |
| 25 | 38 |
| 35 | 38 |
| 40 | 50 |
| 50 | 50 |
| 65 | 50 |
| 80 | 50 |
| 100 | 50 |

4.4.4.6 External Pipework

One layer of 0.8mm thick polyisobutylene sheet shall be applied over the completed insulation, ie vapour seal applied and mechanical protection complete. The polyisobutylene shall be lapped and sealed with a suitable adhesive with the joint on the underside. At all bracket locations the sheet shall pass through the bracket of a non-ferrous metal sleeve, a high density insulated support block shall be used and shall be utilised to glue the sheet to.

4.4.4.7 Plant Rooms

All pipework up to a height of 2.00 metres from floor level shall be additionally wrapped with one layer of 170g/$m^2$ canvas membrane, which shall be fully adhered to the surface of the installation with “Chilseal” CP50.
All canvas shall be stretched tight to eliminate all creases and wrinkles and overlapped on to itself by 250mm at all joints. On complete drying of the adhesive the outer surface shall be treated with “Chilkote” CP55

4.4.5 Insulation for Ductwork

All air conditioning, comfort cooling and ventilation ductwork, unless specified otherwise, shall be insulated with Rockwool rigid duct insulation with a reinforced aluminium foil vapour seal. The thickness shall be in accordance with the table below. The insulation shall be attached to the ducting with adhesive and pins approved by the Manufacturers, and all joints shall be taped to maintain a proper vapour seal; the tape shall be of a quality to withstand all extremes of temperature from 0$^{o}$C to 60$^{o}$C and be approved by the Manufacturers. A further covering of self-adhesive aluminium foil vapour seal shall be applied, and the whole secured with 25mm mesh galvanised wire netting. Where an open grid ceiling is specified or the ductwork is exposed to view or open to the elements at any time after insulation the galvanised wire mesh netting shall be black Japanned in addition.

Flexible duct insulation shall only be used where accessibility would preclude vapour sealing using rigid insulation. The permission of the Employer’s Representative in writing must be obtained before using flexible insulation. Care shall be exercised to ensure that the insulation is not compressed.

4.4.5.1 Plant Rooms

All ductwork within plant rooms and service voids shall be additionally wrapped with a 170 g/$m^2$ canvas membrane which shall be fully adhered to the surface of the insulation with "Chilseal" CP50. All canvas shall be stretched tight to eliminate all creases and wrinkles and overlapped on to itself by 250mm at all joints. On complete drying of the adhesive the outer surface shall be treated with "Chilkote" CP55.

4.4.5.2 Concealed Ductwork

Where ductwork is concealed in false ceilings, service ducts and areas where the insulation is not readily seen, the insulation shall be further secured with aluminium bands placed at 600mm intervals between the insulation and the wire netting.

4.4.5.3 External Ductwork

All external ductwork shall be finished using 2 layers, 0.8mm thick polyisobutylene sheeting with joints overlapping by 75mm and facing downwards.

4.4.5.4 Minimum Insulation Thickness

The thickness and density of the duct insulation shall be in accordance with the following schedules:

**Density**

| | |
|---|---|
| Preformed Rigid Sections: | 112 kg/$m^3$ |
| Preformed Rigid Slabs: | 48 kg/$m^3$ |
| Flexible Ductwrap (where allowed) | 20 to 38 kg/$m^3$ |

**Thermal Conductivity**

0.029 - 0.043 W/mK

**Thickness**

| Nominal Duct Size Circular given or Rectangular equivalent (mm) | Declared Thermal Conductivity (0.0288 - 0.0433 W/mK) Minimum Thickness of Insulation (mm) | | |
|---|---|---|---|
| | 10k* | 25k* | 50k* |
| Up to and including 200 mm | 50.0 mm | 50.0 mm | 65.0 mm |
| 200 mm and over | 40.0 mm | 50.0 mm | 65.0 mm |
| Flexible ducts | 50.0 mm | 50.0 mm | 75.0 mm |
| Air Handling Plant, Fans, Heater and Cooler Coil Casings | Rigid Slabs 38.0 mm wire netting and polished aluminium finish unless of double skinned construction. | | |

| | |
|---|---|
| Plant, vessels and tanks | Rigid slabs 38.0 mm wire netting and polished aluminium finish |
| Any of the above externally exposed | Rigid slabs 75.0 mm thick |

Where rigid slabs are used, these shall be further secured with clips stuck to the surface at 300 mm centres.

*Temperature difference between inside duct and 20$^{o}$C.

4.4.5.5 General

All insulation shall be neatly and carefully sealed around all sensors, motors, test points etc and the covering securely glued to the duct. Stool pieces shall be extended through the ductwork insulation to accommodate items of control and sensing equipment.

Stool pieces shall be of the same material as the ductwork system.

The ductwork insulation shall be continuous under all brackets and supports.

All ductwork flanges shall be properly, neatly and continuously bridged using the same thickness insulation as the main duct insulation.

4.4.6 Services Identification

The identification of all Mechanical Services shall be executed in accordance with BS 1710 for pipeline services and DW 144 for ductwork services. Flow direction arrows shall be provided.

All valves shall be identified with a disc (25mm dia) having red letters on a white background fixed by means of split rings to the valve handle.

## 4.5 Sleeving and Sealing

In addition to the sleeving and sealing of services penetrations through the building fabric the following shall apply:

1. All mechanical services penetrations, through the building fabric shall be sealed and caulked to stop weather penetration and/or fire spread.

2. In the case of all penetrations through the plant room slabs these shall be made good using an intumescent type sealant approved by the Employer's Representative.

3. All sleeved pipe penetrations through horizontal plant room floors and floor slabs. Slabs shall be made such that the sleeve extends at least 25mm through the floor, above the finished surface level.

4. All duct penetrations through the plant room floor slabs shall be sealed using a rolled steel angle 'flashing' frame/flange which shall be securely fixed to the slab and sealed using an appropriate intumescent sealant approved by the Employer's Representative.

5. All pipe penetrations shall be sleeved.

6. All vapour barriers shall be continuous through sleeves.

7. 'Split' pipe sleeves shall not be used.

## 4.6 Site Painting

### 4.6.1 General

All paints and protective coating systems used shall be provided to site with the necessary Health and Safety documentation giving instructions as to Safety and Health protection during application, and also for the removal of the coating since this may be necessary in the future to effect alterations and so on. All such Health and Safety documentation shall be included in the Operating and Maintenance Manuals and Health and Safety File.

All ferrous pipework and ferrous metal shall be thoroughly wire-brushed and cleaned of all mill scale, rust, dirt, welding flux and slag, grease and any other detrimental substances prior to painting. Where brushing or scrubbing is employed only steel brushes shall be used. Where necessary, flame cleaning shall be used. Where surfaces need etching or require preparatory work or some intermediate treatment or coating prior to the application of any paint or coating specified hereunder in order to produce a cohesive and satisfactory coating, such preparation shall be carried out as necessary.

The metal surfaces shall then be painted with a priming coat followed by such top coats as specified prior to insulation.

The use of zinc chromate paint shall not be allowed for new works.

Where a top coat is required to be painted onto a primer and the two paints are incompatible, a suitable undercoat shall be applied to enable the two paints to be linked.

All painting shall be done in dry conditions and at temperatures commensurate with the proper application and drying of the paint. Painting at temperatures below 3$^{o}$C shall not be allowed.

### 4.6.2 Mild Steel Pipework

All mild steel pipework shall be painted with two coats of zinc phosphate primer containing at least 40% zinc phosphate by weight in an alkalide or modified alkyd binder.

### 4.6.3 Exposed Pipework

Exposed pipework in all areas other than in plantrooms shall be finished with a top coat of a compatible high gloss paint to a colour as specified elsewhere in this document or to the relevant British Standard Colour Code or as approved by the Employer's Representative as appropriate to the service and its location.

### 4.6.4 All Other Ferrous Metal Work

All other ferrous metal work including brackets, stools, hangers, channels etc shall be painted with two coats of zinc phosphate primer containing at least 40% zinc phosphate by weight in an alkyd or modified alkyd binder.

Where exposed they shall be further painted with a top coat of a compatible high gloss paint as a finishing coat and this shall be Black in colour.

4.6.5 Prefabricated Ferrous Metalwork or Pipework

Prefabricated ferrous metalwork or pipework shall be delivered to site primed and ready for painting to the above specifications.

The primer paints shall have the following properties:

- They shall not interfere with fabrication welding.
- They shall be non-toxic and give rise to no objectionable fumes when welding or cutting.
- They shall not affect the quality of the welds.
- They shall protect the steel effectively.
- They shall form a suitable basis for the final protective paint system.

4.6.6 Cast Iron Pipework and Equipment

All cast iron pipework and equipment on drainage and soil services shall be painted with one coat of bituminous paint.

4.6.7 Stainless Steel and Chromium Plated Pipework, Valves and Fittings

Stainless steel and chromium plated pipework valves and fitting shall not be painted. These shall be cleaned and be in a polished condition on Practical Completion.

4.6.7.1 Non-Ferrous Pipework, Valves and Fittings

Non-ferrous pipework, valves and fittings shall generally not be painted. However, where the atmosphere is likely to be corrosive or where superficial damage has occurred and is unsightly or may promote corrosion in the future, the pipework, valves or fittings concerned in that whole section shall be thoroughly cleaned and painted with a suitable protective coating. If, in the Employer's Representative's opinion the damage is such that it cannot be suitably treated in this manner, the damaged sections shall be replaced. Such superficial damage shall include surface corrosion caused by the use of excessive flux or the failure to remove flux and properly cleaned soldered joints at the time that the joint is made.

4.6.8 Fresh Air Inlets

The first 1500mm downstream of a louvred fresh air inlet shall be degreased and painted 1 coat calcium plumbate and 1 coat black bitumastic.

4.6.9 External Galvanised Steel Ductwork

All uninsulated ductwork located externally shall be degreased and painted after installation and pressure testing with 1 coat calcium plumbate, 1 coat undercoat and 1 coat gloss paint to a colour to be advised by the Employer's Representative.

# Section E4.00

# Electrical Installation Method and Materials Specification

# Index

# E4.00 Electrical Installation Method and Material Specification

## 4.1 Low Voltage Switchgear and Distribution Equipment

### 4.1.1 LV Cubicle Type Switchboards

The switch panel shall be manufactured and type tested assembly (partially or fully as indicated within Section 2) in accordance with BS EN 60439-1 and have a minimum protection rating of IP31 to BS EN 60529, unless otherwise specified. The switch panel must be vermin-proof.

Busbars shall be of adequate size and rating to withstand load and fault conditions, and shall be fitted with suitable solid mechanical non-ferrous and non-carboniferous clamps. The busbars shall not be drilled, and any connections shall be made only by clamp, nut and bolt.

All fuses shall be of the high rupturing capacity type, to suit the system's conditions, unless otherwise specified. All cables entering switch or distribution units shall be made via proper cable boxes. Pilot cables for meters and indicating equipment etc, shall be fused at the take-off point from the busbars by means of HRC fuses rated at three times the rating of the pilot circuits protective device.

All metal framework necessary for the erection of switchgear shall be supplied and fixed under the contract.

Switchboards shall comprise of the equipment shown on the design drawings together with all the instruments, interlocking current transformers, auxiliary fuses, relays, labels, small wiring and inter-connections.

The switchboard components shall be ASTA certified to 50 KA asymmetric fault rating and be able to withstand the through fault for three seconds. The switchboard shall be constructed to Form 4, type 2.

A minimum of 25% fully fitted spare outgoing ways of each rating used shall be provided.

#### 4.1.1.1 Panel Construction

The switchboard shall be a flush fronted, metal clad protected type enclosure, suitable for indoor use in the form of a free standing floor mounting cubicle. The cubicle shall be sectionalised with no section longer than 1000mm to facilitate transportation and erection. Cabling compartments are to be a minimum of 450mm wide and doors shall not exceed a maximum width of 700mm. All instrumentation must be located at such a height that it may be easily read (maximum height 1800mm). The maximum overall height shall not exceed 2250mm and is to include a plinth of 75mm minimum height.

All edges of switchboards shall be radiused, and when fabricated shall be dead flat and true.

The switchboard shall be built using 12/14 SWG thick sheet steel in conjunction with a substantial integral angle or channel section framework.

The framework shall be of a folded welded or bolted construction and shall be self-supporting free standing and completely rigid.

The switchboard shall be designed so that it can be extended at either end.

Ventilation shall be provided to induce natural air circulation.

All drainage and ventilation holes shall be vermin proof.

It shall be possible to remove each sub-assembly completely from the switchboard for the purposes of maintenance or replacement and shall be adequately shrouded by shutters to prevent accidental contact with 'Live' terminals.

It shall not be possible to replace a switch assembly when it is in the 'ON' condition.

Removable lifting eyes shall be built into each cubicle of the switchboard to facilitate hoisting.

4.1.1.2 Panel Finish

The paint is to be applied to a dry, rust and grease-free metal. The steel may be electrozinc plated or standard mild steel, but either must have a minimum of an etch coat, 2 priming coats, and undercoat and 2 finishing coats. The undercoat and the finishing coats shall be stove enamelled and the panel shall be rubbed down between coats of paint as required.

The finished colour shall be agreed with the employer's representative.

4.1.1.3 Cable Entry

The switchboard shall be manufactured to incorporate suitable cable entry facilities to facilitate the design intent. Gland plates shall be incorporated within the panel framework for top and bottom entry cable.

4.1.1.4 Switchboard Access

The switchboard shall be suitable for all round access or front access only as specified elsewhere to give accessibility as far as cabling and termination is concerned. All removable panels shall be hinged gasketed, and shall be sufficiently rigid to avoid distortion. Large panels shall be provided with external lifting handles and removable hinge pins.

4.1.1.5 Cable Facilities

Cable boxes, glands and lugs are to be supplied and installed as applicable for each main or sub-main cable which will enter or leave the cubicle. Generally the panels shall be arranged for top entry only. Non-ferrous gland plates shall be installed to each cabling chamber.

The manufacturer is to take careful note of the distribution diagram details of cable sizes and types. Cable glands are to be as near to terminations as possible but enough space shall be allowed to terminate and joint cables in

approved manners and also to cater for the bending radii required to install cables to their terminating positions.

Main cable terminations shall be of the 'two-stud' type for accommodating crimped cable lugs. All terminations shall have clearance holes. Cable lugs, fully threaded bolts, plain and shakeproof washers and nuts shall be provided to suit the cable. Cable tails shall be supported within the equipment at intervals not exceeding 450mm. Supports shall be non-metallic and be attached by mechanical means.

Terminal chambers and fuseboard termination, where installed, shall be enclosed in such a manner that tools cannot be dropped into other sections of the cubicle whilst work is being carried out in a particular section.

Adequate insulation and screening shall be provided throughout the interior of the switchboard to prevent accidental contact with any live part during maintenance work.

4.1.1.6 Internal Wiring

Auxiliary and main wiring shall be segregated as far as practicably possible. All internal wiring shall be securely fixed to he enclosures and shall not impede the opening and closing of doors or removal of components. Crimp-type connections shall be used.

No wiring other than the busbar terminations of the connectors to the fuse switches shall be contained in the busbar compartment. Auxiliary wiring run in trunking along the switchboard shall be terminated either side of any busbar section switch. Auxiliary connections through a busbar switch shall be run in a separate section of trunking to prevent the spread of a fault along the whole length of the switchboard.

Small wiring for auxiliary connections shall be of the multi-strand type and shall have a cross-sectional area of not less than 2.5mm$^2$.

Small wiring shall be in accordance with the relevant British Standard and shall be neatly arranged and cleated. Cleats are to be fixed to the switchboard structure at sufficient intervals to avoid cable sag. Where possible all internal control wiring shall be 24V AC and colour coded in accordance with the relevant section of this specification.

4.1.1.7 Earthing

A 65mm x 6mm minimum size hard drawn high conductivity copper tape shall be installed the full length of the switchboard. Each cubicle of the switchboard shall be bonded to a copper tape. At both ends of the board the tape shall be fixed to a threaded brass stud which is to be fixed through the switchboard with nuts and washers to receive the main switchboard earth tape.

Each item of equipment within the switchboard shall be separately earthed to its associated cubicle. Earth tapes shall be joined at connection positions and where lengths are connected together, in an approved manner.

4.1.1.8 Fuses

All fuses shall be rated in accordance with the latest British Standard Specification, 25% spares shall be supplied for all fuses.

Where a control circuit is supplied directly from main power conductors, it shall be protected by HRC power fuses.

In general control fuses bases and carriers, of the fully shrouded type having cartridge fuses will be acceptable subject to formal approval.

The fuse bases and carriers shall be coloured in accordance with the following:

| | |
|---|---|
| 5 amp | Black |
| 15 amp | Light green |
| Link | White |

Fuses of ratings other than 5 or 15 Amp shall have the rating inscribed on the fuse carrier or label. Such fuses shall be distinguished by approved colourings.

4.1.1.9 Busbars

All busbars and connections will consist of hard drawn high conductivity copper and shall comply with the relevant British European Standards BSEN 60439-2. The busbar system shall be ASTA certified to 50 KA asymmetric fault current for 3 seconds. Reduced section neutrals will not be permitted. The creation of closed ferrous metal loops around individual phases shall be avoided.

Busbars shall be located in a separate enclosed compartment within the switchboard, and together with the risers or droppers between busbars and individual fuse switches, shall be fully insulated. The use of insulation tape will not be permitted. Each compartment/Busbar cover shall be fixed with a warning label “Danger 415 Volts”, and also provided with details of the bus bar system (fault rating).

The busbars shall be so arranged in the switchboard that extension can be made at either end in the future.

The busbars are to be securely and rigidly fixed in such a manner that they will withstand the system fault current without permanent damage to supports, or distortion to bars.

Access to busbars and busbar connections shall be only by the removal of bolted covers. A label shall be fixed to the cover giving details of the busbar system (fault rating etc).

4.1.1.10 Fuse Switches

Fuse switches shall be in accordance with the relevant British European Standards and of the current ratings as dictated by the specification.

Mechanisms shall be non-corrosive material. Shafts and bearings shall be of compatible material. Arc-resisting barriers shall be fitted between phases in the vicinity of the arc path. Parts which remain alive when covers are open shall be fully shrouded. Access to fuse links shall not be possible unless they are de-energised.

Air circuit breakers when required shall be fitted with thermal and magnetic overload units to each phase, both of which shall be adjustable. The magnetic elements shall trip the breaker instantaneously if the circuit exceeds the setting.

Operation of air circuit breakers shall be by means of a spring assisted mechanism which shall prevent the possibility of slow closing or opening.

4.1.1.11 Provision for Locking

Padlocks or other approved locking arrangements shall be provided for locking each fused switch, switch fuse and isolator in the 'Open' and 'Closed' position.

All padlocks shall be non-ferrous, of an approved type and size to suit the equipment.

The padlocks or other locking devices fitted to circuit breakers, contactors or free issue equipment shall have differing locks.

A rack or cabinet shall be provided for installations in the switchroom for the accommodation of keys and padlocks when not in use and to house spare fuses.

Cabinets shall include glazed or steel doors, depending on their location and shall be provided with locking facilities. Each key shall be provided with a key label bearing the name of the circuit, the particular item to be locked and the code identifying it to its padlock. This wording shall be repeated on labels inside the key cabinet.

4.1.1.12 Instruments

All incoming services shall be provided with an Ammeter, a Voltmeter and a VAR meter. Where particular metering requirements have been requested to suit project requirements please refer to Section 2.

Ammeters shall be flush mounting pattern with rotary selector switches enabling phase and neutral currents to be read.

Voltmeters shall be flush mounting pattern with rotary selector switch enabling phase t neutral and phase to phase volts to be read.

VAR meters shall be of the time division multiplex type, flush mounted pattern.

The construction of instruments will be in accordance with the relevant British Standard and shall be of industrial grade.

## 4.1.2 Busbar Trunking Systems

### 4.1.2.1 General Requirements

Busbar systems shall comply with the British European Standard EN 60439-2 2000 and shall be installed in accordance with manufacturer's recommendations.

Busbar conductors shall be hard drawn, high conductivity copper to BS 1432 1987 and of suitable rating, with neutral conductor of the same cross sectional area as the phase conductor and provided with a dedicated copper circuit protective conductor.

All copper conductors shall be completely sleeved in non-hygroscopic insulating material and labelled.

The conductors shall be individually supported and each shall be capable of withstanding a prospective fault level of 50 kA for three seconds and shall be sheathed with non hygroscopic, self extinguishing insulation.

The conductors shall be housed in an extruded aluminium channel with side flanges and an interlocking front cover incorporating automatic shuttered outlets at a maximum of 500mm intervals. The minimum degree of protection shall be IP41 to British European Standard BSEN 60529 1992. However, more onerous environmental conditions may take precedence on this specification and particular reference maybe specified with Section 2 of the specification.

The busbar systems shall be of common manufacture utilising the manufacturer's proprietary bends and fittings. Made up fittings shall not be allowed.

The busbar distribution system shall be accredited to ASTA Certification.

Where the busbar system is wall mounted, this shall be achieved utilising a manufacturers' approved slotted channel fixing arrangement. Fixing of the busbar system to the slotted channel/specialist bracket shall be with manufacturer's recommended fixings. Anti-vibration mountings shall be fitted to prevent noise transmission through the fabric of the building.

The busbar installation shall be provided with internal fire barriers where passing through floors/wall and fire compartments. The fire barriers shall be of the intumescent gasket type with a 4 hour rating to BS 476.

The system shall also recognise the requirements for thermal expansion and suitable facilities shall be provided where long straight runs exist. Manufacturer's guidelines shall be followed in this respect.

The tap-off outlets shall incorporate non-detachable cover preventing access to the busbars when not in use. Where the installation utilises both essential and non-essential systems, the busbars shall have uniquely coded tap-offs and corresponding plug-in accessories.

4.1.2.2 Tap-off Units

Tap-off units shall be a common manufacturer to the busbar unit.

All tap-off units shall be of the switched interlock pattern and it shall not be possible to remove the tap-off unit when in the 'On' position.

Where tap-off units utilise fuses, these shall be of the BS 88, and access to these shall only be possible when the fuses are isolated.

The tap-off box shall be arranged to ensure that in the event of removal or insertion, the unit is connected to earth before contact is made with live busbars.

4.1.3 Distribution Boards

Distribution boards shall be manufactured to British Standard 5486 Part 11 and 12, and have an Ingress Protection Rating of minimum IP 31 to BSEN 60529 unless otherwise stated.

Each board shall be soundly constructed of sheet steel of not less than 1.5mm thickness with a hinged door, hung by means of internally fixed hinges. The construction shall be designed to avoid the door 'sagging' when opened and shall be provided with a positive acting door handle or catch device on the front of the door. When closed the board and assembly shall be entirely free from external lugs or protrusions. All distribution boards and doors shall have radiused edges.

Each distribution board shall have an integral isolator or fused switch. The isolators and/or fused switches shall be rated to at least the same amperage as the controlling distribution board fuseway or controlling fuse switch.

All live terminals or parts shall be shrouded to ensure that it is impossible for any live metal to be touched whilst withdrawing or replacing fuse carriers.

The neutral bars in distribution boards shall have the equivalent number of outgoing ways as there are single pole ways. Where TP&N boards are used to feed single phase circuits three such connections shall be provided for each way.

All distribution boards shall have a minimum of 15% spare unused outgoing ways. All unused ways are to be fitted with fuse cartridges/circuit breakers as appropriate. Distribution boards shall be complete with locks (to the building/site standard where appropriate) on the distribution board cover and all such locks shall have a single common key, duplicates (2 sets) of which shall be handed over to the employer on practical completion.

4.1.4 Fuses

4.1.4.1 General

All fuses shall be of common manufacture and shall be installed within carriers in such a way as to allow the rating and category to be ascertained without necessitating their withdrawal.

4.1.4.2 Switchgear – Fuse Switch Units

All fuses located in switchgear or motor control centres shall be HRC type fuses suitably sized to meet the design parameters.

They shall be ASTA Certified for compliance with BS EN 60269-2 1995 for category of duty 550, AC 80.

4.1.4.3 Cartridge Fuses

All fuses installed within 13 amp plug tops, fused connection units etc, shall be cartridge fuse links rated at 240V ASTA certified for compliance with BS1362 or BS2950 as required by the service to which they are dedicated.

4.1.5 Moulded Case Circuit Breakers

Where moulded circuit breakers are used they shall be of the type and rating necessary to suit the service.

Moulded case circuit breakers shall comply with BSEN 60947 parts 1, 2 and 3 and with an operational voltage of 415V. Unless otherwise indicated the short circuit breaking capacity shall be 50KA.

The mechanism shall positively indicate the true position of the toggle/operating switch. The toggle/operating handle shall be designed to facilitate means to lock the padlock in the on/off position. The lock mechanism shall not inhibit the trip mechanism to operate under the respective fault condition.

Where the MCCB is located remote to a fully type test assembly the unit shall be located within a sheet steel enclosure to afford a minimum protected to IP40. The thermal and magnetic settings on the MCCBs shall be adjustable, but means shall be provided to ensure that this can only be carried out by means of a special tool.

The MCCBs may be required to incorporate integral remote tripping facilities and this information shall be checked prior to ordering.

4.1.5.1 Miniature Circuit Breakers

Where miniature circuit breakers are used, they shall be of the type and rating necessary to suit the service.

Miniature circuit breakers shall conform to BSEN 60947-2 and afford a minimum fault breaking capacity of M9 (9KA lcn) to BSEN 60-898 1cn.

Unless otherwise indicated miniature circuit breakers shall be selected to suit the following load characteristics:

Type B / 2 - Commercial, domestic and industrial small power applications.
Type C / 3 - Commercial and industrial applications with moderate inrush circuits – i.e. fluorescent lighting applications with

high frequency controllers.

Type D / - Commercial and industrial applications with high inrush currents – i.e. motor protection, transformers and specialist lighting systems.

All circuit breakers shall positively indicate the true position of their main contacts directly on the toggle handle. All toggle/operating handles shall be designed to facilitate means to lock the padlock in the on/off position. The padlocking means shall not inhibit the trip mechanism to operate under all respective short circuit or overload condition.

All MCBs shall be of the single pole pattern (SPN) triple pole pattern (according to supply voltage) unless otherwise indicated within the specification.

Where small power circuits are selected to incorporate residual current devices this shall be integral to the circuit breaker (RCBO). The device shall be a clip on attachment to the protective device and shall not utilise a module on the distribution board.

All (RCBO) devices shall be rated to a sensitivity of 30ms and m/A, unless otherwise indicated.

General the ratings of the MCBs shall be as follows unless otherwise indicated:

| | |
|---|---|
| Small power – ring circuits | 32A |
| Lighting circuits | 10A |
| Fixed equipment – radial | To suit running current |

4.1.6 Fused Switches, Switch Fuses, Switch Disconnectors and Fuse Combination Units

Fuse switches, switch fuses, switch disconnectors and fuse combination units shall be manufactured to British and European Standard BSEN 60947-3 (2006) of the prospective fault, quick make/load break type with a quick acting, spring assisted mechanism.

Switch mechanism shall be located on a gasketed door to afford a minimum protection of IP41.

All fused switches, switch fuses and isolators shall be hand operated, SP&N/DP, TP&N and four-pole, as required. Fuses shall be HRC and where required solid links shall be fitted.

The neutral contact shall be arranged to be switched and must make before, and break later than the phase contacts.

Each unit shall be fitted with all necessary terminal shrouds, earthing connections etc, and shall be painted to the specified colour finish. All units shall be selected to have positive on/off indication, with facilities for

padlocking in the selected position. General isolators to mechanical plant shall be to AC23 Classification with auxiliary control circuit early break/late make contact.

Devices shall be installed to allow adequate clearance to allow safe operation and shall not be obscured in any manner. The devices shall be located as close as reasonably practical to the field device/equipment. Where structural walls are not available, free standing, custom made galvanised steel channel framework shall be provided.

4.1.7 Contactors and Motor Starters

Contactors and motor starters shall comply with British European Standard BSEN 60947-4-1 (2006), IEC 947-4-1 and VDE 0660 and where specified remote from the associated distribution board shall be mounted in robust dust proof sheet metal cases to a minimum Ingress Protection rating of IP54 with hinged and/or bolted covers and be suitable for surface or switchboard mounting as required. All contactors and motor starters shall be provided with an earthing terminal.

Contactor units shall be ASTA certified and fully type tested to comply with BS EN 60947-4. All contactor units shall provide a minimum type 2 co-ordination as defined under BS EN 60947-4. Documentation shall be produced where requested by the employer's engineering representative.

Contactors shall be rated at a minimum of AC3 duty for normal operation.

The duty and rating of contactors shall also be suitable for intermittent or continuous use and where necessary shall be suitable for a service which may require the contacts to remain open for long periods.

The contactors shall be capable of withstanding the fault rating of the system when protected by HRC fuses. The HRC fuses shall form part of a fuse switch where isolation is required. Fuses shall always be installed on the live side of the contactor.

Contactors shall be magnetically operated clapper or block type and suitable for remote control operation.

Where the operating coil and/or auxiliary contacts are fed from external source voltages, the isolator controlling the contactor shall have fitted the additional switch poles to completely isolate the contactor.

## 4.2 Cable and Cable Installations

### 4.2.1 General

All the clauses in this section of the specification shall apply to all types of cable used throughout the installation as applicable.

### 4.2.2 Cable Type

Each type of cable used throughout the installation shall be supplied by one manufacturer only.

All cables shall comply to the relevant British Standard and shall be certified 'Approved' by the British Approval Service for Electric Cables (BASEC).

Conductors shall be stranded copper.

Where multicore cables are used, the neutral conductor shall have the same cross-sectional area as the phase conductors. The insulation of the conductors shall be suitable for the applied voltage.

The following types of wiring systems shall be used for power circuits and controls

1. Armoured XLPE low smoke and fume cable 600/1000v.

2. Single-core, stranded, thermoplastic insulated low smoke and fume cables in conduit/trunking.

3. MICS cable.

4. Screened cable. Screened cable as required to protect signals and the memory of microprocessor equipment.

5. High temperature cables. In all areas of high ambient temperature where a conduit installation is employed, all cables shall be high temperature type suitable for the application. This applies to all areas through which cables pass or connections are required to equipment where the local ambient temperature is in excess of $40^0$C.

### 4.2.3 Cable Handling

#### 4.2.3.1 In Transit

Cable drums shall at all times be carefully handled at all times, and handled/carried in accordance with the manufacturer's recommendations.

Where cables have been damaged in transit, these shall be rejected and replaced.

4.2.3.2 In Storage

Cables awaiting installation shall be securely stored at normal temperatures. Cables not on purpose-built drums shall be coiled neatly, taking into account any limitations of bend radius and shall be protected against mechanical damage. Cable ends shall be sealed to prevent ingress of moisture. Reference shall be made to the appropriate part of this specification as regards 'sealing'.

4.2.3.3 During Installation

Cables shall be carefully handled during installation to avoid damage of any kind. Repeated bending shall be avoided. Sharp kinks shall be avoided in unreeling, uncoiling and pulling. Cables in riser shafts or ducts shall be lowered down from the top and hot pulled up from the bottom.

All cables shall be installed in accordance with manufacturers' recommendations and IEE Wiring Regulations. Cables shall only be installed when both the cable and the ambient temperatures are suitable.

The pulling of cabling into conduits or ducts shall be carried out with all possible care and shall be set up in such a manner that the cable may be pulled into the conduit or duct as directly as possible, with the minimum of changes of direction or of bending. The cable route termination shall be provided with a suitable protector to guard against damage to the insulation or sheath.

Long lengths of cable shall be laid using an adequate number of drum jacks, rollers and other handling accessories. Make-shift arrangements will not be acceptable. In all cases care shall be taken to brake the rotation of the drum and cables shall not be dragged over loose earth, concrete or any surface detrimental to the insulation. Cables shall not be stretched in any way but shall be adequately supported on rollers or manhandled into position. The labour force shall be sufficiently numerous and distributed along the length of the cable during installation so as to prevent any kind of damage whatsoever to the cable.

Before cables are pulled through ducts, the ducts shall be checked for cleanliness and smoothness. Where ducting is longer than 2.0 metres, a cable stocking shall be used to attach the cable to the draw-in rope.

The minimum bending radii shall be not less than that recommended by the cable manufacturer.

Spacing between cables shall be suitable for the de-rating factors applied to the cable installation design.

Cables shall be installed using the loop-in principle, no straight through or tee joints will be permitted except where allowed by the architect/employer's representative.

Particular attention shall be paid to the programming and co-ordination of the works with all other trades. Should it become necessary to install any parts of

the wiring system in locations where there is a possibility of damage due to other activities, suitable precautions shall be taken to prevent any damage. Cables shall not be exposed in areas where flame cutting, welding or grinding is taking place.

4.2.4 Cable Routing

The general route of all cables shall be indicated on the contract working drawings. The final cable route and length shall allow for all deviations required to set around columns etc, as dictated by the building structure and other services. The final routes of all cables shall be submitted to the architect/employer's representative for approval/agreement before cable installation work commences and in good time to satisfy the requirement of the contract programme.

Cable shall be installed with a minimum of 300 mm clearance from any equipment or pipework including lagging associated with other services. Where this condition is unavoidable or difficult to maintain, the architect/employer's representative's consent shall be obtained in writing prior to the installation being commenced, otherwise it may be necessary to divert or adjust the route of any cable so affected.

Where cables are situated below floor level in sub-stations and switch rooms, they shall be run either in formed concrete open ducts or under fire resisting false flooring. Under no circumstances shall cables be buried directly in concrete flooring or foundations.

Where cables pass through holes in panels or other metalwork, they shall be protected by rubber grommets, compression glands or their equivalent.

Where cables are run vertically heavy gauge sheet metal guards shall be supplied and fixed to the underneath side of the appropriate end dividing box or to a height of 1500 mm above the finished floor level. Detailed drawings showing dimensions and method of manufacture of the cable guards shall be submitted to the architect/employer's representative.

4.2.5 Segregation

Cables of different voltages and duties shall be segregated and particular attention shall be paid to the avoidance of induced electromagnetic interference due to high load currents and/or switching surges. All systems installed shall be arranged to ensure that such disturbances are avoided including the provision of such safety apparatus as necessary to protect equipment from extraneous electromagnetic interference.

All wiring associated with the mechanical services shall be run in independent wireways and on no account shall be mixed with other general electrical supplies and circuits.

## 4.2.6 Cable Jointing

### 4.2.6.1 General

Cables shall not be jointed other than at their proper termination points at the beginning and end of each run.

### 4.2.6.2 Sealing Cable Ends

Cables shall only be cut immediately prior to jointing taking place. Where jointing is delayed, cable ends shall be protected against deterioration due to moisture ingress and/or mechanical damage.

For long term sealing of non-hygroscopic cables a Denso-type seal shall be employed.

Magnesia insulated cables shall be sealed by means of the ends being dipped in hot bitumastic compound and overwrapped with Denso tape or with heat shrink capping.

## 4.2.7 Terminations

All connections throughout the installation shall be so arranged that all cables terminate by one of the following methods unless indicated elsewhere within the Specification.

i. Crimped lugs of appropriate size.
ii. Pillar type terminals of approved make and size.
iii. Clamp type patented appropriate spade tag and compression fitting.
iv. For termination at motor control centres refer to ME3.00.

For all single connections the conductors shall be doubled or twisted back on themselves and the connection shall be so made as to preclude the possibility of the pinching screws cutting the conductors.

When more than one conductor is to be terminated in the same connection, the conductors shall be firmly twisted before the connection is made. No bare conductors shall be visible.

Where butyl or silicone rubber insulated cables are used, the last 12mm of tape and braid shall be stripped from the ends. Care shall be taken to avoid damaging the insulation during this operation.

The cross sectional area of stranded conductors shall not be reduced. Terminations with the conductor strands or conductor area accidentally cut during stripping operations shall be rejected and re-made.

All connections to busbars except where otherwise specified shall be by means of suitable sized cable sockets and busbar clamps.

Where connections are made to motors or equipment subject to vibration, all terminations shall be complete with plain washers backed with shakeproof washers.

4.2.8 Cable Colour Coding

All new build projects shall be installed to the following schedule unless otherwise indicated by the employers representative.

The cores of all conductors and PVC/XLPE (low smoke and fume), and butyl cables shall be identified in accordance with the following table:

Table A
Identification Coding for Electrical Conductors and Cables – European Directive

| CONDUCTORS | COLOUR | LETTER OR SIGN |
|---|---|---|
| 3 ph 4 wire | Brown, Black, Grey, Blue | L1, L2, L3, N |
| 3 ph 3 wire | Brown, Black, Grey | L1, L2, L3 |
| 1 ph 2 wire | Brown | L1 |
| Neutral (230V) | Blue | N |
| Neutral (400V) | Blue | N |
| Protective/Conductor | Green and Yellow | E |
| (BMS Field Wiring), (AC/DC Control Voltages), (12/24V unless otherwise stated) | Grey for live and white for return connections. | As selected |
| Positive | White with Red Ferrule | As selected |
| Negative | White with Blue Ferrule | As selected |
| Midwire | White and Black Ferrule | As selected |
| Earth Connection | Green and Yellow | As selected |

4.2.9 Cables Installed in Conduits and Trunking

4.2.9.1 General

All cables for lighting, small power, and auxiliary services, including low and extra low voltages shall be multi-stranded single core LSF, butyl, or silicone insulated as required of 600/1000 volt grade to the relevant specification having stranded copper conductors.

All cables shall be colour coded in accordance with the current edition of BS 7671 and particular colour code section of this specification.

Cables shall be contained within a protective enclosure throughout their whole length of a size not less than that complying with the latest edition of the IEE On-Site Guide and such enclosures shall be tested for earth continuity prior to the installation of any cable.

4.2.9.2 Bunching of Cables Etc

The number of cables installed in any one conduit or run of trunking shall be limited to be in accordance with the latest edition of the IEE On-Site Guide

and the maximum permitted numbers shall be calculated in accordance with that document.

Cables installed in conduits and trunking shall be so bunched that the cables of all phases and the neutral, if any, are drawn into the same conduit. Not less than two single core cables shall be enclosed in any one conduit or trunking compartment.

Where cables are bunched in trunking they shall be grouped in their respective circuits or services and bound by means of nylon cable straps at 1.0 metre intervals to provide easy means of identification. Pin racks shall also be employed to segregate groups of cables.

Cables in multi-compartment trunking or similar shall be installed only in the compartment allocated for the particular type of service and in each case sufficient slack length of cable shall be provided to permit easy insertion and removal of the cable separators.

4.2.10 Cable Installed on Support Systems

4.2.10.1 General

The method of fixing cables shall be either laid on metal cable tray or supported by cleats where permitted by the BS 7671 latest edition and approved by the architect/employer's representative. Otherwise cables shall be installed in conduit or metal trunking systems.

4.2.10.2 Cleats

Cable cleats shall be of either non-ferrous metal, or plastic material, claw or split clamp type suitable for the size and type of cable and shall be so selected so that all cleats can be tightened down without exerting undue pressure or strain on the cables.

In the case of vertical cables the cleats shall be so designed and of sufficient number to grip the cable firmly to prevent creeping. No cable shall be run without fixings. Cable hangers and rack details shall be submitted to the architect/employer's representative for comment prior to the installation of cables. Where cable routes are subject to numerous changes in level and direction, additional cable hangers shall be provided to satisfactorily negotiate all such obstructions.

Cables shall be supported or fixed throughout their entire length with fixings being spaced in accordance with the latest edition of the IEE On-Site Guide or to the manufacturer's recommendations, whichever gives the lesser spacing distance. Sagging cables or stress on any cable caused by wrongly positioned or inadequately spaced fixings shall not be acceptable.

Cleats shall be fixed by means of suitably sized rawlbolt type fixings, with backstraps where necessary.

4.2.10.3 Fixing Arrangements

Cables shall be fixed to ladder racking, cable support work or cable bridges by means of clamps or cleats on galvanised mild steel studding. The cleats shall be spaced at not more than 500mm for cables having overall diameters up to and including 40mm and at not more than 1000mm for cables having overall diameters exceeding 40mm.

4.2.11 Cables through Walls and Floors

Single cables passing through walls and floors shall be protected by means of tubular non-combustible sleeves of sufficient size to give 12.5mm clearance all round the cable. Sleeves passing through floors shall protrude above the finished floor level by not less than 40mm. Where passing through walls the sleeve shall finish flush with the finished surface.

All sleeves shall be tightly packed with suitable fire resistant materials of an approved type after cables have been installed. For multiple cables purpose made cable transfer boxes shall be used. All cable sleeves and transfer boxes shall be provided. All fire stopping between the cable(s) and the sleeves or in transfer boxes shall be carried out as necessary to achieve the required fire rating.

4.2.12 PVC/XLPE/LSZH (Low Smoke Zero Halogen) Insulated Cables

4.2.12.1 General

All power cables shall have copper conductors and the insulation to the cores shall be identified in full compliance with British Standard 7671, latest edition.

All multicore power, pilot and control cables shall have galvanised steel wire armouring complying with the relevant British Standard. Single core cables shall have aluminium wire armour.

4.2.12.2 Armoured Cable Terminations

All PVC/XLPE/LSZH cables shall be terminated in the cable manufacturer's approved glands. These shall be of the compression type providing controlled radial compression of the sheath seal. The gland bodies shall be made from brass having neoprene inner and outer washers for non-metal sheathed cables and lead for metal sheathed cables other than copper sheathed cables. The gland shall incorporate an armour clamping 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 together with rubber compression ring to provide a seal between the gland and the PVC sheathing. All glands for use with metal sheathed cables shall be provided with copper (self colour) earth tags.

All gland terminations shall be protected by a suitable shroud, which shall fit tightly over the cable and the end of the cable. The shroud shall be slipped over the cable before the gland is fitted.

When using single core armoured cables for individual circuits, the armouring of each set of circuit cables shall be bonded at both ends of the run and be

terminated on an approved non-ferrous gland plate on the switchgear to prevent overheating.

When terminations are made off into tapped boxes, a coupler with compression washer between the coupler and box shall be used and secured by a male brass bush, the gland shall then be screwed into the coupler and locked tight.

4.2.12.3 Termination of Cores

The conductor insulation shall be stripped to allow adequate termination of the conductor, but excessive stripping such that the bare conductors protrude from the insulating shroud of terminations shall not be allowed. The conductor strands shall not be 'nicked' or 'scored' such that their mechanical or electrical characteristics are reduced and such nicked or scored cable ends shall be unacceptable and removed and remade.

Where conductors are directly connected into terminal pillars, these shall be arranged to ensure that the internal walls are clean and free from burrs and that the clamping screw ends are profiled to prevent damage to the conductor. The lay and route of l cable conductors is to be such that undue strain is not applied to support or post structures or to the cores themselves.

Where it is necessary to terminate cores under the heads of screws, purpose made ring terminals or lugs shall be used.

Where stud terminals are provided, the conductor shall be terminated by means of a cable lug suitably sized for the conductor shape, cross-sectional area and stud threaded size. Flat washers shall be provided between the lug and securing nut to ensure adequate electrical contact.

The use of soldered lugs will not be permitted.

Under no circumstances shall a lug be used to terminate a core of larger size than recommended by the manufacturer of the lug.

Compression-indented lugs must make complete and full contact with the cable and are to be fixed by the manufacturer's crimping tools, applied in strict compliance with the manufacturer's recommendations.

Cable lugs shall be of the indented compression type selected to match the conductor profile.

Compression terminations for copper conductors shall be manufactured from seamless copper tube, tin plated to resist corrosion and maintain low contact resistance and shall comply with British Standard 4579: Part (1988).

Where the ambient temperature at terminations exceeds the characteristics of the cable insulation heat resistant sleeving shall be used, otherwise cable tails of the appropriate temperature rating shall be employed.

## 4.2.13 Mineral Insulated Copper Sheathed Cables (MICS)

### 4.2.13.1 General

MICS cable shall comply with British Standard 6207 B (1995), Parts 1 and 2, and shall be supplied only by an approved Manufacturer.

All MICS cables shall be not less than the 1000 Volt grade except for single phase and low voltage circuits where they shall not be less than the 660 Volt grade. MICS cables shall be PVC sheathed overall where they are used in the following conditions or situations such sheathing shall be of (LSF) disposition.

i. Exposed to the external elements or in damp or corrosive conditions (sheathed ORANGE)

ii. Installed in plant rooms or service ducts (sheathed ORANGE).

iii. Buried underground or in screed or plaster (sheathed ORANGE).

iv. Subject to galvanic action or electrolytic corrosion (sheathed ORANGE)

v. Fire alarm and detection systems (sheathed RED)

vi. Security systems (sheathed WHITE)

MICS cables shall not be installed on cable trays or in contact with a different metal unless they are sheathed and protected.

MICS cables shall be fixed, supported and terminated in accordance with the following schedule unless otherwise recommended by the manufacturer. Where there is a possibility of vibration or fatigue fractures occurring such as when connected to motors, a ‘pig tail’ loop shall be provided.

| Overall Diameter of Cable mm | Maximum Spacing of Fixings | |
|---|---|---|
| | Horizontal mm | Vertical mm |
| Not exceeding 9 | 600 | 800 |
| Exceeding 9 and not exceeding 15 | 900 | 1200 |
| Exceeding 15 and not exceeding 20 | 1500 | 2000 |
| Exceeding 20 and not exceeding 40 | 2000 | 3000 |

Cable glands, seals and associated accessories shall be purchased from the manufacturer of the cables.

The manufacturer’s recommended standard tools shall be used for making off all terminations and bending or straightening of cables.

### 4.2.13.2 Seals and Terminations

All MICS cables shall include a dedicated circuit protective conductor and not rely on the sheath.

The making off of all cable terminations shall be in accordance with the manufacturer's recommendations.

Terminations shall have standard screw-on wedge type seals, cold plastic compound and neoprene or other approved sleeving. Universal ring type glands fitted with brass locknuts shall be used at terminations but where restriction of space within boxes or boards etc occur, a 'space saving' gland shall be used, which in turn shall be fixed to the unit by means of a brass male bush, complete with compression washers.

'High Temperature' terminations shall be used as required for the 'in-service' environmental conditions.

Where MICS cable is required to be flameproof then glands of an approved flameproof type shall be used.

Coloured identification sleeving in addition to the normal insulating sleeving shall be fitted in all cases to indicate phase colours.

Where PVC sheathed cables are used, PVC shrouds of the same colour as the sheathing shall be fitted to gland terminations.

Heat resisting sleeving shall be used where the installation may be affected by high temperature.

4.2.13.3 Installation Arrangements

Cabling run in building finishes shall be immediately protected to ensure that no damage or displacement occurs.

Cables shall be installed parallel to the building lines and shall not be run diagonally on floor, wall or ceiling finishes.

Cables shall be straightened and dressed neatly on the runs by approved methods. All bends shall have an inside radius of not less than six times the overall diameter of the cable and shall be made with the aid of bending tools.

Cables shall be secured by PVC coated metal clips or saddles of the correct sizes to fit the diameter of the sheath and number of cables. Single cables shall be secured by PVC coated spacer bar saddles. Multiway saddles shall be used whenever multi-cables runs occur.

Where Multi-runs of cables occur in certain areas such as plant rooms they shall be fixed to cable trays.

The fixing of clips and saddles shall conform to that for conduit installations except that brass round-headed screws shall be used.

4.2.14 Flexible Cords and Cables

4.2.14.1 General

The use and type of flexible cables or cords shall be to suit the application.

Cables shall be butyl, silicone, PVC or impregnated glass fibre insulated as necessary for the particular application. The cables shall be suitably sized, with a rating not less than the protective device of the particular circuit, unless exempted by IEE Wiring Regulations latest edition and, in any case shall not be less than 0.75mm$^2$ (24/00.20mm diameter) with a voltage grading of 300/500 volts.

4.2.14.2 Extent of Use

Flexible cables and cores shall be used for pendant luminaires, LCM wiring, adjustable lamps, portable appliances and certain items of special equipment.

The cables shall have the correct number of cores necessary for the particular connection and a strain cord shall be included where necessary to obviate the possibility of excess weight being carried on the conductors. The earth conductor shall be of sufficient length to ensure that undue stress is not placed upon it.

No flexible cable, other than that enclosed in conduits etc, shall be in excess of 3 metres in length.

4.2.14.3 Heat Resistant Cables

Flexible cables for use with heating appliances or luminaires shall be heat resistant of silicone, butyl or equal and approved construction.

4.2.14.4 Low Smoke and Fume (LSZH) BSEN 6387 Flame Retardant Cables

4.2.14.5 General

Where indicated within Section 2, BSEN 6387 LSZH fire rated cables may be permitted in conjunction with fire detection or annunciation systems.

The cable selected shall comply with the testing and performance category CWZ as defined within BS 6387 B (2005).

The tests confirm compliance with respect to:

Resistance to fire alarm – 3 hours at 950$^o$C Category C

Resistance to fire with water – 15 minutes at 650$^o$C plus 15 minutes with water spray Category W

Resistance to fire with mechanical shock – 15 minutes at 950$^o$C Category Z

Coloured cable oversheaths shall be low smoke zero-halogen and selected to reflect:

(i) Red – fire alarms
(ii) White – Emergency annunciation and evacuation systems
(iii) Grey – Control systems or security systems

4.2.14.6 Installation Arrangements

To avoid damage to and twisting of the cable, the reel should be mounted on a suitable spindle placed through the centre of the reel and the cable pulled off. Care should be taken in dressing off cable by hand into final position on walls or ceilings especially when passing around corners.

The minimum bending radius for the zero-halogen low-smoke cable shall not exceed 6 x D, where D is the nominal cable diameter given in the table of physical data.

Cables shall be fixed direct to a surface using purpose designed coloured zero-halogen low-smoke coated copper 'P' clips. On installation where cables are fastened to the cable trays or similar structures, stainless steel cable ties shall be used.

Cables fixed direct to the building fabric shall be installed in accordance with the following recommendation:

| Cable Diameter (mm) | Maximum Spacing | |
|---|---|---|
| | Horizontal (mm) | Vertical (mm) |
| Not exceeding 9mm | 250 | 400 |
| Exceeding 9mm but not exceeding 15mm | 300 | 400 |
| Exceeding 15mm but not exceeding 20mm | 350 | 450 |

4.2.14.7 Seals and Termination

With silicone rubber being an inherently weak material, damage to the insulated cores can be avoided by the following preparation procedure:

For easy removal of the sheath, make a continuous circular score mark around the cable, being careful not to penetrate through to the screen. Then, by bending the cable at this point the sheath will separate, which can then easily be removed by sliding the sheath over the screen. Using this method, up to 100mm of sheath at a time can be stripped from the cable leaving no sharp edges.

4.2.14.8 Final Termination

Care must be taken to ensure that the insulated cores are not 'pinched' or damaged when making final termination. When encountering limited space or vibration inside termination boxes OHLS clear sleeving shall be fitted over individual cores including the earth continuity conductor.

4.2.14.9 Glands

In normal conditions of use entry to fittings should be through Type A2 brass or zero halogen low smoke polymeric glands.

In totally dry conditions ordinary grommets can be used as entry to fittings.

## 4.3 Cable Support Systems

### 4.3.1 Cable Trays

Cable trays shall be of sufficient width to accommodate all cables without crowding and shall allow for future additions to the proportion of 25% of present requirements. Cables shall be run singly and stacking shall not be permitted.

Purpose made tray fittings, including branches, reducers, flat elbows, tees, and crosses, shall be used for changes in direction and elevation. The dimensions of tray fittings shall provide ample bending radii for the cables contained on them for all changes in tray direction.

Trays shall be carefully aligned and levelled plumb and true. Tray sections and fittings shall be assembled on their supports and joined together, using the manufacturer's standard connector units, properly aligned and secured. Sufficient space shall be allowed behind the cable tray to allow the insertion of tools for the tightening up of nuts.

Steel angles, trapeze hangers, channels, bolting and miscellaneous materials required for the support of trays from the building structure, shall be furnished and installed. Additional supports as required, shall also be provided for individual cables where the cables leave trays before reaching their final termination. All support systems shall be provided with end caps and channel lids, with drop rod threads out to within 2mm of the fixing bolt.

Cable trays shall only be installed on a structure that is capable of supporting the tray and its load, and of providing secure fixings. Any secondary or supplementary support framework shall be provided as necessary and supporting calculations submitted if so requested by the employer's representative.

Suitable protection by means of grommets to the relevant British Standard shall be provided where holes have been cut to allow cables to pass through.

Cable trays shall be of the conventional galvanised perforated pattern with upturned lips of the following mild steel material thickness:

| | |
|---|---|
| Up to 100 mm width: | 1.0 mm |
| From 100 mm to 150 mm in width: | 1.25 mm |
| Above 150 mm in width: | 1.6 mm |

The entire cable tray shall be bonded and copper links shall be bolted across each joint in the system by means of brass nuts and bolts, complete with flat and spring washers.

Cables on trays shall be fixed by PVC covered saddles or suitable non-corroding straps, or cable ties spaced in accordance with the IEE Wiring Regulations latest edition for vertical trays and shall not be more than 500 mm apart on horizontal runs of tray. In areas where temperatures are likely to be detrimental to PVC coatings, the cables shall be fixed by means of galvanised metal saddles and clips. Brass screws, bolts, nuts etc shall be used.

All cables are to be run with particular regard to neatness of appearance. Multiple runs are to be arranged so that cables entering or leaving the run do so in a logical manner and the crossing/overlapping of cables shall not be permitted.

4.3.2 Cable Ladder Racking

Cable ladder support systems shall be of heavy duty manufacture from thick mild steel, hot dipped extra thick galvanised in accordance with British Standard 729. The ladder system shall be of common manufacture and installed utilising manufacturer's approved fixing and support steelwork.

The ladder system shall be supported at 600mm centres and within 150mm at any change of direction whether vertically or horizontally.

The systems shall consist of prefabricated accessories such as bends, risers etc and shall be electrically and mechanically continuous throughout.

The ladder racking shall generally consist of rungs at 300mm centres.

If Unistrut or other proprietary channel system is used then all ends shall be sealed using PVC caps and open channel faces shall be sealed using PVC lids.

## 4.4 Conduits and Accessories

### 4.4.1 Conduits

All conduits shall be of heavy gauge metal, seam welded or screwed electrical thread, manufactured in accordance with British Standard 31 (1987) and British European Standard BSEN 50086-1 (2004) and shall not, unless otherwise stated, be less than 20mm diameter.

Conduit systems installed shall either be Class 4 hot dipped galvanised Class 2 or black enamelled unless otherwise stated and be suitable for the surrounding environment. Classification of external influences can be found in Appendix 5 of British Standard 7671, latest edition.

In plant rooms all conduit shall be galvanised. Where conduit is installed in a building prior to the building being weather tight, sealed and dry only Class 4 hot dipped galvanised conduit shall be used.

All conduits shall be so sized to enable easy ‘draw in’ and ‘out’ of all the cables within the conduits. The number of conductors shall not exceed that laid down in the latest edition of British Standard 7671.

Care shall be taken to ensure that all conduits are adequately protected whilst stored on site prior to erection. No damaged conduit shall be used. Conduits shall be stored on a covered rack at all times.

All conduit ends shall be reamed and filed to remove rough edges, and inside surfaces of conduits shall be left smooth and free from burrs and all other defects.

Conduits showing traces of rust shall be wire brushed and painted with an approved suitable protective paint.

### 4.4.2 Conduit Accessories

#### 4.4.2.1 General

All conduit accessories shall be Class 2 Black enamelled or Class 4 hot dipped galvanised to match the conduit installation selected and installed to meet the application.

Manufactured bends, solid or inspection elbows or tee-pieces shall not be permitted. The formation of conduit bends shall be site fabricated and provided with the appropriate draw points as prescribed in Section 4.4.5.1.

#### 4.4.2.2 Circular Boxes

Circular conduit boxes shall be made of malleable iron, complete with heavy or medium duty covers as specified and manufactured in accordance with the relevant British Standard and to the requirements of British Electrical Standards Association (BESA). All boxes shall be enamelled or galvanised to match the conduit used.

4.4.2.3 Loop-In Boxes

Loop-in boxes shall be of malleable iron and unless otherwise specified, the maximum number of entry holes shall be limited to three. Only in cases of necessity shall the use of four way loop-in boxes be permitted.

4.4.2.4 Adaptable Boxes

Adaptable boxes shall be of heavy gauge pressed steel where enamelled conduit is required and of galvanised cast iron where galvanised conduit is used.

The minimum size of box to be used shall be of 100mm square, by 50mm deep for cables up to 6mm$^2$, or conduit up to 25mm diameter, and not smaller than 150mm x 75mm x 75mm deep for larger cables or conduits.

Boxes of the weatherproof or watertight patterns, as applicable, shall be used in all situations exposed to dampness.

Overlapping box covers shall be provided and secured by brass round headed screws.

4.4.2.5 Stopping Plugs

The use of stopping plugs shall be kept to a minimum. Where their use is necessary they shall be of the hexagon headed type.

4.4.2.6 Brass Bushes

All bushes shall be manufactured from best quality brass. Male bushes shall be hexagon headed and of standard length.

4.4.2.7 Lock Nuts/Rings

Locknuts/rings shall be of the circular milled edge type or hexagonal pattern and of a material to match the item they are screwed to.

4.4.2.8 Couplings

Couplings shall be of the solid malleable iron type.

Threadless couplings and connections will not be permitted.

4.4.2.9 Compression Washers

Compression washers for ensuring continuity at conduit connections shall be the steel shake proof type.

4.4.2.10 Saddles

Saddles used to secure surface conduits inside the building shall be of the pressed steel spacer bar type. The saddle tops shall be fixed by means of round headed brass screws.

Saddles used to secure surface conduits run externally shall be galvanised 'distance' type.

All saddles used to secure flush conduits shall be of the single hole fixing type.

4.4.3 Method of Installing Conduit (General)

4.4.3.1 Preparation of Conduit

The inside surface and ends of conduits and fittings used in connection therewith, shall be smooth, cut square and free from burrs and all other defects. Reamers shall be used on the ends of all conduits after screw threads have been cut and all grease, enamel etc removed.

All threads shall be clean and free from rust.

Where threads are cut, tallow or other approved lubricant shall be used.

4.4.3.2 Erection

The conduit shall be properly and tightly screwed between the various lengths and to the boxes to which it runs and terminates, so that the wiring is continuously and effectively protected throughout its entire length. No part of the conduit shall be under mechanical stress and the whole conduit system shall be electrically and mechanically continuous throughout.

Corners shall be turned by means of easy bends or sets, made cold without altering the section or opening the seam. The radius of every conduit bend shall be such as to allow compliance of British Standard 7671 latest edition, for bends in cables, and in addition the inner radius of the bend shall not be less than 2.5 times the outside diameter of the conduit.

Where conduits are connected by means of a socket, the ends of the conduits shall butt together in the centre of the socket and except in the case of a running joint, no exposed threads shall be visible after erection.

Where the finish of the conduit is damaged during erection it shall be immediately made good with an approved metallic paint. All vice marks shall be removed and the conduit well protected where the galvanising or other specified finish has been damaged.

Where conduits terminate at a drilled hole entry, connection shall be made by means of a coupler and brass make hexagon bush. A serrated or compression washer shall be fitted between the bush and box to ensure good continuity.

4.4.3.3 Terminations at Sheet Metal Boxes etc

Where conduits terminate at trunking or sheet metal boxes of any type that are not provided with an integral cast spout, a coupling and male brass hexagon bush shall be used.

Where a number of conduits are brought to a central point of permanent access, pressed steel adaptable boxes shall be used. The boxes shall be of ample size to take all conduits without crowding. The conduits shall terminate by means of a socket bearing on the outside of the box, and a hexagon head smooth bore male brass bush screwed into the socket from the inside of the box, the bushing being made up sufficiently tight to draw the socket into firm electrical contact with the box.

4.4.3.4 Expansion Joints

Provisions shall be made at expansion joints, where they occur in a building structure, for approved conduits and finishes. Continuity through all such joints shall be maintained.

4.4.3.5 Contact with Other Services

All conduits shall be kept clear of other services except where intentionally earthed or bonded. Conduits shall be fixed to prevent contact at the following minimum spacings:

150 mm away from and below hot water and steam services.

50 mm away from all other services and where horizontal conduits are installed parallel with cold water pipes they shall, wherever possible, be run above such pipes.

4.4.3.6 Sealing Conduits

Where conduits are required to pass into or out of ducts between the inside and the outside of buildings or in any other positions where a considerable variation in temperature exists between sections of the building, free circulation of air must be prevented between the conduit system of each section by inserting plastic compound filled conduit boxes.

Plastic compound shall have the following properties:

i. It shall not affect the physical properties of the enclosed cable at any temperature.

ii. It shall have no detrimental effect on metals, porcelain, synthetic resins etc.

iii. It shall be waterproof and resistant to chemicals.

iv. It shall be unaffected by atmospheric and temperature extremes.

v. It shall remain plastic indefinitely.

vi. It shall have a high insulation quality.

4.4.3.7 Protection of Open Conduit Ends

Particular care shall be taken during the progress of the works to prevent the ingress of dirt and rubbish into erected conduits. Any run which has become clogged shall be entirely freed of accumulations or shall be replaced.

Screwed plastic or metal caps or turned wooden plugs shall be employed to protect open ends. Plugs of waste wood, paper or other fibrous matter shall not be used.

All unused conduit entries shall be blanked off. All removable box covers shall be firmly secured to provide a complete enclosure and must be fitted with neoprene gaskets in all damp, exposed or corrosive situations.

All conduit shall be dry and where necessary they shall be swabbed out by drawing dry swabs of rag through the conduit to remove all moisture prior to any cables being drawn in.

4.4.3.8 Completion Prior to Writing

All conduit installations must be completed and erected in their entirety before they are wired and must be fully rewirable from outlets to distribution boards or trunking systems etc. to which they are connected. Conduits installed for future wiring by others, draw wire shall be allowed.

4.4.4 Method of Installing Concealed Conduits

4.4.4.1 System

For concealed work, the whole of the conduit shall be installed in such a manner that rewiring can be carried out from the fitting boxes and switch boxes only.

4.4.4.2 Fixing Conduits and Accessories

Where concealed conduits are to be installed into walls and under floors etc, they shall be fixed by approved methods, using single hole fixing saddles, spaced not more than 900 mm apart and shall be firm against the structure along their length, without springing.

Switch boxes and socket boxes etc shall be securely fixed by means of steel screws and suitable plugs. They shall be firmly grouted in position prior to plastering or screeding.

Any light point or socket outlet boxes associated with conduits buried in concrete, shall not normally be fixed, but shall be held rigidly in position, in an approved manner, by the conduits before being grouted in.

Where conduits are concealed in wall chases, they shall be recessed in such a manner that they shall be firmly covered by the full thickness of plaster and/or rendering to a minimum depth of 12.5 mm.

4.4.4.3 Extension Collars

Extension collars of suitable depth shall be used as necessary to leave all boxes absolutely flush with the finished wall or ceiling surface.

4.4.4.4 Conduits in In-Situ Concrete and Floor Screeds

Conduits run in floors shall be installed in one or more of the following ways, as may be appropriate to the type of floor construction actually adopted:

i. In the middle third of the floor.
ii. In the screeding on top of the structural slab.
iii. Laid direct onto the shuttering.

Where conduits are specified to run in floor screeds, the proposed screed depths shall be carefully checked at the positions before installing conduits and shall wherever possible, arrange to cross conduits where there is ample thickness of screed. The conduits shall be securely fixed and provided with a minimum screed cover of 60mm.

Upon completion of the works, the route/location and cover depths shall be accurately recorded on the installation as fitted drawings.

Flush installations, conduit boxes for luminaires, switches and other accessories shall be installed to finish flush with the final surface.

4.4.4.5 Conduits in False Ceilings

In false ceilings, the conduits shall be fixed by conduit saddles to the soffit of the structural ceiling slab. Conduit boxes shall be independently supported by means of a separate fixing so that the box is held rigid.

Fixings to the hangers or framework of the false ceiling is not permitted.

4.4.5 Method of Installing Surface Conduits

4.4.5.1 System

Wherever conduits have to be run on the surface of walls or ceilings particular attention must be paid to neatness and all conduits shall be run in as inconspicuous a manner as possible.

Conduits shall be installed with draw boxes provided at regular 3 metre centre intervals. Not more than two site fabricated right angled bends shall be installed between boxes. Boxes installed in voids shall be accessible.

All exposed conduits shall be run parallel or perpendicular to walls or structural members with right angled turns consisting of boxes specified herein or symmetrical bends. Conduits exposed to the weather shall be so installed and equipped as to prevent water entering the conduit. All exposed threads shall be given two coats of rust preventative (zinc rich) paint.

Surface conduit shall be installed with running threads and sockets, secured by locknuts as required.

Conduit which has become crushed or deformed in any way shall not be acceptable and must be replaced.

The crossing of surface conduits shall not be permitted. Trunking shall be used in preference to a multiplicity of separate conduit runs.

4.4.5.2 Fixing of Conduits

The spacing of saddles shall be at 1.2 metre centres for 20 mm and 25 mm diameter conduits, and at 1.5 metre for conduit sizes of 32 mm diameter and above. In addition, saddles shall be fixed at each side of any bend or set. The saddles shall be secured by means of plated steel counter sunk screws and metal, plastic or rawlplug type plugs. In the case of galvanised installations, the screws shall be brass or sheradised. Fixings shall only be made to solid elements of construction. No fixing shall be made to building boards or to plaster. he holes in brickwork or concrete for fixing plugs shall be neatly drilled by means of a masonry drill of the appropriate size.

Where conduits are run on steelwork they will be fixed by means of purpose made clips.

4.4.5.3 Draining of Water

The installation programme shall be so arranged to ensure that the installation is not subjected to water penetration.

Conduit shall not be laid to falls. Suitable drainage holes shall be drilled in strategic places so that in the event of ingress of moisture or condensation taking place, water does not collect in the system. Where there is evidence of this event the conduit shall be internally 'wiped' to remove the settlement. This activity shall be completed prior to cabling. (See Clause 4.4.3.7).

4.4.5.4 Inspection Boxes etc

Small circular BESA boxes shall be used for inspection and point boxes on conduits, up to and including 25mm diameter. Where inspection boxes are necessary for conduits larger than 25 mm diameter, the trough pattern type shall be used.

Wherever several conduits are run together, adequately sized adaptable boxes, common to all runs shall be used, to avoid inserting inspection boxes in the individual runs. Where it is necessary to segregate wiring, metal fillets shall be securely fixed within the box.

4.4.5.5 Fixing of Boxes

All boxes, except those for external works, shall be securely fixed with screw fittings utilised at each fixing point provided within the accessory.

The fixing holes shall be suitable for countersunk screws, so that the screw heads do not project into the boxes and all screw driver burrs shall be removed before cables are drawn in.

For external work and other particular damp situations, weatherproof boxes with external fixing lugs shall be sued. In addition, to the external fixings, the boxes shall be supported by saddles spaced not more than 150 mm on each side of the box. Fixing holes shall not be drilled in the box.

4.4.5.6 Holes in Adaptable Boxes

Wherever boxes are drilled for conduit entry, the holes shall be positioned correctly to permit all conduits to enter without sets or bends of any description.

4.4.5.7 Hot Spots

In the case of conduits run to 'hot spots', e.g. Immersion heaters, room heaters, insert thermostats etc, a conduit box shall be fitted adjacent to the termination point and other flexible or solid conduit as required, shall continue to the final termination.

The box shall be suitable for use as a cable change box to facilitate change of wiring locally to the apparatus.

4.4.5.8 Terminations at Motors Etc.

Where conduit is used for final connection to motors or other equipment, subject to vibration, or thermostats mounted in pipelines, a minimum length of 450 mm of flexible conduit shall be used between the equipment and a through box at the end of the conduit run. Sufficient coils of motor cables shall be provided to enable 'tong test' readings to be taken in each conductor.

4.4.5.9 Flush to Surface

Flush conduits serving surface mounted equipment shall terminate at a flush box at the back of the equipment so that the flush box will be fully covered by the equipment. The means of fixing and the earthing arrangement shall be arranged as to be fully covered by such surface mounted equipment.

Alternatively a terminal extension box shall be fitted to the flush conduit box, and a break joint ring shall be fitted between boxes.

4.4.5.10 Flexible Conduit Systems

4.4.5.11 General

Where it is necessary to move equipment regularly for adjustment during normal operation and for final connections to motors, sensing heads and thermostats, conduit runs shall be made by means of flexible conduit of not less than 450 mm in length.

All flexible conduit shall be water tight and shall be of metal, sheathed externally with PVC, and all fittings shall be of the appropriate type and as recommended by the manufacturer.

4.4.5.12 Erection

Flexible conduits shall be installed in such a manner so that the conduit will be suspended naturally and that no stress will take place due to bends and sets being created against the lay of the conduit. The connections at both ends shall be by means of adapters fixed to the flexible conduit.

Flexible conduit shall not be used as the sole mans of providing earth continuity. A separate circuit protective conductor shall be provided.

## 4.5 Trunking Installations

### 4.5.1 Metal Trunking Systems

#### 4.5.1.1 General

Steel surface cable trunking shall be manufactured from galvanised sheet steel to British Standard 4678 Part I 1988.

Cable trunking runs shall consist of neatly butting sections manufactured from galvanised sheet steel not less than 1.6mm thick. In straight runs one section only shall be less than 2.0 metres in length.

Where multi-compartment trunking is used, the largest compartment shall determine the gauge of metal used.

The inside shall be free from sharp edges, burrs, fixing screws or any other projection liable to damage cable when open or after the cover has been fitted. Self tapping screws shall not be used with the trunking. Round head screws shall be used throughout for fixing.

All trunking including bends, tees and other accessories shall be supplied by the same manufacturer and shall be of similar sheet metal and finish. Accessories fabricated on site shall not be acceptable.

The trunking shall be fitted with overlapping, drip-proof, well fitted removable covers, screwed to the trunking with captive mushroom head screws. Screws and bolts securing covers to the trunking or fixing sections of the trunking together shall be arranged to prevent damage to the cables. Where trunking is used to connect switchgear and fuse boards such connections shall be made by trunking fittings manufactured for this purpose and not by multiple conduit connection couplings.

All trunking shall be provided with removable bridges to retain the cables and all vertical trunking shall be provided with pin racks to support the cables at a nominal spacing of 1.35 metres. The pins shall be insulated or provided with insulated sleeves.

#### 4.5.1.2 Fixing and Bonding

All trunking shall be installed parallel to building grid lines.

All lengths of cable trunking shall be independently fixed and supported to the building, and shall be rigidly supported throughout its length with purpose made expansion and settlement joints.

Where trunking passes through ceilings, floors and walls, the cover shall be fixed solid 150mm either side of the ceiling and floor and 25mm either side of walls. Outside these dimensions covers shall be removable.

All trunking shall be made electrically and mechanically continuous throughout. All joints shall be bonded together by means of copper bonding links bolted across each butt joint in the system. Connections shall be made by means of electroplated bolts and nuts of 6mm minimum diameter, with the head of the bolt inside the trunking and complete with spring and flat washers. All paint shall be removed under earth bonding to the nearest earth continuity conductor.

The trunking shall be installed so that the lid section is located on top, parallel to the building surface and serves to allow a minimum clearance for access and inspection. Where this is impractical or cannot be achieved with written authority, the trunking shall be installed on its side or inverted. When inverted, the lid shall be fitted with a chain or similar fixing method to withhold the lid when removed, in all instances cable retaining straps shall also be provided.

4.5.1.3 Multi-Compartment Trunking

Multi-compartment trunking or stepped arrangements of single compartment trunking shall be used wherever segregation of services wiring is necessary and shall be factory made.

Conductors for lighting, power and mains voltage socket outlets may be run in the same compartment of the cable trunking, but cables carrying low voltages shall be installed in a separate compartment of the cable trunking.

Segregation of circuits shall comply with Categories 1, 2 & 3 as determined by the latest edition of British Standard 7671.

4.5.1.4 Skirting Trunking

Skirting trunking where specified or utilised shall be fabricated from 1.6 mm mild steel zinc sheet and shall comprise a nominal 200 mm x 30 mm three compartment unit with lipped dividers. The trunking shall be supplied with one coat of primer and one coat of undercoat only ready for the application of finishing paint.

The contract works shall include for the forming of the required access holes on the rear of the skirting trunking to allow logical lining-up with the rear entry units.

At every location where the trunking changes direction, the appropriate inside and outside, factory corner units shall be installed. They shall be manufactured from the same gauge metal as the skirting trunking. The installation shall consist of the required number of such bends, tees and pier sets, which shall be manufactured to site dimensions to give a tight fit to building line.

Socket outlet assemblies and/or telephone outlets etc, shall be mounted on separate short lengths of the cover plate.

Covers shall be removable and 150mm fixed lengths shall be allowed on all partition lines.

4.5.1.5 Sizing of Trunking

Where trunking sizes are not specified, the size selected shall be the most economic size consistent with a minimum space factor of 35%.

4.5.1.6 Installation Requirements

All trunking shall be free from rust patches or other defects on delivery and protected from the weather by proper storage on site. Trunking shall be stored on a covered rack prior to installation.

Fire resisting barriers of suitable material shall be provided where vertical runs of trunking exceed 3.0 metres in length and also where trunking passes through fire barriers, floors and ceilings.

Before commencement of wiring, the trunking shall be cleaned out and any sharp edges, burrs and damaged enamelling removed, wire brushed to remove any rust or dirt and painted with cold galvanised primer and enamel finishing coat.

Where drilled boxes are connected to trunking, the connection shall be made using a male brass bush, locknut and female brass bush. A serrated or compression washer shall be fitted between the make brass bush and the trunking and between locknuts and box.

Care shall be taken to remove all paint (where appropriate) from around holes drilled in the trunking, for the connection of conduits etc, to ensure good electrical continuity.

4.5.1.7 Contact with Other Services

All trunking shall be kept clear of other services except where intentionally earthed or bonded. Trunking shall be installed to prevent contact and at the following minimum spacings:

150mm away from and below hot water and steam services.

50mm away from all other services and where horizontal trunking is installed parallel with cold water pipes they shall, wherever possible, be run above such pipes.

4.5.2 Non-Metallic Trunking Systems

4.5.2.1 General

Where non-metallic single/multi compartment trunking systems have been specified these shall be constructed from unplasticised polyvinyl chloride and manufactured in accordance with the requirements of British Standard 4678, part 4, 1985.

The material shall be non-flame propagating and non-corrosive to comply with British Standard 476 and be suitable for operating in temperature conditions between -5°C to 60°C.

All colour finishes shall be agreed with architect/employer's representatives prior to ordering.

The trunking shall be sized in accordance with the current edition of British Standard 7671 and shall afford 45% spare wiring capacity.

All systems shall be installed utilising prefabricated Manufacturers component parts and accessories. No site made accessories shall be accepted.

Trunking lids shall be provided with joint covers where lid sections abut and end caps shall be installed where necessary.

All accessories mounted on the trunking shall utilise the manufacturer's outlet box accessory fixed in accordance with manufacturer's recommendation.

Accessories/outlet plates fixed on the trunking system shall utilise manufactured trunking lid outlet plate. Where such component parts are not available accessories shall be installed to afford a minimum 300mm clearance between adjacent outlets. Infill trunking lid sections shall be installed between accessories.

In multi compartment trunking dividers shall be continuous to suit the trunking requirements. Unless otherwise indicated, metallic screen dividers shall be installed between data wiring adjacent compartments.

4.5.2.2 Installation

All trunking systems shall be installed in accordance with manufacturer's recommendations.

All trunking sections cut on site shall be carried out using manufacturers approved tools and cutting blocks. All sections shall be carefully rubbed down and provided with an approved edging tape or rubber seal.

All trunking lengths shall be installed in straight runs with manufactured sets employed in changes of direction, whether horizontal or vertical. All trunking sections shall be thoroughly cleaned internally before cable installation with lid sections installed immediately after.

The trunking system shall be adequately protected from damage and scuffing prior to project handover. Any section damaged or marked shall be replaced as necessary.

Conduit connections to non-metallic trunking systems shall be carried out utilising a coupling, brass male bush and washer connected to the trunking lid or end cap.

## 4.6 Electrical Accessories and Fittings

### 4.6.1 General

All accessories used for the Works shall be new and of the highest grade of their respective kinds and in accordance with British Standard.

Samples of proposed materials and fittings shall be submitted for comment to the architect/employer's representative before any work is put in hand. Each sample shall bear a label giving the supplier's name, catalogue number and the services in connection with which the item is proposed.

The samples shall be retained until after completion of the contract. The architect/employer's representative reserves the right to subject any of the samples submitted to tests and will in no way be responsible for damage or breakage as a result of any such tests.

### 4.6.2 General Purpose Sockets

#### 4.6.2.1 General

General purpose socket outlets of both surface and flush type shall be of the 13 amp rectangular 3-pin type, and shall be switched pattern and incorporate neon indicator lamps unless detailed otherwise.

Flush pattern shall be fitted with overlapping plates where required for flush switches.

Each socket outlet shall be provided with a corresponding patterned plug top.

#### 4.6.2.2 DC and Low Voltage Sockets

Where other types of sockets are required for use with AC or DC supplies either low voltage or medium voltage, they shall be non-interchangeable and clearly marked as to their duty. (e.g. Maintenance socket outlet).

Socket outlets connected to DC systems shall have double pole switches of the quick make and quick break type. Polarity shall also be indicated on the face plate.

#### 4.6.2.3 Multi-Gang Sockets

Where two or more socket outlets are required at any one position they shall be combined in a twin or multi-gang unit. The use of single gang assemblies in multi-gang boxes shall not be allowed.

#### 4.6.2.4 Arrangement of Circuits

General purpose sockets of the 13 Amp type shall be connected to a ring circuit and no spurs off the ring shall be permitted in any circuit.

All wiring shall connect from socket to socket and connectors shall not be permitted in any part of the circuit.

4.6.3 Fused Connection Units

4.6.3.1 General

Fused connection units shall be flush or surface mounted as required. They shall be fitted with a double pole switch, neon pilot lamp and cartridge fuse of a rating appropriate to the equipment they protect.

Fused connection units shall be installed to supply power to items of fixed equipment such as water heaters, convectors, fan coil units, incinerators, small window mounted extract fans, Wallgate units, door access controls, security and fire alarm system panels etc, and shall be engraved as to their function.

4.6.3.2 Flush Units

Flush pattern units shall be fitted with overlapping plates.

Where flush units are installed a concealed conduit shall be extended from the spur unit to a flush conduit box mounted adjacent to the equipment.

Where equipment connections are required to be in flexible cable the fused connection units shall have flexible cable outlet plates.

Flexible cables shall be multicore of circular form, coloured white of a rating applicable to the load supplied.

4.6.4 Industrial Round Pin Pattern Industrial Plugs and Sockets

All industrial ‘round pin’, connectors and socket outlets shall comply with British Standard EN60309-2.

All socket outlets shall be provided with spring return shutters and shall include a switch interlock.

Sockets located within internal rooms shall conform to IP44 and plant oom and external areas to IP67 unless indicated elsewhere within the Specification or on the suggested scheme drawings.

All plugs and socket outlets shall be selected in accordance with the voltage requirement indicated with the correct pin configuration.

All units shall be labelled to indicate voltage and current rating with the manufacturers label and shall be correctly colour coded to comply with British Standard EN60309-2.

Contact pins and sleeves shall be of solid brass and stainless steel.

All socket outlet units shall be installed within a suitable sized enclosure to allow correct connection of the conduit/cable entry.

All units shall be of common manufacture unless indicated otherwise in the Specification.

All socket outlet units installed shall be provided with a plug top unit corresponding rating and pin configuration.

On all multi-phase configuration socket outlets the correct internal wiring shall be demonstrated to the architect/employer's representative by use of a suitable plug in test socket.

## 4.7 Luminaires and Accessories

### 4.7.1 Light Switches

#### 4.7.1.1 General

The switches for lighting control shall be of 15/20 Ampere single pole type, contained in steel boxes with conduit entry. Where flush switches are required, these shall be of the grid pattern.

Efficient means shall be provided to ensure that the switch mechanism is effectively earthed to the box and when grouped, multiple gang boxes shall be used.

Flush switches shall be provided with overlapping moulded plates and finished in accordance with the requirements of the particular specification. Surface switches are to have protected steel plates.

On AC circuits switches shall be capable of switching the full rated inductive loads. On DC circuits they shall be of quick break type.

All switch positions shall relate to the swing of doors and shall ensure that locations comply with the latest architect's drawings.

#### 4.7.1.2 Multiple Units

Multiple switches shall be of the grid switch mounting pattern enclosed in boxes of the appropriate size to suit the number of switches to be provided and shall have a combined cover plate of appropriate type,

The switches of multi-gang units shall, wherever possible, be geographically arranged to match the lighting layout. Phase barriers and warning labels shall be employed where multiple phasing exists within the unit.

#### 4.7.1.3 Ceiling Switches

Ceiling switches shall be rigidly mounted, independently supported and of the moulded insulation type, coloured white, being suitable for mounting on circular conduit boxes. Suitable breakjoint rings shall be fitted wherever these switches are used in conjunction with concealed conduit boxes.

### 4.7.2 Luminaire Final Connections

#### 4.7.2.1 General

Prior to the final connection of each luminaire one of the following accessories shall be installed.

1. A ceiling rose to British Standard 67 (1987)
2. A luminaire supporting coupler to British Standard 6972 (1996) or British Standard 7001 B (1998).
3. A bayonet lampholder to British Standard 5042 (1987) or Edison screw lamp holders to British Standard EN60238 B (2005).

4. A 3 pin plug socket.

4.7.2.2 Plug In Ceiling Roses

Ceiling roses shall be of the best quality moulded plastic type suitable for direct mounting on conduit boxes.

The semi-recessed pattern shall be used and suitable break joint rings shall be fitted where the conduit boxes are recessed into ceilings or slabs.

Fixing screws for all ceiling roses shall be of brass.

Where the use of plug in type ceiling roses are required for flexible connections to lighting fittings mounted on demountable ceilings, they shall be suitable for mounting on standard conduit boxes. They shall be of the 3 pin type complete with plug and retaining cover with earthing facilities. They shall be of moulded plastic.

4.7.2.3 Batten Holders

Lampholders screwed direct to conduit systems shall be of the batten type, suitable for direct mounting on circular conduit boxes and shall conform to British Standard EN60238.

Generally batten holders shall be of the insulated type complete with ventilated skirts and provided on all luminaire final connections within bathroom and kitchen or similar environments.

4.7.3 Lamps and Tubes

4.7.3.1 General

All luminaires to be installed under this contract shall be supplied with the correctly selected lamp.

They shall be obtained from a manufacturer holding a British Standard Institution licence for electric lamps.

Where lamps supplied for the contract have been in operation prior to practical completion these shall be replaced at handover.

Approval shall obtained from the architect/employer's representative's for the utilisation of the project luminaires for temporary lighting, however this, when granted, is on the understanding that the lamps will be replaced immediately following practical completion.

4.7.3.2 Fluorescent Tubes

All fluorescent tubes shall be of the triphosphor, high efficiency type of approved manufacture and possess suitable colour rendering properties. Where lamp specifications are not detailed on drawings/schedules these shall be agreed with the architect/employer's representative prior to ordering.

## 4.8 Earthing

### 4.8.1 General

The whole of the metallic portion of the project shall be electrically and mechanically bonded to the consumer's main earth terminal and also, to the lightning protection system or other points specified.

The installation shall be effectively earthed in accordance with the following:

1. Part 4, Chapter 54 latest edition of British Standard 7671
2. British Standard Code of Practice: Earthing
3. British Standard Code of Practice for the Protection of Structures against Lightning.
4. Supply Authority requirements for compliance with the protective Multiple Earthing Regulations.
5. Any other relevant, statutory or government authority.

In those circumstances where earth rods and/or earth leakage protection devices are to be used, these shall be as detailed.

All protective conductors shall, where possible, be enclosed within metal trunking or conduit serving switchgear distribution boards etc, so as to provide mechanical protection. Where protective conductors are run on building surfaces they shall be properly fixed and supported by means of PVC coated metal saddles, along selected routes.

Earth continuity between separate items of switchgear distribution boards etc, mounted adjacent to one another shall be affected by means of high conductivity continuous copper tape, or PVC 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 PVC/SWA/PVC cables, together with all other items of electrical plant and equipment, shall be effectively earthed by means of protective conductor.

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 labelled and 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.

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.

A 50mm section of each pipe, at positions close to their entry into each facility, 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, suitably sized to fit tight on the pipe. Brass bolts shall pass through holes drilled in the end return sections of each clamp and a brass bolt, washer and nut shall tighten the clamp onto the pipe. Connections to duct risers shall generally be made at flanges where at least two lock-nutted set screws shall secure each section.

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. Welded stud connections shall be permitted where welding does not adversely affect the quality of the structural steel and written approval has been obtained before starting work from the architect/employer's representative.

A permanent label, indelibly marked with the words "SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE" in legible type not less than 5mm high, shall be permanently fixed at the points of connection.

Connection between each terminal and the consumer's main earthing terminal shall be made in PVC/PVC stranded copper cables. Each end shall be terminated in a sweated or crimped cable socket and connection to the pipe clamps and earthing terminal shall be made on to the studs or bolts using brass nuts, washers and locknuts.

Connections between dissimilar metals are to be avoided. If unavoidable they shall have the faces coated with petroleum jelly or similar neutral grease and in the event of copper being present it shall be tinned.

The protective conductors shall be fixed by means of PVC coated metal saddles.

The final connection of bonding conductors from gas, water pipes and other services to he earthing terminal shall not be completed until earth electrode and earth impedance tests have been satisfactorily completed.

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 Record Drawings.

The metal waste of all sinks and basins shall be bonded to the hot and cold water pipes. The cables shall be run so as to be as inconspicuous as possible.

All equipment located in kitchens, e.g. cookers, hotplates etc, shall have an additional supplementary protective conductor interconnecting all pipework and the main earth terminal.

All earth bonding connections and safety earth labels shall be clearly visible at all times and shall not be covered by paint or lagging or otherwise obscured.

Connections to lightning conductors shall be as detailed in the relevant British Standard.

The provision of protective multiple earthing shall be in accordance with the Electricity Supply Authority and as detailed.

All materials and sundry items shall be provided whether or not specifically mentioned, as necessary to complete and effectively earth the installation. The installation shall be fully protected against dampness and corrosion and the effects of electrolytic action between dissimilar materials. A completely permanent installation shall be provided which shall be fully accessible for regular testing and inspection.

All earth bonding points shall be clearly shown on the record drawings and the Ze shall be recorded on the drawing for each connection point.

## 4.9 Painting

### 4.9.1 General

Unless otherwise stated, all equipment is to be delivered to site with the manufacturers' standard finish.

All equipment installed under the contract shall be adequately protected from damage to ensure preserving the finish.

All items of equipment and accessories supplied with a factory applied paint or finish shall have the coating or finish made good on site, after installation, where any damage has occurred to it.

All painting required in connection with sign writing or colour coding of services, which are required in connection with the electrical works shall be carried out under the contract.

### 4.9.2 Fixing Brackets and Frames

All fixing brackets, steel frames and metalwork associated with the electrical installation shall be painted and free of sharp edges. The metal works shall be painted before being assembled or installed, and made good after installation. Metalwork shall be protected against corrosion with an etch primer.

### 4.9.3 Switch Panels and Distribution Gear

All switchgear, control panels and similar items of equipment supplied as a part of the Works shall have any damage to the paintwork or factory finish made good to the satisfaction of the architect/employer's representative.

The architect/employer's representative reserves the right to decide whether the amount of making good requires specialist or factory treatment and such a decision shall not involve the employer in any additional cost whatsoever. The architect/employer's representative decision shall be final.

### 4.9.4 Conduit and Accessories

All conduit boxes and conduit fittings which are to be buried in concrete or behind plaster shall, immediately after being fixed in position, be thoroughly coated with bitumastic paint or plastic PVC composition to give full protection before being covered in.

## 4.10 Mounting Heights

All mounting heights shall be agreed with the architect/employer's representative prior to installation.

## 4.11 Hydraulic Crimping Tools

All tools to be used for the installation of uninsulated compression and mechanical connectors for power cables with copper or aluminium conductors shall be certified for fitness of use to comply with British Standard 7609.

All tools shall carry a current certificate recording the date of its last ‘service and calibration’ check.

Any tool where the date of the last calibration check falls outside a six month period preceding the date of its intended use on site shall not be used.

## 4.12 Emergency Lighting

### 4.12.1 General

The emergency lighting scheme installation shall comply with BS 5266 : Part 1 2005, Code of Practice for Emergency Lighting of Premises and BS 5266: Part 8 2004, Emergency Escape Lighting System and in full compliance with ICEL 1001 Parts 1-4.

The emergency lighting system shall consist of self-contained maintained and non-maintained luminaires with 3 hour integral nickel cadmium batteries. Test key facilities shall be provided for the purpose of localised testing and these locations shall be determined from the Tender drawings.

The operation of each switch shall interrupt the local maintained supply to the emergency lighting units within the immediate area to enable the emergency lighting system to be tested. Operation of the test key shall interrupt the mains supply to the local circuit simulating a mains failure condition.

All key switches shall be an integral part of the normal service lighting switch plate and the gangway shall be engraved “E/L Test” in black 3mm high characters.

Each self-contained emergency luminaire and/or conversion kit for standard fluorescent luminaire shall comply with the requirements of BS 4533 – 102.22 (1990) and shall carry BSI Kitemark approval.

Self contained exit/fire exit signs shall be provided and these shall incorporate pictogram legends to BS 5499 - Part 1 (2002) and the European directives.

All emergency luminaires shall be provided with a ‘circuit healthy’ red LED indication lamp, which must be clearly visible when the luminaires are functioning. Where the emergency facility consists of a remote pack this shall be fixed to the soffit located on a custom made slotted channel support.

## 4.13 Labelling and Identification

### 4.13.1 General

Where specific site standards exist, the following labelling and identification format shall not be adopted.

Identification and descriptive labelling shall be applied to all distribution equipment, cabling, switchgear, plant items, service switches and outlets etc, using Traffolyte labels fixed to the front plates of all equipment. The size of all lettering for main equipment, such as switchboards etc, and danger labels shall be not less than 14mm in height. The styling and lettering shall be submitted to the architect/employer's representative prior to manufacture. Labels using adhesive backed materials will not be permitted. All labels are to be secured using screws, rivets etc.

All mechanical services sensors, valves and control items shall also be identified and labelled. The correct referencing and style of the labelling shall be agreed with the employer's representative.

Where blank labels are provided with the equipment these shall be suitable engraved.

The colours of all labels shall be in accordance with British Standard 5378, p1 (1987).

### 4.13.2 Danger Labels and Notices

Danger or warning labels shall be of yellow ivorine, having lettering coloured black and marked 'DANGER' together with a description of the hazard, eg. 'High Voltage' or '415 Volts', etc.

All sub-station and main switchroom accessories shall be clearly marked with labels of yellow ivorine with black lettering having letters not less than 28 mm in height with the designation "Danger, High Voltage Sub-Station" or "Danger, Medium Voltage Switchroom" as appropriate. Main switchrooms shall also be provided with wall charts required under statutory regulations along with a wall mounted framed copy of the distribution network drawing.

All earthing conductors shall be fitted with embossed aluminium strip labels in accordance with IEE Wiring Regulations latest edition. Under the contract works warning notices associated with plant that is controlled remotely or automatically shall be provided. Such notices shall be fixed in all locations necessary to warn personnel adequately of the danger. Such notices are to be yellow with black inscription, with characters not less than 25mm high and shall read to the following effect:

***DANGER. THIS APPARATUS* IS REMOTELY CONTROLLED. DO NOT WORK ON IT UNTIL THE CONTROL* EQUIPMENT IS ISOLATED OR DISCONNECTED AND CAUTION NOTICES ARE DISPLAYED AND A PERMIT TO WORK IS IN PLACE/OBTAINED.***

(* Describe apparatus - machine etc - controlled and the method of operation - starting, closing etc.).

4.13.3 Plant and Equipment Labels

Labels on all items of plant, equipment, switches etc shall include the following information:

i. The service controlled
ii. The circuit reference
iii. Voltage, type of supply and phase, etc.

4.13.4 Engraved Switchplates etc

Switchplates, spur units, pushes and special plates for special units, call systems, fire alarms etc shall have engraved labels as necessary with 7mm high letters coloured black.

Fire alarm points shall have Traffolyte labels with 7 mm high letters coloured white on a red background.

4.13.5 Distribution Boards

Where a circuit schedule is fitted within the lid of a distribution board, it is to be installed in a clear plastic wallet. The wallet is to be secured by brass raised head screws and nuts.

Each distribution board shall be provided with a unique identification label of the pattern indicated within Clause 001, and the front cover fitted with a "DANGER 415V/DANGER 240V" label as necessary.

Each distribution board shall have every outgoing way identified. A circuit schedule shall be fitted in a plastic glazed frame securely mounted on the wall adjacent to each distribution board, clearly indicating in typed script the phase and circuit identification number, fuse or circuit breaker rating the number of points, earth fault loop impedance test figure, loading and a precise description of what the circuit supplies and the area and/or equipment served.

The distribution board shall also be fitted with a label of the pattern and type required under clause 514-12-01 of British Standard 7671. The relevant sections shall be completed in durable black ink.

4.13.6 Contactors

In addition to labels required for general specification clauses for workmanship and materials, an additional label shall be provided for each unit stating "Before removing cover, incoming supplies from Distribution Board No. …….. circuit ways ……. must be isolated".

4.13.7 Cabling Identification

All sub-main and multicore core cables, other than final sub-circuit wiring enclosed in conduits or trunking shall be provided with labels fixed at each

end of the cable. All mechanical services control cabling shall be labelled at point of source and at the item served.

The identification band/label shall be of the slip-on pattern utilising proprietary type manufactured for the particular environmental conditions. Loads shall generally be provided at every 4 meters or change of section. At fire break/cavity barrier locations cable shall be labelled at respective points.

The labels shall show the following information:

i. Reference number of cable
ii. Points of termination and origin
iii. Size and number of conductors
iv. Type of cable and date installed
v. Operating voltage of cable

Unless specific site services exist or where a numbering system has not been defined on the tender drawings a unique system of numbering shall be adopted. Any such arrangement shall start at the origin of the system with the reference 001 and the following prefix.

P Low Voltage 230/400V cables
F Fire alarm cabling
C Control circuit wiring
S Security/CCTV wiring

Upon completion of the contract the cable schedules shall be submitted and issued within the operating and maintenance manuals presented in the following format.

| | Cable Type | | Designation | | | |
|---|---|---|---|---|---|---|
| Cable | No of Cores | Disposition | From | To | Lm | Install Date |
| P001 | 4C 50mm2 | XPLE/SWA/LSF | Main switchboard MB01 | First floor distribution BD LP007 | 40 | June 95 |

All distribution cables shall have identification bands attached at each end of termination and at any set in the cable route. The identification bands shall be permanently embossed with the reference number of the cable. Cable references shall correspond to the reference number of the distribution board being fed by the cable, and the size type and rating of the cable.

All multicore sheathed cables shall be labelled for identification purposes by means of cable identification bands which shall be stamped to clearly indicate details of the cable, type, circuit and size. The bands shall be fixed on all cables wherever they are terminated and shall be fixed adjacent to the sealing glands.

Core identification shall also be provided at each cable end by the methods detailed above and in addition power cables shall have the appropriate phase shown by coloured tape affixed at their terminating points.

On distribution boards the neutral cores and circuit protective conductors shall also be marked with the cable or circuit number.

On control circuits, engraved plastic markets shall be provided on each core used. These shall be permanently marked in accordance with terminal numbers indicated on the equipment of associated schematic drawings.

All permanent and temporary record systems shall show cable identification in accordance with the above requirements.

4.13.8 Origin of Installation

Labels of the pattern and type shall be provided at the origin of the installation as required to achieve full compliance with Clause 514-12 latest edition of British Standard 7671. Where relevant the labels shall be completed in durable black ink.

# Section ME5.00

# Builderswork

# Index

# ME5.00 Builderswork

## 5.1 Drawings

Full working details of Builderswork shall be provided in good time to enable the construction programme to be maintained. Builderswork drawings shall be submitted to the Architect and Employer's Representative prior to any work being carried out on the site.

Submission of the Builderswork drawings to the Employer's Representative shall be made at least a minimum of 7 days before they are required by the programme of works.

Drawings showing Builderswork only shall be provided.

All information shall be available for issue to the Architect and Employer's Representative in sufficient time that the requirements can be designed and detailed by the Architect and Engineer, including structural design and detailing of reinforcement with due allowance for material deliveries, without delay to the construction programme.

## 5.2 Access to Equipment and Services

All plant, equipment and services requiring maintenance or access for balancing and commissioning purposes shall be fully accessible. This access shall be fully detailed on the builderswork drawings . This shall include all access required through the false ceilings, false floors, riser ducts and the like.

Such information shall be provided to the Architect and Employer's Representative within 7 days of Contract Award and/or the placing of a letter of intent.

## 5.3 Static, Dynamic Loads, and Anchor Points

Static loads for all equipment, plant and services shall be provided as a schedule or marked on the builderswork drawings. Where plant or equipment are subject to the forces of motion or have moving parts, then dynamic loads shall be scheduled.

Schedules of anchor points together with the loads shall be provided for all plant equipment and services. This includes pipework and particular attention is drawn to the problems related to expansion bellow, expansion and contraction.
The nature of all loads shall be described on the Schedules. Where an anchor or fixing is subject to compressive and tensional forces both of these shall be defined.

All information shall be available for issue to the Architect and Structural Engineer in sufficient time that the requirements can be designed and detailed by the Architect and Structural Engineer, including structural design and detailing of reinforcement with due allowance for reinforcement deliveries, without delay to the Contractor's programme.

## 5.4 Services Identification when Enclosed by Builderswork Casing

All services shall be identified before enclosure in a builderswork casing. Where a builderswork casing is required for reasons of safety, fire protection etc, this shall be included in the list of builderswork submitted with the Tender.

## 5.5 Fixings for the Works including Pipework and Ductwork

All fixings shall take due account of all load restrictions imposed by the Structural Engineer and shall include for all necessary fixings together with any spreaders, secondary or supplementary steelwork and/or supporting frames that may be required for securely fixing his work.

## 5.6 Built-In Plant and Equipment

All plant and equipment, including all louvres, grilles and diffusers, access doors, fire and smoke dampers etc, which require building-in, shall be provided with purpose made sub-frames to facilitate such building-in.

## 5.7 Holes

The Schedule of Builderswork provided with the Tender shall schedule all holes required and shall individually itemise any holes with a dimension of 75mm or greater.

## 5.8 Stopping of Holes

Where holes are required in the structure, or in any wall, floor or ceiling or any shaft enclosure for the purpose of facilitating the installation or the passage of the Mechanical or Electrical Services and such a hole requires to be sealed subsequently so as to provide an imperforate surface for the purposes of water tightness, air tightness, acoustic sealing, fire stopping or smoke containment, etc, all such stopping of holes and all ‘making good’ and finishing shall be the responsibility of the Contractor. This shall include the building-in of all fire dampers, duct and pipe sleeves, puddle flanges, cable sleeves, cable transfer boxes, conduit, trunking, access doors etc.

**All services penetrations through building elements (except false ceilings) shall be sleeved with a material identical to the pipe service. Split sleeves shall not be used. The Contractor shall provide all sleeves.**

## 5.9 Builderswork Schedule

The following schedule is not considered to be conclusive but contains principle elements of Builderswork issues that have been identified during the design process. The Contractor shall liaise with all his specialist Sub-Contractors and ensure that all other BWIC issues not specifically identified, but required to complete the project works are included within the tender returns.

# Section ME7.00

# Inspection, Testing and Commissioning

# Index

# ME7.00 Inspection, Testing and Commissioning

## 7.1 Mechanical Services

Three weeks prior to commencing the testing and commissioning of the mechanical and electrical services a fully detailed programme shall be issued for each service identifying key dates for witnessing by the employer's team.

The following requirements for testing and commissioning of the mechanical services shall be carried out as the contract works.

### 7.1.1 Introduction

The employer's representative shall be notified of all the temperature and relative humidity conditions and their rates of change likely to occur to the conditioned areas during the testing and commissioning period. This information is required to enable an assessment to be made of these effects on materials and methods of working in relation to the contractor's activities and programme.

Upon completion of the installation, the following tests and commissioning shall be executed employing and/or providing specialist traders/suppliers of equipment and plant necessary to complete the Contract Works.

**Note: Before inviting the architect/employer's representative to witness the commissioning results the contractor shall first make his own tests and establish conclusively that all systems have been properly vented, tested, regulated and balanced and are fully operational in accordance with the requirements of the specification.**

### 7.1.2 Air and Water Distribution Systems - Heating Systems and Automatic Controls Systems

These systems shall be tested and commissioned in accordance with the Chartered Institution of Building Services Engineers codes, revision as current at the time of project, as listed below:

| | |
|---|---|
| Series A | Air Distribution |
| Series B | Boilers and Heating |
| Series C | Controls |
| Series W | Water Distribution |
| Series L | Lighting |
| Series M | Commissioning Management |

In addition the recommendations of the following BSRIA documents shall be complied with:

The Commissioning of VAV Systems in Buildings – Applications Guide 1/91.

The Commissioning of Pipework Systems – Applications Guide 20/95.

The Commissioning of HVAC Systems – Technical Memorandum 1/88.1.

The Commissioning of Air Systems in Buildings – Applications Guide 3/89.3.

The Commissioning of Pre-commissioning Cleaning of Pipework Systems – Applications Guide 1/2001.

The Commissioning of Water Systems in Buildings – Applications Guide 2/89.2.

The Commissioning Management – Applications Guide 5/2002.

Variation of air volumes between supply diffusers and extract grilles shall not be more than 5% in the same area unless otherwise dictated by a pressure regime requirement.

The air volumes handled by terminal devices in an area shall not vary by more than 5%, eg. all air supply ± 5% of mean volume flow.

7.1.3 Domestic Hot and Cold Water Systems

The hot and cold water systems shall be tested for outflow in accordance with the appropriate British Standard Codes of Practice. In addition all tests and commissioning procedures required by local authority and statutory undertaking officers/engineers shall be executed.

All test results shall be recorded and presented on test sheets similar in format and content to those ‘specimen’ sheets shown in Appendix A OF Health Technical Memorandum 2022 - Good Practice Guide.

7.1.4 Soil and Waste Systems

Soil and waste system shall be tested in accordance with the recommendations of BSEN 12056 – 2:2000.

The systems shall be tested during the installation at agreed stages. All work which will be concealed shall be tested and certified before it is finally enclosed. A final test shall be made upon completion of the entire installation for soundness and performance. In addition such tests and commissioning procedures required by the local authority shall be witnessed by them and the architect/employer’s representative. On completion all drainage systems shall be flushed and rodded through to ensure and prove its integrity.

7.1.5 Instruments

All necessary instruments required to test and commission the complete mechanical services Installation shall be provided. All instrumentation and test equipment shall be fully checked and calibrated by the manufacturers prior to the commencement of the test against a standard fully traceable to a National Physics Laboratory or equivalent national standard.

Current calibration certificates for each instrument shall be provided to cover the entire period of its use on this project.

A full list of all test equipment and instrumentation intending to be used on the project shall be prepared and passed to the employer's representative at least 4 weeks before such tests and commissioning are carried out. This list shall also include a statement as to the function each instrument shall perform or be used for.

7.1.6 Documentation

A separate document containing all test and commissioning results, certificates, diagrams, drawings and the like shall be presented by the Contractor on completion of the testing and commissioning work. This document shall be amended and revised on completion of the witnessing procedure by the architect/employer's representative and shall be presented as a bound appendix to the operating and maintenance Instructions. All test and commissioning sheets shall clearly indicate the date and time of any test duly signed by the engineer responsible for the measurement and a space shall be incorporated for a Witnessing signature and date.

The test and commissioning sheets shall be available for signature at the time of the witnessed testing by the architect/employer's representative.

The test sheets shall include a diagrammatic layout of the fluid flow circuit under test and shall indicate all regulating valve and damper positions.

Test sheets shall include a diagrammatic layout of the fluid flow circuit under test and shall indicate all regulating valve and damper positions.

Test sheets shall include but not be limited to record the following areas of work.

a) Check lists for all plant
b) Fan performance curves and motor data
c) Main and branch duct flow rates
d) Terminal air balance
e) Pump performance curves and motor data
f) Main and branch pipe flow rates
g) Terminal water balance
h) Temperature, humidity and noise level checks.

7.1.7 Pressure Testing

Partial pressure testing of pipework and ductwork systems shall be permitted to allow construction work to progress, but a full and final pressure test of pipework system shall be executed after flushing and chemical cleaning.

Schedule of Services

| Service | Test Pressure | Duration | Hydraulic/Air |
|---|---|---|---|
| LTHW | 6 bar g | 1 hour | Hydraulic |
| | | | |
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7.1.8 Environmental Testing

On completion of the balancing and regulation of the systems environmental testing shall be executed as a part of the testing and commissioning procedure. These checks shall take the form of thermohydrograph monitoring for a period of 3 days, 24 hours per day throughout each room and prior to practical completion being awarded. External ambient conditions shall also be continuously monitored and recorded at the same time.

The above tests shall not be taken as an indication of the plant and system's capabilities in terms of performance at the design conditions. It shall be interpreted as an indication of the plant and system's ability to provide stable environmental conditions in the space concerned.

At least three changes of at least 2°C about the design set point shall be made during the 3-day period, each change lasting 12 hours.

7.1.9 Load Performance Tests

All installed systems and equipment shall be simultaneously load tested in order to demonstrate satisfactory performance.

In the case of heating calorifiers these shall also be factory tested and certified in the manufacturer's works by the manufacturer in order to demonstrate their ability to perform at the required design conditions with the necessary output.

7.1.10 Controls Testing

No controls systems testing or commissioning shall be carried out until such time as the air and water systems have been properly tested, regulated and commissioned in terms of fluid flow and the results witnessed by the architect/employer's representative.

The controls system shall be fully operational prior to the commencement of any load and/or environmental testing.

A demonstration of ALL control actions for ALL plant and systems, safety features, alarms and the like shall be executed as a part of the practical completion exercise detailed elsewhere in this specification. This demonstration shall include physical confirmation that field components status matches that indicated by the BMS.

A 'Doomesday' Test shall be carried out in the presence of the employer's representative. This test shall involve the simulation of mains power failure and the restarting of the plant automatically.

7.1.11 Pre-Commissioning Checks

All necessary pre-commissioning checks required and/or recommended by the CIBSE Commissioning Codes shall be executed and all systems shall be properly tested as required by this specification and as detailed in all associated documentation.

Full support services shall be available and these shall include, but not be limited to, the following:

a) Power and mains services
b) Proven controls systems and safety interlocks
c) Design fluid flow data
d) Schematic diagrams of the Installation including control systems
e) Test certification
f) Certified plant performance data
g) Wiring diagrams including control panel diagrams
h) Installation record drawings

Prior to the testing and commissioning works clean air filter medial shall be installed and all water filters and strainers shall be checked and maintained clean throughout the testing and commissioning procedures.

## 7.2 Testing and Commissioning - Electrical

### 7.2.1 Introduction

As required all specialist companies shall attend the project at the testing and commissioning stage to ensure the system achieves the design intent.

All routine tests to be carried out on the electrical services during the installation stage shall be notified five working days beforehand to the architect/employer's representative so he may witness same.

The complete electrical installation shall be tested in accordance with British Standard 7671, IEE Wiring Regulations latest edition plus Appendix 1. The tests shall be carried out sequentially as prescribed in the wiring regulations. Upon completion of the installation an electrical test completion certificate shall be issued. This certification shall be the same as or of similar format to that produced by the National Inspection Council for Electrical Installation contractors (NICEIC).

### 7.2.2 Inspection and Verification

All labour, materials, apparatus and properly calibrated and certified instruments for carrying out the specified tests shall be provided.

Site testing of all systems and components comprising the installation works shall be carried out in the presence of the employer's representative first proving that the installation and systems have been properly and fully inspected and tested and are operating correctly.

At least 7 days written notice shall be given when the installation or any part is ready for witnessed test.

A comprehensive schedule of test results shall be provided and submitted, and four signed copies of the schedules together with four signed copies of the Completion and Inspection Certificate shall be issued within 14 days of tests taking place. Handwritten copies of all test certificates shall be held on site at all times.

No section of the installation, plant or systems shall be energised, except for testing purposes, until such time as the required tests have been properly carried out and completed and the appropriate certificates have been issued certifying that the installation and its apparatus is safe to operate.

Only one set of instruments shall be used for testing the installation and at the date of commencing the works the manufacturer's name, instrument type and serial number for each instrument shall be recorded.

The same information shall be entered on all test sheets and certificates. If required by the employer's representative the accuracy of all or any instrument(s) shall be demonstrated prior to use on site.

All instruments to be used for site testing shall carry a current certificate recording the date of its last service and calibration check.

Any instrument where the date of the last calibration check falls outside a six month period preceding the date of its intended use on site shall not be used.

The employer's representative shall have access at all times to such parts of contract works as may be necessary for the purpose of inspecting, examining and testing the materials, workmanship and performance of the installation and equipment.

Any equipment, materials or work which is found to be unsatisfactory by the employer's representative during the inspection and testing procedures shall be replaced by new equipment or material and/or the defect corrected.

All necessary attendance during the commissioning of all plant and apparatus connected under the contract shall be provided whether or not the plant and apparatus was supplied as part of the contract works. In the event of any dispute in this regard the employer's representative be the sole arbiter.

Prior to handover, functional tests on all systems forming the installation shall be demonstrated to the employer's representative to prove that all systems function correctly.

Where specialist attendance (eg fire alarms) is necessary for the commissioning, testing and certifying of particular items of installation or equipment this shall be included in the Tender. All associated manufacturers or specialist fees or other expenses shall be included..

All arrangement associated with the engagement of specialists shall be carried out as part of the contract works and these shall afford 7 working days' notice. All associated costs shall be included in the tender offer. All factory built assemblies under the supply shall be tested at the manufacturer's works before despatch and six copies of test certificates in respect to each test shall be forwarded to the employer's representative.

Type tested certificates will be accepted for all proprietary manufactured switchgear and equipment.

All works tests shall comply with the relevant BS Specification or IEC Standard.

The contract works shall include for the inspection, testing, commissioning and certification of the electrical installation, fire alarms and emergency lighting systems in accordance with the requirements and recommendations of the following documents:

| | |
|---|---|
| Electrical Installation | BS 7671 |
| Fire Alarm System | BS 5839 Parts 1-9 - 2002 Fire Detection and Alarm Systems for Buildings |
| Emergency Lighting System | BS 5266/BSEN 1838 Parts 1-7 1999 – Emergency Lighting |

7.2.3 On-Site Testing

7.2.3.1 General

The extent of testing shall include, but not be limited to:

i Electrical Wiring Installation
ii Fire Alarm Detection System
iii Emergency Lighting Installation
iv Plant Shut-down System

7.2.4 Fire Alarms

On completion of the fire alarm installation, the system shall be commissioned and demonstrated to the employer's representative. The extent of testing shall include for:-

a) All devices are tested and operate correctly and results are uniquely logged on the commissioning schedule.

b) All manual controls operate correctly.

c) The correct information is displayed on the control and indicating equipment.

d) The system responds according to the operational sequence details in this Specification, and all outputs operate correctly.

Commissioning shall be fully documented and the documentation submitted to the employer's representative.

The fire detection system shall be demonstrated by conducting a series of witnessed acceptance tests as directed by the employer's representative. This shall take place after commissioning and following the receipt of the commissioning documentation by the employer's representative. Acceptance testing shall include the operation of all devices on the system, the simulation of various faults, and the operation of all manual controls.

Subject to satisfactory completion of all tests and all necessary rectification work, the new system shall be rendered fully operational.

Once handed over, the system shall become the operational responsibility of the employer.

## 7.3 General

### 7.3.1 Commissioning Staff and Engineers

Under the contract a competent commissioning engineer shall be appointed and named for the carrying out of the commissioning. He shall be experienced in the type of work required and shall be qualified to at least CIBSE Standard, or equivalent.

### 7.3.2 Reporting

The responsible commissioning engineer shall submit written reports during the commissioning period to the architect/employer's representative detailing:

a) Progress to date
b) Summaries of results obtained
c) Details of any problems encountered

The reports shall be submitted on a weekly basis or as the architect requires.

### 7.3.3 Practical Completion

As a part of the procedure in achieving practical completion for the services contract works and systems these shall have satisfied the requirements of the testing and commissioning procedure as specified and defined in this and related documentation. Test data and results shall be provided in draft form in order to satisfy one of the requirements for achieving practical completion.

### 7.3.4 Lighting Installation

In accordance with CIBSE guidelines utilising calibrated lux meters, verify and record the defined working plane lighting levels to all modified areas.

## 7.4 Witnessing by Employer's Engineering Representative

The contractor shall conduct his own inspection and witnessing of tests prior to offering the mechanical and electrical services for inspection to the employer's engineering representative.

All internal reports and tests results shall be offered to the employer's engineering representative for his inspection to demonstrate compliance in this respect when offered to witness and inspect the works on behalf of the employer.

The inspection of the installed services shall be conducted by the employer's engineering representative at a time agreed with the contractor.

Upon completion of this inspection, the employer's engineering representative shall produce a report detailing the items which require attention and these shall be rectified and offered for inspection. Where it is found that the items included have not been addressed or rectified to the benchmark standards, the employer's engineering costs for subsequent visits shall be withheld from the contractor's final account.

Where the employer's engineering representative is requested to attend site to witness test results and the contractor has not been able to demonstrate the activity at the time agreed, then the employer's engineering representative costs shall be withheld from the contractor's final account.

# Section ME8.00

# Completion Record Drawings and Operating and Maintenance Instructions

# Index

# ME8.00 Record Drawings and Operating and Maintenance Instructions

## 8.1 Introduction

A certificate of Practical Completion shall not be issued until the services installation is complete in every respect and to the satisfaction of the Employer's Representative. In particular, the following items are regarded as highly critical:

1. Engineering installation must have been completed and all snags have been attended to.

2. All commissioning and testing reports have been issued.

3. All performance and acceptance tests have been carried out.

4. All "As installed" and Record Drawings have been issued, to the Standard as detailed below and in Appendix.

5. Fully approved and complete Operating and Maintenance Instruction Manual has been issued, to the Standard as detailed below and in Appendix A.

6. Fully approved and complete Plant Asset Register as detailed in Appendices A & B.

## 8.2 Operating and Maintenance Instructions

Record Drawings and Operating and Maintenance Instructions of the complete Mechanical and Electrical Services Installations covered by this Specification and the final scope of the Contract Works shall be prepared and issued for review to the Employer. Where specialist companies have been employed these shall be included as an integrated part of the documentation and not presented separately.

It shall be a condition of the Contract that 2 no.draft copies of both Record Drawings and Operating and Maintenance Instructions shall be supplied to the Architect/Employer's Representative at least 4 weeks before the expected Practical Completion of the Project. One copy of the Instructions and two copies of the Record Drawings shall be provided. The Architect/Employer's Representative shall have 2 weeks to review and comment on the documentation leaving 2 weeks for the Contractor to execute any comments and prepare the final issue.

The draft documentation shall be complete and sufficient to allow the correct, complete and safe operation and maintenance of the building until final documentation is provided. The final documentation (excluding commissioning data) shall be presented at Practical Completion.

Practical Completion of the Contract Works will not be acknowledged or awarded of the final documentation is not of sufficient quality or is not provided. The Employer's Representative be the only arbiter in determining that the documentation is of sufficient quality.

The format of the documentation, quantity and quality shall be as detailed below:

1. Description of the installed systems clearly stating system component arrangements, intended modes of operation, together with detailed descriptions of the method of control and final settings of control parameters.

2. Description of the installation and equipment/ancillaries.

3. Description of emergency action(s) which should be taken in the event of equipment failure.

4. A Schedule of Maintenance Requirements, clearly identifying operations on a daily, weekly, monthly, annual and breakdown basis.

5. A list of manufacturers names, addresses and telephone and fax numbers.

6. Schedule of equipment with manufacturers reference/catalogue/parts numbers and name plate data.
7. A list of manufacturers recommended spares for each item.

8. Schedule of lubricants for use with equipment.

9. "As Installed" drawings including brackets, supports and guides.

10. Pressure Systems Regulations schematic indicating all components within the written scheme including a schedule of components and their component numbers.

11. Method of adjustment and fault finding routine(s) for appropriate items of equipment.

12. Details of all consumables.

All of the above information, except record drawings, shall be bound into high quality A4 4-ring binders and three copies shall be provided. Where the original information is on different sized paper it shall be reduced on to A4 or A3 paper. The manual shall contain an index and be arranged to contain the following sections, arranged in the sequences shown:

1. Section 1: Introduction, Abbreviations, Health and Safety at Work Act and Warning Notices etc.

2. Section 2: Full description of each system together with the main plant components and locations.

   This section shall incorporate schematics showing areas served from the system.

   **Note: Each system must comprise the complete plant technical data on each item of equipment, eg manufacturer's name and address, type and size of unit, serial number, order number. This information must be derived from a site inspection of identification plates together with information obtained from manufacturers.**

3. Section 3: Detailed description of all operating procedures necessary for starting up, running and shutting down of each individual system.

4. Section 4: Description of all maintenance operations on a daily, weekly, monthly, yearly and breakdown basis. The preparation of this section must be carried out by obtaining from the manufacturer his advice and recommendations for lubrication, adjustment and routine maintenance.

5. Section 5: Details of all emergency procedures to be adopted by personnel engaged in the operation and maintenance of the services, with respect to fire, first aid, general failures to systems and call out procedures for maintenance personnel during working hours and out of working hours.

6. Section 6: To consist of a set of indexed test sheets as witnessed/agreed by the Employer's Representative, together with all other relevant welders certification.

7. Section 7: List of recommended spares and lubricants.

8. Section 8: Schedule of the record “As Installed” drawings. Cross indexed with valve schedule and manufacturer’s drawings.

## 8.3 Record Drawings

The Contractor shall keep a record in his Site Office as the Contract Works proceed of any amendments to the installation as designed and laid out. These marked up, as installed, drawings shall form the basis of the Record Drawings which shall be specially prepared and be presented by the Contractor in Draft Form for comment by the Employer's Representative as detailed above.

The Record Drawings shall show/comprise:

a. The complete installation of all systems, plant and equipment including duct, pipe and tube sizes, cables, wireways and individual conduit ways. All circuits and cables shall be referenced and labelled to record with information on test certificates.

b. The precise, dimensioned location of all buried services, whether in the ground or encased within the structure.

c. System diagrammatic schematic drawings showing all valves which shall cross refer to the valve schedule. Such drawings shall indicate all plant and equipment duties, commissioned air and water flow rates.

d. System diagrammatic and schematic drawings showing all control panels, building management systems, and electrical panels, including main switch panels and distribution boards. The schematic drawings shall detail design criteria and criteria measured during the testing and commissioning phase. All cable and wire sizes shall be shown on the drawings including circuit protective conductors and the full earthing system.

e. General arrangement drawings at a scale of not less than 1:50 metric.

f. Plant area, Plant and Switch Room arrangement drawings at a scale of not less than 1:20 metric.

On approval of the Record Drawings one photocopy copy of each drawing on 90gsm white paper shall be included in each Operating and Maintenance Manual and a single further copy of each drawing shall be presented to the Employer's Representative, unfolded. The unfolded copy shall be presented on 120gsm high quality white paper.

In addition all Record Drawings shall be presented compact disk formatted for use on 'Autocad' Release 2008 Computer Aided Draughting Software. The Contractor shall use the symbol convention used at the Tender Issue stage or the Employers methodology as directed by the Contract Administrator/Project Manager/Employers Representative.

## 8.4 Design Data

The Contractor shall integrate into the Operating and Maintenance Instructions a section containing the Designer's load calculations and plant and equipment sizing schedules.

The Design Section shall be presented by the Contractor as a separately bound document arranged in a number of uniquely identified sections each pertaining to a particular service.