MAX FORDHAM

Kings College Chapel PV

Specification for the Mechanical, Electrical & Public Health (MEP) Installations

For Client

February 2022

SPEC-100

Status Code	revision	status description	project code		originator		volume		level		type		role		number
D1	**P02**	**Issued For Tender**	**J7008**	**-**	**MXF**	**-**	**XX**	**-**	**XX**	**-**	**SP**	**-**	**J**	**-**	**30100**

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ISSUE HISTORY

Issue	Date	Description
P01	14/02/22	Issued for Tender
P02	13/05/22	Inclusion of solar panel model

MAX FORDHAM LLP TEAM CONTRIBUTORS

Engineer	Role
PA	Senior Partner
EJ	Engineer

CONTENTS

INTRODUCTION

Project Overview, Design Philosophy and Key Aspects of the Brief

As part of a larger scheme for the renovation of the Kings College chapel lead roof, a solar array design is being proposed to be incorporated into the lead roof design.

Key MEP Design Strategies

A photovoltaic array is to be installed on the roof of King's College Chapel Cambridge. Micro Inverters are to be located beneath the array on the roof, and the PV system is to be connected into an existing 3-phase distribution board in the study, on the ground floor of the Chapel.

MEP documentation

This document "MEP Employers Requirements/Specification" (SPEC-100) provides a project-specific description of the MEP engineering services installation. This document forms part of the design information and should be read in conjunction with the Main Contract Preliminaries and all associated documents.

The MEP installations are also described by the following documents:

- SPEC-100 – Project specific description of the MEP installations
- SPEC-200 – Project preliminaries setting out the Contractor's responsibilities in relation to design, coordination, management and documentation.
- SPEC-300 – Reference specification setting out the required standards for installation, testing and workmanship for the MEP installations.
- Drawings and schedules listed in Appendix A of SPEC 100

Basis of Tender and Contractor Design Responsibilities

With the exception of the performance specified MEP installations listed in clause 4.2 of SPEC-200, the tender documents for the MEP engineering services include MEP design developed to RIBA Stage 4.

The contractor shall allow for the design responsibilities set out in Section 4 of SPEC-200 within their tender price.

The contractor shall include for the provision of a complete working installation as set out in clause 3.4 of SPEC-200.

Complete in full the pricing documents (Tender Summaries in the following section) and return with tenders.

SUMMARY OF TENDER – ELECTRICAL

The Contractor is to complete the following in full.

SPEC-200	MEP Preliminaries Generally	£	
	3.8 Provisional sums (Total of Appendix B)	£	
	3.11 Modelling responsibilities of the Contractor	£	
	4.0 Design Responsibilities	£	
	7.1 Surveys	£	
	7.6 Maintenance of existing services	£	
	11.1 Record Information	£	
	11.2 Operation and Maintenance Manuals	£	
	11.3 Building User Guide	£	
	11.4 Testing and Commissioning - Demonstration	£	
	12.1 Training of employer's staff	£	
	12.3 Seasonal Commissioning	£	
	12.4 Maintenance during rectification period	£	
	Total of Preliminaries		£
	Identification, decommissioning and strip out of existing services – Electrical	£	
	Builderswork	£	
Ss_70_10_70_35	Electricity Generation – PV	£	
	Panels	£	
	Inverters	£	
	DC cabling	£	
	LV switchgear and cabling	£	
	G99 installations	£	
	Export limiter	£	
	Other	£	
SS_75_50_28_29	Fire Detection and Alarm	£	
SS_75_50_45_45	Lighting Protection	£	
	Total of Work Sections		£

Signed .....

For & on behalf of .....

.....

SS_70_10_70_35 ELECTRICITY GENERATION – PV

PERFORMANCE OBJECTIVES

- Convert solar irradiation into electrical power and transmit it to the LV network for use within the college site.
- Generate a minimum peak output of 63kWp for the North and south panelled arrays. A 19.7% efficient panel or greater, metered by the system (including all inverter and DC/AC system losses to the point of electrical LV connection).
- Be grid connected with metering of generated an exported electricity.
- Be eligible for Feed-in-Tariffs (should FiTs for PV become available again)
- Be maintainable, cleanable, and safe.
- Comply with the Design Parameters and System Description.
- Installation of the desired PV model: REC Alpha Pure Series (REC400AA-PURE)

DESIGN PARAMETERS

Industry Standards

Statutory Acts	The Building Regulations The Electricity at Work Regulations 1989 The Electromagnetic Compatibility Regulations, 2015 , SI 2006/3418 Health and Safety at Work Act 1974 The Memorandum of guidance on the Electricity at Work Regulations 1989 (the Memorandum) IET Wiring Regulations 18th Edition, (BS7671:2018)
Building Control / Local Authority requirements	The Building Regulations Approved Documents (latest version) • Part L2b Conservation of fuel and power in existing buildings other than dwellings • Part B Fire safety • Part P Electrical safety • Non-Domestic Building Services Compliance Guide
Industry standards	Chartered Institute of Building Services Engineers (CIBSE) • CIBSE F guide • CIBSE J guide • CIBSE K guide • KS15 Capturing Solar Energy • TM38 Renewable Energy Sources for Buildings

Building Services Research and Information Association (BSRIA)

- BSRIA Power quality guide (AG 2/2000)
- Design Checks for Electrical Services - A quality control framework for electrical engineers (BG 3/2006)

IEE Code of Practice for In Service Inspections and Testing of Electrical Equipment

Energy Networks Association

- Connection of Generation < 3.68kW (G98)
- Connection of Generation > 3.68kW (G99)

Electrical Contractors Association (ECA) Guidance

- Guide to the installation of photovoltaic systems

Department of Trade and Industry

- Photovoltaics in Buildings – Testing, Commissioning and Monitoring Guide
- Photovoltaics in Buildings – Safety and the CDM Regulations
- Photovoltaics in Buildings – Guide to the Installation of PV Systems

Microgeneration Installation Standards

- MIS 3002 (issue 3.3)

NICEIC

- Technical Guidance

British Standards	BS 7430	2011	Code of practice for protective earthing of electrical installations
	BS 7671	2008	Requirements for Electrical Installations. IET Wiring Regulations
	BS EN 60947-6	2005	Low-voltage switchgear and controlgear. Multiple function equipment. Transfer switching equipment
	BS IEC 62548	2016	Photovoltaic (PV) arrays - design requirements
	BS EN 61194	1996	Characteristic parameters of stand-alone photovoltaic (PV) systems.
	BS EN 61215	2017	Crystalline silicon terrestrial photovoltaic (PV) modules. Design qualification and type approval.
	BS EN 61727	1996	Photovoltaic (PV) systems - Characteristics of the utility interface.
	BS EN 61000	varies	Electromagnetic compatibility (EMC) – All parts
	BS EN IEC 61730	2018	Photovoltaic (PV) module safety qualification.

BS EN 62920	2017	Photovoltaic power generating systems. EMC requirements and test methods for power conversion equipment.
BS EN 50618	2014	Electric cables for photovoltaic systems
BS EN 62446	2016	Photovoltaic (PV) systems. Requirements for testing, documentation and maintenance. Grid connected systems.
BS EN 50583	2016	Photovoltaics in buildings. BIPV
BS IEC 62894	2014+ A1: 2016	Photovoltaic inverters. Data sheet and name plate.
BS EN 62109	2011	Safety of power converters for use in photovoltaic power systems. All parts
BS EN 62124	2005	Photovoltaic (PV) stand-alone systems. Design verification.

SYSTEM DESCRIPTION

The PV installation will be designed, supplied and installed by a specialist PV Installer. The specialist contractor will be expected to provide the following as part of the overall works:

- An isolator at board wall mounted on roof for connection to PV installation, and make final connection.
- Metering as indicated on the schematic drawings.
- a complete, fully working and tested PV system, to convert solar irradiation to electrical power

It is the responsibility of the Specialist PV Installer to liaise with the DNO at the earliest opportunity with details of the proposed PV installation, including application and completion for approval under the requirements of ENA EREC G99.

The system is to be grid tied with no battery storage.

The system is to generate electricity synchronised with the electricity supply.

The system is to be designed, installed, commissioned, and documented in such a way that the electricity production from PVs, and exporting of any electricity to the grid, is metered, and that the scheme is designed in line with the requirements for the (recently retired) Feed-in-Tariffs. Refer to all relevant drawings, schedules, and ERs.

The system will contain the following principal elements:

- Framed PV module system mounted on the existing roof, complete with associated accessories such as inverters, cables, cable conduits, carriers, fixings, DC switchgear, AC isolators, G99 relays, export limiter, etc
- Standalone monitoring installation (e.g. Solar-Log), with potential for connection to Psilon BMS
- All necessary mountings for panels integrated into lead roof
- All mountings for switchgear in roof void with small inverters local to the panels
- Routing, builderswork, and connection to the mains panel at GF office.
- All necessary provision of earthing and bonding for the installation.
- All necessary expansion/movement joints.
- All necessary provision of brackets/cut-outs for fixings and connections.

- All necessary gaskets and sealants.
- Surge protection on DC wiring.

All cables, fixings, and equipment are to be concealed within the building fabric and in dedicated rooms/voids.

The inverters for the system are to be located at roof level to minimise the size of cabling routing through the building. The submain from the inverter will pass via voids, and below ground to the GF office 3Ø LV panel which it will connect into via a busbar extension panel.

Roof mounting

- Specialist brackets which DO NOT require drilling-through lead are to be coordinated to support the PV array. These will be supplied and installed by others to agreed setting dimensions provided by the PV installer. The PV installer will be responsible for surveying the levels of the top surface of the installed mounting brackets and providing any shims necessary to meet the installation tolerances of the PV array.

The PV supplier/specialist will ultimately provide mounting details to the main contractor for integration of the panels with the roof.

- The panels will be mounted as the roof pitch.
- The panels will be on both north and south facing slopes.

Performance

The theoretical annual output as specified in the performance objectives is to be demonstrated by the method stated in the MCS "Guide to the Installation of Photovoltaic Systems".

Overshading calculations are to be comprehensive and include the effect of the tower, parapets, adjacent buildings, roof levels, and plant mounted on the roof. Provide details of alternative software-based calculations if proposed.

Panel string design is to be in accordance with inverter manufacturer's recommendations to achieve their published inverter efficiency.

The annual performance in practice is to be demonstrated and benchmarked, with data reported via a standalone monitoring system with potential connection to Psilon BMS.

Roof locations

- PV panels and roof mounted equipment to be installed only within the zones indicated on the drawings.
- Be aesthetically pleasing and minimise impact.

Panels

- REC Alpha Pure Series
- REC400AA Pure
- Power output per panel 400W
- Panel product warranty – in excess of 10 years.
- Panel efficiency to be no less than 18%
- Module output guarantee, maximum allowable reduction in output of 10% after 10 years, 20% after 25 years (as a percentage of initial maximum output).
- Single panel model to be used throughout.
- All black panel with low reflectivity.

Inverters

- Inverter warranty – in excess of 10 years.
- Inverter efficiency greater than: maximum 97.7%, European weighted 97.1%.
- Mount inverters so sufficient natural cooling is available at all times.

- Include software to monitor performance and transmit alarms – see Control Requirements section of this specification.
- Suitable for external mounting on roof.

Wiring, containment and electrical accessories
Typical cable and containment types to be used in the installation:

XLPE insulated single core aluminium armoured cable. BS6724
Application: Primary distribution: Submains.
Manufacture: PRYSMIAN
Conductor: Bare Copper
Core Insulation XLPE Armour: Aluminium wire, Inner and Outer Sheath: LSOH

XLPE insulated multicore steel armoured cable. BS6724
Application: Primary LV Distribution: Submains, final runouts to fixed plant.
Manufacture: PRYSMIAN
Conductor: Bare Copper
Core Insulation XLPE Armour: Aluminium wire, Inner and Outer Sheath: LSOH

Single Core XLPE insulated armoured cable 11kV Cable
Application Primary HV distribution.
Manufacture: PRYSMIAN
Conductor: Stranded Copper BS6360 Class 2
Armour: Aluminium wire, Insulation: XLPE 90°¬C, Bedding: LSOH

Three Core XLPE insulated armoured cable 11kV Cable
Application Primary HV distribution.
Manufacture: PRYSMIAN
Conductor: Stranded Copper BS6360 Class 2
Armour: Aluminium wire, Insulation: XLPE 90°¬C, Bedding: LSOH

Cable armour must be bonded at BOTH ENDS in accordance with BS7671. Circuits must be installed grouped together in 'Trefoil'.

Cable Tray: Galvanised Steel Cable Tray
Cable Ladder Rack: Galvanised Steel Cable Ladder
Buried Direct in Ground: Bury cables direct in the ground in neatly trimmed trench. All cables run below ground to be armoured.

No cables shall be installed in a wet or damp environment. All cable ends shall be suitably protected from the ingress of water prior to and during all stages of the installation. All cables and cable supports shall be installed in accordance with manufacturer's recommendations. All containment supports and fixings necessary to install the works shall be included. Armoured cables 50mm2 or greater are not to be fixed to cable basket. All cables are to be labelled in accordance with the requirements of BS7671.

Maintenance and Access
- Access for maintenance to be provided.
- Be self-cleaning, requiring minimal maintenance.
- Provide a cleaning and maintenance report.

General
- Disconnect safely in a mains outage.
- Provide safe earthing arrangements.
- Provide safe connection to the lightning protection system.
- PV array open circuit voltage not to exceed 120V.
- Provide protection against UV damage for cables.
- Ensure all cabling (including DC) is labelled appropriately.

- Ensure all PV installation equipment has appropriate safety and warning labelling.

CONTROL REQUIREMENTS

Control Strategy – Self Contained
The system is to control itself automatically to optimise performance.

The system is to include remote monitoring via inverters, so performance and diagnostics can be undertaken. The structured cabling system within the building is to be used for communication. The remote monitoring is to be via a single software interface, rather than multiple separate instances of the same software.

Control Points for Logging and Monitoring
The inverters are to be linked to a standalone monitoring system (e.g. Solar-Log), to provide system performance information and diagnostics, including:

- Current energy production
- Total energy production
- Daily energy production
- Fault

The standalone monitoring system must be capable of future connection to the college Psilon BMS.

SYSTEM DRAWINGS / SCHEMATICS

7008-MXF-XX-XX-SC-E-10200_PV Schematic – LV Layout showing cable run from PV.

TESTING AND COMMISSIONING

Carry out the testing and commissioning in accordance with the following:

- SPEC-200 MEP Preliminaries
- Schedule of Testing and Commissioning – J7008-XX-XX-SH-J-00001

Practical Completion will not be achieved until all the activities described above have been completed.

SYSTEM DRAWINGS / SCHEMATICS

7008-MXF-XX-XX-DR-E-10100_PV Layout
7008-MXF-XX-XX-DR-E-10300_PV Framing Detail
7008-MXF-XX-XX-SC-E-10200_PV Schematic
7008-XX-XX-SH-J-00001 Testing, Commissioning & Handover Schedules

REFERENCE SPECIFICATION CLAUSES

Also see the following Reference Specification SPEC-300 clauses for further details of Workmanship, materials standards, builders work standards, testing/ commissioning, and identification:

- PR_65_70_11_00 CONDUIT AND CABLE TRUNKING
- PR_65_70_36/48_00 HV/LV CABLES AND WIRING
- PR_60_70_48_06 BUSBAR TRUNKING
- PR_65_70_11_00 SUPPORT COMPONENTS - CABLES

- PR_60_70_48_00 LV SWITCHGEAR AND DISTRIBUTION BOARDS
- PR_75_51_52_00 CONTACTORS AND STARTERS
- PR_70_70_48_00 LUMINAIRES AND LAMPS
- PR_65_72_00_00 ACCESSORIES FOR ELECTRICAL SERVICES
- PR_65_70_46 LIGHTNING PROTECTION AND EARTHING COMPONENTS
- AC_70_65_00_00 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES
- PR_40_10_57_24 IDENTIFICATION - ELECTRICAL
- PR_20_29_00_00 FIXING TO BUILDING FABRIC
- PR_35_31_68_72 PAINTING AND ANTI-CORROSION TREATMENTS

SS_75_50_28_29 FIRE DETECTION AND ALARM

PERFORMANCE OBJECTIVES

To coordinate and maintain fire detection for the Kings College Chapel during normal operation and during refurbishment of the lead roof.

DESIGN PARAMETERS

Industry Standards

Statutory Acts	The Building Regulations		
	The Regulatory Reform (Fire Safety) Order 2005		
	The Electricity at Work Regulations 1989		
Building Control / Local Authority requirements	The Building Regulations Approved Documents • Part B 2013 Fire Safety • Part M 2015 Access to and use of buildings • Non-Domestic Building Services Compliance Guide • Section 2 (Fire) • Section 4 (Safety) The Memorandum of guidance on the Electricity at Work Regulations 1989 (the Memorandum)		
	IET Wiring Regulations 18th Edition, (BS7671:2018)		
	Local Authority building control and licensing requirements		
Industry standards	Chartered Institute of Building Services Engineers (CIBSE) • CIBSE E Guide • CIBSE K Guide		
	Building Services Research and Information Association (BSRIA) • Design Checks for Electrical Services (BG3/2006)		
	NIC/EIC • Technical Guidance		
	Fire Industry Association • Technical Guidance		
British Standards	BS 5839	Varies	Fire detection and fire alarm systems for buildings – all parts

BS EN 14604	2005	Smoke Alarm Devices
BS EN 54		Fire detection and fire alarm systems – all parts
BS 9999	2017	Fire safety in the design, management and use of buildings. Code of practice

SYSTEM DESCRIPTION

During renovations of the roof, the existing smoke detection in the chapel should be retained and maintained. Temporary isolation to the equipment is to be provided when needed for construction, to prevent false alarms during the work. The existing detection is as follows.

Smoke detection
The ground floor side rooms in the chapel are being served by smoke detectors, with their own sounders.

Aspirating system
The Chapel's main ceiling along the Ante-chapel and Sanctuary uses an aspirator system, which drops down from the ceiling void, for discreet protection.

Chapel roof void
The roof void is a large continuous space, with beam detection looking down the length of the void. Three sounders are spaced along the void for suitable coverage.

Coverage during construction
The scaffolding installation is to include a wired IP66 heat detector system within the temporary scaffolding roof to provide useful fire detection while minimising the occurrence of false alarms, position and number of detectors are to be decided by the appointed specialist.

The contractor should put in place management strategies for rising a fire alarm during hot working activities.

Additional coverage
An additional beam detector is to be installed alongside the existing beam detector in the roof void to provide some redundancy in this space.

Controls
The fire alarm system is controlled via fire alarm panel located in the South west stair at ground level and is to be maintained during construction.

REFERENCE SPECIFICATION CLAUSES

Also see the following Reference Specification SPEC-300 clauses for further details of Workmanship, materials standards, builders work standards, testing/ commissioning, and identification:

- PR_65_70_11_00 CONDUIT AND CABLE TRUNKING
- PR_65_70_36/48_00 HV/LV CABLES AND WIRING
- PR_60_70_48_06 BUSBAR TRUNKING
- PR_65_70_11_00 SUPPORT COMPONENTS - CABLES
- PR_60_70_48_00 LV SWITCHGEAR AND DISTRIBUTION BOARDS
- PR_75_51_52_00 CONTACTORS AND STARTERS
- PR_70_70_48_00 LUMINAIRES AND LAMPS
- PR_65_72_00_00 ACCESSORIES FOR ELECTRICAL SERVICES
- PR_65_70_46 LIGHTNING PROTECTION AND EARTHING COMPONENTS
- AC_70_65_00_00 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES
- PR_40_10_57_24 IDENTIFICATION - ELECTRICAL

- PR_20_29_00_00 FIXING TO BUILDING FABRIC
- PR_35_31_68_72 PAINTING AND ANTI-CORROSION TREATMENTS

SS_75_50_45_45 LIGHTNING PROTECTION

PERFORMANCE OBJECTIVES

The existing lightning protection, air terminations and their corresponding down conductors, are to be maintained during the replacement of the lead roof.

DESIGN PARAMETERS

Industry Standards

Statutory Acts	The Building Regulations		
	The Electricity at Work Regulations 1989		
Building Control / Local Authority requirements	The Building Regulations Approved Documents • Non-Domestic Building Services Compliance Guide • Section 2 (Fire) • Section 4 (Safety) The Memorandum of guidance on the Electricity at Work Regulations 1989 (the Memorandum)		
	IET Wiring Regulations 18th Edition, (BS7671:2018)		
Industry standards	Chartered Institute of Building Services Engineers (CIBSE) • CIBSE K guide		
	Building Services Research and Information Association (BSRIA) • Design Checks for Electrical Services - A quality control framework for electrical engineers (BG 3/2006)		
	Health and Safety Executive • HSG85 Electricity at work: Safe working practices		
	NICEIC • Technical Guidance		
	Energy Networks Association • Distribution Code: Engineering Recommendation G12/4 (Requirements for the application of protective multiple earthing to low voltage networks) – a review of Engineering Recommendation G12/3		
British Standards	BS 7430	2011	Code of practice for protective earthing of electrical installations

BS EN 62305	Varies	Protection against lightning. All parts
BIP 2118	2007	Protection against lightning. A UK guide to the practical application of BS EN 62305

SYSTEM DESCRIPTION

The current lightning protection installation gives the building a Class 1 level of protection. Each turret has their own air termination and down conductor at around 5m intervals to form the protective mesh. This to be maintained and where new bonds are to be formed to the new lead roof, the number and locations should match the current installation.

Testing
Testing should continue to be carried out by a specialist LPS installer/Server in line with the recommendations of BS EN 62305-3:2011 for the duration of the works. Where new bonds are to be formed from the ATN to the new lead covering a continuity test should be carried out at completion of the works and the results recorded for presentation as part of the handover documentation.

Solar panel array
With the addition of solar panels to the roof, protection is required to prevent any additional lightning risk created by the equipment.

As the PV's sit at a low profile adequate protective coverage exists from the current air terminations on the turrets, no new air termination is proposed along the roof. The solar panel array and structure is to be bonded to the existing lighting protection to prevent any isolated extraneous metal parts from being at a different potential.

Temporary Scaffolding
Lighting protection on the scaffolding is to be designed and intergraded via the main scaffolding contractor and is detailed out in the scaffolding tender design.

Surge protection
Provide surge suppression in a new enclosure adjacent to the existing switchgear panel at ground floor.

REFERENCE SPECIFICATION CLAUSES

Also see the following Reference Specification SPEC-300 clauses for further details of Workmanship, materials standards, builders work standards, testing/ commissioning, and identification:

- PR_65_70_11_00 CONDUIT AND CABLE TRUNKING
- PR_65_70_36/48_00 HV/LV CABLES AND WIRING
- PR_60_70_48_06 BUSBAR TRUNKING
- PR_65_70_11_00 SUPPORT COMPONENTS - CABLES
- PR_60_70_48_00 LV SWITCHGEAR AND DISTRIBUTION BOARDS
- PR_75_51_52_00 CONTACTORS AND STARTERS
- PR_70_70_48_00 LUMINAIRES AND LAMPS
- PR_65_72_00_00 ACCESSORIES FOR ELECTRICAL SERVICES
- PR_65_70_46 LIGHTNING PROTECTION AND EARTHING COMPONENTS
- AC_70_65_00_00 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES
- PR_40_10_57_24 IDENTIFICATION - ELECTRICAL
- PR_20_29_00_00 FIXING TO BUILDING FABRIC
- PR_35_31_68_72 PAINTING AND ANTI-CORROSION TREATMENTS

APPENDIX A – MEP ENGINEERING SERVICES TENDER DOCUMENT LIST

Please see accompanying issue sheet.

MAX FORDHAM

Kings College Chapel PV

Preliminaries for the Mechanical, Electrical & Public Health (MEP) Installations

For Client

February 2022

SPEC-200

Status Code	revision	status description	project code		originator		volume		level		type		role		number
D1	**P01**	**Issued For Costing**	**J7008**	**-**	**MXF**	**-**	**XX**	**-**	**XX**	**-**	**SP**	**-**	**J**	**-**	**30200**

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ISSUE HISTORY

Issue	Date	Description
P01	14/02/22	Issued for Tender

MAX FORDHAM LLP TEAM CONTRIBUTORS

Engineer	**Role**
PA	Senior Partner
EJ	Engineer

CONTENTS

1.0 INTRODUCTION

1.1 The Mechanical, Electrical & Public Health (MEP) Engineering Services documentation

This document SPEC-200 the "MEP Preliminaries" sets out the Contractor's responsibilities in relation to design, coordination, management and documentation for the MEP installations. This document forms part of the design information and should be read in conjunction with the Main Contract Preliminaries and all associated documents.

The MEP installations are also described by the following documents:

- SPEC-100 – Project specific description of the MEP installations
- SPEC-200 – Project preliminaries setting out the Contractor's responsibilities in relation to design, coordination, management and documentation.
- SPEC-300 – Reference specification setting out the required standards for installation, testing and workmanship for the MEP installations.
- Drawings and schedules listed in Appendix A of SPEC 100

1.2 Other Design Information

Obtain and take notice of all other relevant design information relating to the project as listed in the Main Contract Preliminaries. Some key documents include, but are not limited to the following:

Design information	Source of information
Architect's design information	Caroe Architects Ltd
Structural Engineer's design information	JM Structural Consultant
Civil Engineer's design information	Conisbee

The Contractor shall review the design documents and give notice of any inconsistencies, errors, omissions or inadequacies that are apparent.

1.3 Record information and reports

The Contractor shall obtain and take notice of all available record information, reports and regulatory requirements relating to the project, including but not limited to:

- Site services / Utility record drawings
- Existing building record drawings
- Planning conditions
- All others listed in Main Contract Preliminaries

1.4 Privacy

The information contained in the tender documentation shall be treated as private and confidential.

2.0 THE ENGINEERING SERVICES WORKS

2.1 Scope of MEP Engineering Services

The MEP Engineering Services included in the project works and covered by this specification comprise the following installations for the building(s) and site:

- Electrical services.

In relation to these MEP Engineering Services, the Contractor shall complete the design, coordination, drawing production, manufacture/fabrication, supply, installation, testing, setting to work, commissioning, system proving, making good of defects and fine tuning as described by the contract documentation.

The Contractor shall include for all the labour & materials required to deliver a complete, effective and safe working installation.

Allow for the coordination and cooperation with others when designing and installing the MEP Engineering Services.

3.0 TENDERING REQUIREMENTS

3.1 Tender Information

These conditions are supplementary to those stated in the invitation to tender and on the Form of Tender and Agreement.

3.2 Checking Documents

The Contractor shall check the tender documentation for obvious errors and omissions. Should any such errors or omissions be discovered, the Contractor shall inform the Contract Administrator (CA) / Employer's Agent (EA) immediately in writing in order that a correction may be issued before the date for submission of the tender.

3.3 Basis of Tender

With the exception of the performance specified MEP installations listed in clause 4.2 below, the tender documents for the MEP engineering services include MEP design developed to RIBA Stage 3. The contractor shall carry out the design for all aspects of the MEP engineering services as part of a Design and Build tender process.

All design responsibility for the correct operation and compliance with the Performance Objectives and Design Parameters within this specification rest with the Contractor. The contractor's design shall meet the Employer's Requirements for the MEP Engineering Services in full, including concepts, performance requirements, details, materials and equipment specifications. Any information relating to the size and duty of equipment that has been included within the tender information, has been included to indicate the assumptions used to establish the space requirements and distribution routes, and should not be relied upon for the purposes of the Contractor's design. The tender price must include for the cost of a complete working installation within the scope of the design described by the Employers requirements, whether explicitly indicated on the drawings or not.

The contractor must not rely on further design detail from the client/employer to complete their design. Max Fordham LLP will be retained by the client/employer to review Contractor's design proposals for compliance with the Employer's Requirements, attend site to inspect services installations and check commissioning of M&E systems prior to Practical Completion.

As part of the tender process, the contractor shall review the MEP designs, performance requirements, details, materials and equipment specifications and report any concerns with completing, and taking full ownership of the design and installation on this basis.

The contractor may offer alternative design proposals as part of his subsequent design development but these must be presented as optional, including details of the benefits to the client (such as capital, maintenance or running cost savings).

The contractor shall include for the provision of a complete working installation as set out in clause 3.4.

3.4 Provision for Complete Working Installation

As well as the MEP plant, equipment and materials described within the tender documentation, the Contractor shall also include in the tender price all other components that are required for the proper and safe working of

the MEP Engineering Services systems, whether explicitly described in the contract documents or not.

3.5 Site Visit

Before tendering, ascertain the nature of the site, any access constraints and all local conditions and restrictions likely to affect the execution of the MEP Engineering Services. Inspect any existing installations relevant to the works and study all available existing records.

Arrangements for visiting the site must be made with prior agreement with the CA/EA.

3.6 Selection of Plant & Equipment

Where manufacturers, suppliers or installers of products are identified by name, or names, but NO reference is made to "Or Equivalent" the submitted tender must include the specified manufacturers, suppliers or installers.

Where manufacturers, suppliers or installers of products are identified by name, or names, but reference is made to "Or Equivalent" the submitted tender must also include the specified manufacturers, suppliers or installers. The Contractor shall submit full technical details of any alternatives to the CA/EA with an associated revised cost with their tender returns.

The Contractor shall fully re-evaluate and price for all parts of the MEP Engineering Services and building design that may be affected by the implementation of the alternative. Where manufacturers, suppliers or installers of products are NOT identified by name, the Contractor shall select products that comply in all respects with the specification. The Contractor shall submit full technical details to the CA/EA with their tender returns demonstrating compliance.

The Technical Submittal for alternative proposals must include all information set out in clause 9.7. Incomplete submittals will be rejected by the CA/EA.

3.7 Tender Submission

Tenders shall comply with the requirements of this Specification. Where the Tenderer wishes to submit an alternative for consideration, it shall be submitted as a separate proposal. The alternative proposal shall include a full description, including details of the variation from the Specification and the cost and programme effect of the proposal.

Alterations and qualifications to the specification must not be made without the written consent of the CA/EA. Tenders containing such alterations or qualifications may be rejected.

In addition to the Main Contract Preliminaries tender requirements, the Contractor shall provide the following information:

- Tender Summary pricing document included at the start of the MEP Specification (SPEC 100), completed in full.
- Method statements for any MEP works requiring interruptions of supplies, out of hours working, noisy work, road closures or disruption to other building users or neighbours. See clause 10.1 for further method statements required prior to the commencement of the contract works
- Programme indicating the sequence and timing of the principal parts of the MEP works including periods for planning, design, procurement, installation and commissioning.
- All H&S information required by the Main Contract Preliminaries, CDM Regulations and all other legal obligations.
- Management procedures to be adopted for the project.

- Details of management and resourcing of MEP design duties and responsibilities including design capability.
- MEP commissioning and testing procedures and management.
- Quality control management and procedures including a statement outlining the MEP management team, stating the definition of each person's role, and the commitment to the project. Include the curriculum vitae and references for each of the key personnel that will be used on the project and a line management diagram.
- Any foreseen difficulties with delivery periods for materials and equipment.

3.8 Provisional Sums

No provisional sums are detailed in the MEP specification – SPEC 100.

3.9 Utilities and Statutory Authorities

The Contractor shall carry out all works relating to the utility services disconnections, diversions and provision of new supplies, including:

- Obtain/finalise quotations for all necessary utility works
- Place orders for works to meet programme.

The Contractor shall

- Liaise with the Statutory Authorities and provide any test notices required to ensure final connections are made in accordance with the requirements of the programme.
- Notify the District Surveyor, Building Control Officer and Fire Officer directly in respect of all tests and demonstrations relevant to life safety installations, and include for all necessary attendance, documentation, etc., to ensure full Statutory Authority approval of the installation.
- Observe and comply with the requirements of all Statutes and Bye-Laws.
- Serve notices on the Authorities having control of the road surfaces before the same are broken up and likewise serve notices on the owners of sewers, drains, water, gas or other mains, electric cables, tramways and other services which may in any way be affected by the execution of the MEP Engineering Services.
- Advise CA/EA of their obligations relating to agreement of all necessary wayleaves in good time to ensure no delay to the programme.
- Inform all necessary parties when work necessitates such notices to be given.

3.10 Building Information Modelling (BIM) Strategy

Where the project includes a BIM strategy the Contractor shall comply with the project's BIM requirements set out in the Main Contract Preliminaries.

3.11 Use of BIM Model Information

The tender/contract documents for the MEP Engineering Services are based solely on the drawings, specifications and schedules listed in Appendix A of SPEC-100.

3.12 Modelling responsibilities of the contractor

Ensure models are developed on the basis of the architectural, structural and other specialist subcontractor models. Issue the model along with all drawing submissions (and technical submissions where relevant) for comment and review. Provide the modelled information to the Client at hand-over.

4.0 DESIGN RESPONSIBILITIES

4.1 Contractor Design responsibilities

The contractor shall be responsible for carrying out the following reviews, design development, technical submittals and coordination.

- **Contractor Design Review** – Review the MEP design information and advise the CA/EA of any errors or discrepancies that are reasonably apparent in the design, specification & drawings provided by or on behalf of the Employer. Prior to placing orders for materials and equipment, the contractor shall check schedules for any discrepancies, such as between model/catalogue number and the specified duty/description. Prior to commencing installation on site, the contractor shall check that the MEP design information is compatible with best practice installation standards and current manufacturers' installation instructions/requirements. The Contractor shall be responsible for the compatibility and correct installation of all components.
- **Contractor Design** – The Contractor shall employ specialist subcontractors and/or consulting engineers to complete the design of MEP installations which have been performance specified (listed in clause 4.2 below) and all other MEP engineering services installations forming part of the Design & Build contract. The Contractor shall submit design proposals which meet the requirements of the MEP Engineering Services documentation in full – including any concepts, performance requirements, details, materials and equipment specifications.
- **Coordination Drawings** – For all MEP installations, issue Coordination Drawings and 3D model from which they were where generated (if required by the MC prelims) showing the interrelationship between the various MEP services, structure and architectural details. The coordination drawings must demonstrate the proper separation of MEP services, maintenance access arrangements and plant replacement strategies. See clause 5.0 for more detail.
- **Technical Submittals** – For all MEP installations, provide manufacturers drawings/details/schedules indicating proposed equipment selections and arrangement. See clause 9.7 for Technical Submittals requirement.
- **Installation Drawings** – For all MEP installations issue Installation Drawings incorporating sufficient detail enable to works to be installed on site. See clause 9.2 for more detail.

The Contractor shall request such further information as may be required to carry out the MEP Engineering Services in sufficient time to meet the programme.

4.2 Performance Specified MEP installations

Performance specified MEP systems

- Ss_70_10_70_35 Photovoltaic system (including electrical connections and support system)
- Modularisation of any prefabricated MEP installations
- Capacity, location, routes and design of electrical cable ways (conduit, trunking, tray, basket, etc.).

Coordination/arrangement/selection/workmanship/commissioning/maintenance

- Control of thermal expansion.
- Temporary access platforms and safe working access for installation
- Brackets, supports and plant bases (including roof plant support platforms)
- Builders work requirements (final setting out and confirmation of sizes and extent). See clause 4.4 below.
- Detailed setting out of electrical plant (architect to provide setting out of visible equipment in occupied areas).
- Arrangement of MEP installations to facilitate maintenance and replacement access
- Alternative equipment and plant items selected by the Contractor (see clauses 3.6 and 9.5).
- Detailed proposals for cleaning, flushing, testing, and commissioning.
- Temporary installations and sectional commissioning to facilitate phased handover where required

- Survey, isolation, identification, disconnection, strip out and disposal of existing M&E services.
- Phasing, sequencing and temporary supplies necessary to ensure MEP supplies are maintained to other occupied parts of the building/site/surrounding area.
- Temporary power and lighting systems, including 3h self-contained emergency lighting for public escape routes through the Contractor's site.

4.3 Responsibility Matrix / Model Information Delivery Plan

Contractor shall provide all design information set out in the responsibility matrix in Appendix A of this document and the Model Information Delivery Plan (MPDT).

4.4 Builders Work

The contractor shall

- Check and confirm (in writing) that the structural design drawings incorporate all necessary builderswork holes and openings.
- Confirm and amplify any further non-structural provided by the CA/EA.
- Provide builders work information, appropriate to the stage of design development. Revise, supplement and/or issue final information, drawings/details for the actual requirements of the contract works.
- Provide fully dimensioned drawings showing both size and position of builders work making due reference to the structural engineering and architectural final dimensioned detailed drawings.
- Mark out on site all cut holes and chases required, any pockets cast in concrete, any inserts, any built in sleeves or similar items.
- All builders work information shall be provided to comply with the programme and include sufficient time for the necessary approvals.
- Where alternative equipment or materials has been offered that the CA/EA has accepted and which subsequently varies the works in any way whatsoever, then undertake the redesign of the associated builders work.

Marking Out of Builders Work Holes on Site:
Mark out on site actual locations of minor non-structural holes through walls, partitions, floors, etc. and also chases in non-fair-faced walls and the like in preference to providing drawings of such builders work requirements.

Builders Work Information to Be Provided:

- All builders work drawings shall be fully dimensioned.
- Builders work drawings to be provided shall be as follows:
    - Details of all bases for plant formed in concrete, brickwork or blockwork
    - Details of all attendant builders work, holes, chases, etc. for conduits, cables and trunking etc. and any item where access for a function of the installation is required
    - Details of all types of purpose made brackets for supporting service or plant/equipment
    - Details of all accesses into ceilings, ducts, etc.
    - Details of all special fixings, inserts, brackets, anchors, suspensions, supports etc.
    - Details of all sleeves, puddle flanges, access chambers
- Submit all necessary load and thrust calculations with drawings/details.

Structural Steelwork:

- No steelwork shall be cut, drilled or welded without written approval from the structural Engineer.
- The cutting and drilling of structural steelwork shall be agreed with the CA/EA prior to the commencement of the work and shall require application in writing with all necessary drawings/details.
- Fixings to steelwork shall be

    - the approved clamp type
- All fixings shall be of the correct size and type for the fixing load applied and the type shall be approved prior to commencement of the works.
- Permitted holes in steelwork must be drilled - burning by means of welding equipment is prohibited.

Pre-Cast Concrete:

- Holes may not be cut in precast concrete without written approval from the CA/EA.
- Under no circumstances will holes be cut in pre-stressed concrete

Secondary Steelwork:

- The Contractor shall include in their tender for the supply and installation of all steelwork required to support the services from the primary structure.

4.5 Fire Stopping of Services Penetrations

It is critical that the fire compartmentation is effective in case of fire. The Contractor will take responsibility for making sure that the fire-stopping is carried out all areas of the building and in accordance with the fire strategy, the Building Regulations, manufacturers information and all other relevant standards.

The Contractor will employ a FIRAS Certified Specialist Installer who is also a registered member of the Association for Specialist Fire Protection (ASFP) to carry out all of the fire-stopping of services penetrations, and certify the work.

The Contractor will:

- Use a fully certified, traceable system of fire-stopping products which are LPCB / CERTIFIRE approved and CE marked – from a quality fire-stopping manufacturer, e.g. Astroflame, PFC Corofil or Promat.
- Coordinate the fire-stopping process and produce detailed documentary evidence for inclusion in the O&M manuals
- Ensure that all of the fire compartmentation requirements of Approved Document B (England), Section 2 (Scotland), BS 9991 (Residential) and BS9999 (All Buildings) are met.
- Meet any additional fire-stopping requirements required by the Fire Engineer and the Approved Inspector
- Follow all latest guidance from the Association for Specialist Fire Protection, as set out in the latest available version of 'Fire Stopping and Penetration Seals for the Construction Industry' and all relevant document to which it refers.
- Ensure that the all necessary active fire/smoke separation devices are incorporated into the engineering services to meet Approved Document B (England), Section 2 (Scotland), BS 9991 (Residential) and BS9999 (All Buildings)
- Ensure all fire rated ductwork, Fire-Smoke Dampers, Fire Dampers and Motorised Smoke Control dampers are suitably rated for their location, properly installed in accordance with manufacturers' instructions and standard details, and that these devices are LPCB certified and CE marked.
- Make sure that all intumescent pipe collars are suitably rated for their location, properly installed in accordance with manufacturers' instructions and standard details, and that these devices are LPCB certified and CE marked.

As part of the documentation and demonstration process the Contractor shall:

- Offer areas for inspection to the Fire Engineer, Approved Inspector and Employer's representatives prior to covering up with wall finishes, floor finishes or ceilings.
- Note that the Contractor has full responsibility for making sure the fire-stopping is complete and to the correct standard – these quality inspections are not exhaustive and serve only as cross-checks that the work is generally being managed and carried out in accordance with the ERs.

- Make a complete photographic record of all fire-stopping penetrations before and after application of the fire-stopping systems/materials and include in the O&M manuals. Mark the location and direction of these photographs on the building compartmentation drawings.
- Make good (and completely re-install where necessary) any fire-stopping where additional holes have been cut and services have been run through after the first round of fire-stopping. All making good must be to the same standard as the original fire-stopping, in accordance with the system manufacturer's standard details and installation guidelines.

If any of the inspections by other consultants highlight potential problems or lapses of quality with fire-stopping, the Contractor will carry out a full review of their photographic records and identify any other areas where a similar problem may occur. The Contractor will open up risers, ceilings walls and/or floors wherever necessary, carry out remedial works to re-install the correct fire-stopping, and then make good.

5.0 COORDINATION

5.1 Additional Co-Ordination Responsibilities of the Mechanical Contractor:

Notwithstanding the overall responsibility of the Main Contractor to programme and coordinate the entire works, the contractor responsible for the mechanical services installations (the "Mechanical Contractor") is to allow for and price within their tender the following additional responsibilities:

(a) the overall coordination of all services installations within the MEP Engineering Services, utilising information provided by others for the structure, architectural form, electrical installations, security installations, fire protection installations, and all other specialist services installations.

(b) Production of composite Builders Work Drawings incorporating all services installation requirements.

(c) arranging receipt of, and reviewing, all other services contractor's coordinated drawings, and immediately advising, confirming and agreeing with the said contractors and the Main Contractor any necessary alterations/changes/amendments in order to make these drawings truly and fully coordinated with each other.

The Mechanical Contractor is to nominate a representative to be responsible, in conjunction with the Main Contractor, for the management and programming of the entire services coordination for the MEP Engineering Services including, but not limited to, chairing services coordination meetings, preparing a schedule of drawings required, preparing a production programme, reporting on progress, and supervising the timely production of coordinated drawings by each of the relevant services contractors.

Cooperation of Others:

All other services contractors (electrical, security, fire, etc.) are to ensure that the programming and production of their design and working drawings allows the Mechanical Contractor to fulfil their obligations under this clause. Each individual contractor will retain full responsibility for the programming and accuracy of the information provided by them

5.2 Coordination of Trades:

Allow for co-ordinating the contract works with the works of other trades and installations which may be on site during the period of the contract.

5.3 Coordination of MEP Services:

All aspects of the works require detailed co-ordination to avoid any possible clash or conflict with other trades and disciplines. Undertake such co-ordination in relation to the MEP Engineering Services.

- No extra cost or claim will be allowed due to conflict of works or installations, where full liaison with other trades and disciplines would have prevented such an occurrence.
- When any new, revised or updated architectural, structural or services information is issued by the CA/EA under the authority of an instruction, examine such information and if necessary modify the works accordingly to prevent any clashes or abortive work due to such instruction.
- No extra cost or claim will be allowed to cover any clashes or abortive work that result from not requesting an explanation or seeking clarification in respect of any such revision.
- No extra cost or claim will be allowed due to conflict of works or installations, where full liaison with other trades and disciplines would have prevented such an occurrence.

5.4 Coordination of Services on Site:

Allow for co-ordinating the contract works with the works of other trades and installations which may be on site during the period of the contract either during or prior to their incorporation into the works.

- Where minor clashes of services occur on site that were not foreseeable at the design or co-ordination drawing stage then these clashes or minor co-ordination matters shall be resolved by discussion and agreement with other trades and disciplines. The CA/EA shall be informed of the action to be taken by an approved means.

5.5 Maintainability:

- At all times give proper consideration to the future maintenance of the installed plant and services, and shall include for such component parts as are provided by the manufacturer of equipment and plant for this purpose.
- Ensure that adequate space for maintenance is provided and that all serviceable components can be dismantled and replaced with minimal disturbance to the surrounding installations and building components. Demonstrate that all plant and equipment incorporated into the MEP Engineering Services can be safely and easily maintained in full compliance with:
    - Health and Safety legislation
    - CDM requirements
    - British Standards
    - Health Technical Memoranda.
- All parts of the service installations are to be selected and designed for minimum maintenance during their life. The planned and preventative maintenance requirements of the installed services and plant are to be coordinated within the design.
- All conduit, trunking, pipework and the like for future use will be installed with draw wires and located to afford access for and to facilitate or addition of further circuits etc. without the removal of fixed sections of walls, ceilings and the like.
- Where pipes cross access routes at low level purpose made step-overs shall be installed to provide safe access and prevent damage to the services.

6.0 MATERIALS & EQUIPMENT SELECTION

6.1 Certification Standards for Materials & Equipment

The Contractor shall ensure all MEP materials and equipment installed are suitable for operation in the environment in which they can reasonably expected to operate and have been tested and certified to meet the standards described below.

- Ensure systems plant and equipment required to operate under fire conditions are tested, selected, certified and arranged to ensure correct operation in the temperatures and fire conditions specified.
- Ensure all MEP plant, systems and equipment are suitable for operation at full capacity under the worst case operating conditions (with appropriate margins) to suit the site including:
    - Height above sea level
    - Internal conditions such as temperature and humidity
    - External conditions such as temperature, humidity, moisture, coastal conditions (e.g. sand & salinity), exposure/wind speeds, local ecology/flora and fauna.
    - Power supply characteristics – Confirm with the Supply Authority before ordering any equipment dependent upon voltage or frequency. And ensure all electrical equipment supplied and installed is suitable for the power supply characteristics measured on site.
- Unless stated otherwise the MEP materials and equipment shall comply with, and be certified to the appropriate British Standard (BS) or Code of Practice (CP) and where no BS or CP is applicable comply with
    - The Agrément Certificate for the particular item.
    - CIBSE recommendations and guides to current practice.
    - BS 7671 Requirements for Electrical Installations
    - Guidance published by IEE and IET.
    - Building Regulations
    - Energy Related Products (ErP) Directive
- Ensure all equipment and systems are designed and installed in accordance with the relevant standards and that operational compatibility exists between the systems and any other system installed in the same location.
- All product and materials shall have product conformity certification (e.g. BSI Kitemark, BSI Safety Mark or CARES scheme) or product approval (e.g. British Board or Agrément Certificate).

6.2 Electromagnetic Compatibility

The Contractor shall ensure that all equipment and systems are installed to provide electromagnetic compatibility within the system and with any other systems installed in the same area.

Ensure all equipment meets the requirements of the appropriate electromagnetic compatibility standard including:

- Industrial, Scientific and Medical – BS EN 61000-6-4 and BS EN 55011.
- Household electrical appliances, portable tools and similar apparatus – BS EN 55014.
- Fluorescent lamps and Luminaires – BS EN 55015.
- Information technology equipment – BS EN 55022.
- Mains signalling – BS EN 50065.
- Broadcast receivers and associated equipment – BS EN 55013 and BS EN 55020.
- Industrial process measurement and control – BS EN 60801.
- Other equipment to generic standards
- Emissions
- Domestic, commercial and light industrial
- BS EN 61000-6-3.
- Heavy industrial
- BS EN 61000-6-4

- Immunity
- Domestic, commercial and light industrial
- BS EN 61000-6-1
- BS EN 55014-2
- Heavy industrial
- BS EN 61000-6-2.
- Particular environments
- BS EN 61000
- Ensure all apparatus covered by the Wireless Telegraphy Act meets regulations issued by Ofcom.
- Ensure all equipment and systems meet the requirements of BS 6701 and BS EN 41003.
- Ensure that all cable installations meet the minimum guidance separation in EMC of Installations and Recommended Cable Separations, published by the ECA.
- Ensure that all cable installations meet the minimum separation in BS 7671 and BS EN 50174.

6.3 Pressure Directive:

All pressure equipment and assemblies with a maximum allowable pressure greater than 0.5 bar shall comply with the European Community (EU) Pressure Equipment Directive (PED) 97/23/EC.

Pressure equipment shall be marked as a minimum with:

a) unique identification of the manufacturer
b) unique identification of model and serial number
c) the year of manufacture
d) maximum/minimum allowable pressure limits
e) CE marking

Provide:

- A declaration of conformity for all pressure equipment.
- Copies as part of the record documentation.

Ensure all components or sub-assemblies in their finished assembly are used within their safe operating range and correctly installed and tested.

Ensure that adequate instructions are provided by the manufacture for the safe installation, testing and operation.

Instructions shall be provided within the Operating and Maintenance Manual to ensure for the safe maintenance and operation of the equipment when in operation.

Pressure equipment and assemblies below the specified pressure / volume thresholds must:

a) be safe
b) be designed and manufactured according to sound engineering practice

6.4 ATEX Directive:

All equipment and protective systems used in potentially explosive atmospheres shall comply with the ATEX Directive 94/9/EC of the European Parliament and the Council.

6.5 EU Declaration of Conformity:

Provide an EU Declaration of Conformity prior to delivery to site.

The declaration shall state the following as a minimum:

- The manufacturer (or representatives).
- Description of equipment.
- The harmonised standard(s) that have been applied.
- The signatory who has been empowered to enter into commitments on behalf of the manufacturer.
- The last two digits of the year in which the CE marking was affixed.

6.6 Equipment specified by the Consultant

Where materials and equipment have been specified by the consultant the Contractor shall check that:

- In the absence of specific design, performance or installation standards being stated seek the instructions of the CA/EA prior to commencement of the MEP Engineering Services and with adequate time so as not to cause delay.
- When new editions, versions and amendments are published during the construction, seek the instructions of the CA/EA with respect to any modifications or changes necessary.

7.0 EXISTING MEP SYSTEMS, EQUIPMENT AND TEMPORARY WORKS

7.1 Surveys:

- Ascertain the nature of the site and all local conditions and restrictions likely to affect the execution of the MEP Engineering Services works.
- Before commencing work, carry out a survey and examination of buildings, structure and engineering services affected by the works.
- Examine all available drawings of the engineering services and report any discrepancies to the CA/EA.

7.2 Site Dimensions and Levels:

Install all engineering services using a laser levelling system wherever possible and co-ordinate the measurements with all other trades and disciplines to prevent any clashes.

Obtain all dimensions and levels on site for the actual setting out of the works.

As the development advances measure on site all works by others that may foreseeably affect the works. These dimensions shall be incorporated into the installation drawings or marked up on revised drawings if already issued.

No extra cost or claim will be allowed for any errors arising from inaccurate setting out or failure to check actual site dimensions.

7.3 Existing Mains:

Existing services shall not be interfered with, nor interrupted in any way without the prior written permission of the CA/EA.
Be responsible for any damage entailed and make good any such damage to the satisfaction of the CA/EA at no extra cost.

7.4 Facilities for Removal of Equipment:

- Ensure isolation and drain down of any item of equipment without isolating large sections of the remaining system.

7.5 Risks to Health and Safety:

The nature and condition of the existing services have not been fully ascertained. All information relating to the existing services should be checked by the contractor on site. The contractor shall carry out risk assessments and ascertain the nature and condition of the existing services prior to working around or amending existing services.

7.6 Maintenance of Existing Services:

- Fully maintain the following existing services during the progress of the contract works
- Include in the contract price all costs to maintain the existing services at all times during the duration of the contract works.
- Submit with the tender a method statement outlining how the maintenance works is to be undertaken

including any necessary specialist maintenance.

- Prior to commencement of the contract works submit a method statement to the CA/EA outlining how the existing services are to be maintained including all planned and preventative maintenance measures.
- Provide any additional work and materials necessary to maintain these services at all times during the duration of the contract works.
- Make all connections to existing services
    - out of normal working hours.
- Existing services disturbed or damaged during the contract works are to be reinstated
    - Submit to the CA/EA a method statement outlining the method and procedures for the remedial and reinstatement works.
    - Any shut down of existing services to undertake remedial and reinstatement works shall be to an agreed procedure.
    - Reinstate fully in accordance with the standards of quality as defined in the specification and to the satisfaction of the CA/EA.

Maintain new services during the rectification period as set out in clause 12.4

7.7 Strip-out

Provide method statements for surveying, identifying, isolating and stripping out existing services

7.8 Interruption of Supply

Work that requires interruption or interference with the operation of any existing services or buildings shall not be commenced without prior written permission of the CA/EA.

14 days' notice of intention to proceed with such works shall be given to the CA/EA.

8.0 HEALTH AND SAFETY

8.1 CDM Regulations:

- The management of health and safety is to be undertaken in conformity with the requirements of The Construction (Design and Management) Regulations 2015, and the corresponding Approved Code of Practice.
- See the Main Contract Prelims for further details.

9.0 INFORMATION FLOW

9.1 Drawings

Information Provided By Others:
Instructions, drawings, or other information required to be provided by the CA/EA will be provided in due time upon written request provided always that such information is not requested unreasonably distant from nor unreasonably close to the date upon which it is necessary.

Provide written request to the CA/EA in good time for any information required.

Supply of Information:
The CA/EA will provide supplementary information from time to time as may be necessary to enable the completion of the MEP Engineering Services Works in accordance with the contract conditions. Allow for such progressive release of further information by the CA/EA during the course of executing the MEP Engineering Services Works.

In order to facilitate the orderly and timely production of all further information that shall be considered necessary, submit to the CA/EA for approval a programme indicating the progressive release of such information to enable the completion of the MEP Engineering Services in accordance with the contract conditions.

Progress:
At regular intervals as agreed with the CA/EA provide progress reports during the execution of the contract works in addition to any other similar information required by the contract conditions.

The reports shall include:

- particulars of materials and equipment on site, or installed
- site labour employed
- progress of the works
- Record progress of the MEP Engineering Services Works weekly on a copy of the programme.

Mark up for inspection and record purposes a set of the latest drawings as the works progress. The progress drawings shall be available for inspection by the CA/EA at any time.

9.2 Drawing Definitions

The Tender Drawings:
Drawings produced to enable those tendering to interpret the design and to submit a tender for executing all or any part of the MEP Engineering Services Works as defined elsewhere.

The tender drawings are listed in Appendix A of SPEC-100

Sketch Drawings:
Line diagrams and layouts indicating basic proposals, location of main items of plant, routes of main pipes, air ducts and cable runs in such detail as to illustrate the incorporation of the engineering services within the project as a whole and with respect to any zoning.

Sketch Schematics:
Line diagrams indicating main items of plant and their interrelationship in such detail as to illustrate the incorporation of the engineering services within the project as a whole.

Detailed Schematics:
Line diagrams describing the interconnection of components in a system and showing the engineering

principles. The main features of a schematic drawing are as follows:

- The drawings include all the functional components that make the system work, such as ducts, pipes, cables, busbars, plant items, pumps, fans, valves, dampers, control devices, strainers, terminals, electrical switchgear and components, security and fire sensors and control equipment.
- Symbols and line conventions in accordance either with a recognised standard, such as ISO or BS, or a supplied legend.
- Drawings labelled with appropriate pipe, duct, busbar and cable sizes, pressures and flow rates.
- The drawings indicate components which have a sensing, control or measurement function.
- Identify major components on the schematic drawing for cross-referencing purposes.
- All data essential to testing and commissioning including:
    - volumetric flow rates.
    - design total pressure losses at equipment.
    - location of dampers.
    - location of valves and flow measuring stations.
    - electrical fault levels.
    - current ratings.
    - short circuit capacities and tripping times.

Detailed Design Drawing:
A drawing showing the intended locations of plant items and service routes in such detail as to indicate the design intent. The main features of detailed design drawings should be as follows:

- Plan layouts to a scale of at least 1:100.
- Plant areas to a scale of at least 1:50 and accompanied by cross-sections.
- The drawing will not indicate the precise position of services, but it should nevertheless be feasible to install the services within the general routes indicated. It should be possible to produce co-ordinated working drawings or installation drawings without major re-routing of the services.
- Pipework and cable containment represented by single line layouts.
- Ductwork represented by either double line or single line layouts as required to demonstrate that the routes are feasible.
- Symbols and line conventions in accordance with either a recognised standard, such as ISO or BS, or supplied legend.
- The drawing should indicate the space available for major routing in both horizontal and vertical planes.

Coordinated Working Drawings:
Drawings showing the inter-relationship of two or more engineering services and their relation to the structure and building fabric. The main features of co-ordinated working drawings are:

- Plan layouts to a scale of at least 1:50, accompanied by cross-sections to a scale of at least 1:20 for all congested areas.
- The drawings should make allowance for installation working space and space to facilitate commissioning and maintenance.
- The drawings should be spatially co-ordinated and there should be no physical clashes between components when installed. Critical dimensions, datum levels and invert levels should be provided.
- The spaces between pipe and duct runs down on the drawing should make allowance for the service at the widest point. Insulation, standard fittings dimensions and joint widths should therefore have been allowed for on the drawing.
- The drawing should indicate positions of main fixing points and supports where they have significance to the structural design of spatial constraints.

Installation Drawing:
A drawing based on the detailed drawing or co-ordination drawing with the primary purpose of defining that information needed by the tradesman on site to install the works. The main features of installation drawings should be as per co-ordinated working drawings plus:

- Allowances should be made for inclusion of all supports and fixings necessary to install the works.
- The drawing should make allowances for installation details provided from manufacturer's drawings.
- Allowances should be made for plant and equipment. This includes any alternatives to the designers original specified option that have been chosen.

Manufacturer's Drawing:
Drawing prepared by a manufacturer, fabricator or supplier for a particular project, and which is unique to that project. Examples include drawings for ductwork, pre-fabricated pipework, sprinkler systems, control and switchgear panels and associated internal wiring, pre-fabricated plant, customised plant and equipment.

Record Drawing:
Drawing showing the building and services installations as installed at the date of practical completion. The main features of the record drawings should be as follows.

- The drawings should be to a scale not less than that of the installation drawings
- Locations of all mechanical, electrical and public health systems and components installed including ducts, pipes, cables, busbars, plant items, pumps, fans, valves, dampers, control devices, strainers, terminals, electrical switchgear and components, security and fire sensors and control equipment.
- The drawing should be labelled with appropriate pipe, duct and cable sizes, pressures and flow rates.
- The drawings should have marked on them positions of access points for operating and maintenance purposes.
- The drawings should not be dimensioned unless the inclusion of a dimension is considered necessary for location.

Builders Work Details
Drawing to show requirements for building works necessary to facilitate the installation of the engineering services.

Unless stated or agreed with the CA/EA the following builders work details can be marked out on site:

- Holes less than the threshold dimension stated elsewhere.
- Electrical socket and switch boxes.
- Openings that are best cut into blockwork and partitions.

Builders work drawn information to be provided shall include:

- Details of all bases for plant formed in concrete, brickwork or blockwork to a scale of not less than 1:20
- Details of all attendant builders work, holes, chases, etc. for conduits, cables and trunking etc. and any item where access for a function of the installation is required to a scale of not less than 1:100
- Details of all-purpose made brackets for supporting service or plant/equipment to a scale of not less than 1:50
- Details of all accesses into ceilings, ducts, etc. at a scale of not less than 1:50
- Details of all special fixings, inserts, brackets, anchors, suspensions, supports etc. at a scale of not less than 1:20

Plantroom Schedules And Schematics:
Provide good quality plant and switch room drawings, schedules, schematics and instructions and hang in the respective plant room or any other appropriate location or where directed by the CA/EA.

Protect surfaces of such information by

- Pressure lamination.
- Framing under glass or other rigid, transparent, cleanable and protective surface.

Hang using suitable fixings and provide backboards if necessary

A sample shall be submitted for approval to the CA/EA prior to commencing production.

- Schematic drawings of circuit layouts showing:
    - Location, identification and duties of equipment.
    - Location of controls devices.
    - Circuit layout.
- Valve schedules in the form of printed sheets showing the number, type, location, application/service and symbol, and normal operating position of each valve.
- Control schematics.
- Location of mechanical and electrical plant and equipment items.
- First aid instructions for treatment of persons after electric shock.
- Location of isolating switch for electricity supply.
- Location of main incoming gas valve serving gas meter and isolation point.
- Location of main incoming water main and isolation point.
- Location of sprinkler fire main control valve.
- Emergency operating procedures and telephone numbers for emergency call out service applicable to any system or item of plant and equipment.
- All other items required under Statutory or other regulations.

9.3 Prefabrication Proposals

Provide fabrication drawings for comment

9.4 Programme

Provide a detailed programme(s) clearly illustrating how the overall programme:

- Will be achieved within the contract period.
- Demonstrate compliance with the Main Contract programme.

Provide the detailed programme:

- within one month of the award of the contract

Due allowance is to be made in the programme(s) for, but not limited to, the following:

- Statutory authority approvals including Building Regulations.
- The latest dates for release of final information required from the CA/EA.
- Required method statements.
- Ordering dates and manufacturing periods. The proposed delivery to site for each item of major plant to be clearly defined.
- The period required for the production, approval and issue of:
    - Builders work information
    - Co-ordinated working drawings
    - Installation drawings
    - Manufacturer's drawings.

Allow adequate time for the examination and approval by the CA/EA. Actual activities of production, adjustment, resubmission and review must be identified

- Installation periods for each system
- Work resulting from instructions issued in respect to the expenditure of provisional sums.
- Concurrent work by other trades.
- Any temporary works necessary for the completion of the engineering services installations.

- Period required for operating the systems, load simulation tests and final adjustment.
- Environmental load testing.
- Period for instructing the Employer training.
- Pre-commissioning, commissioning and performance testing of the engineering services installations.
    - The period required and latest dates for the production, approval and issue of record drawings and operating and maintenance instruction manuals.
    - Provide programme information as
    - critical path network.
- Provide a separate and detailed commissioning programme for agreement with the CA/EA. Make due allowance for the following.
    - Commissioning, demonstration and instruction procedures.
    - Provision of written notice before each (or series of) test, inspection, commissioning or demonstration procedures are to be carried out, not less than 1 week
    - Demonstration to the CA/EA that test instruments and equipment are accurate.

9.5 Commissioning and Handover plans

The Contractor shall develop and issue for comment separate plans for commissioning and handover as set out in sections 11 & 12. The first draft plans should plans should be issued for comment 4 months prior to practical completion.

9.6 Alternative Contractors Proposals

Where the CA/EA has accepted proposed alternative equipment or materials prior to the award of the contract and which subsequently varies the main works and/or the MEP Engineering Services Works in any way whatsoever, then:

- Be responsible for meeting all the additional costs and technical requirements arising from such a change
- No claim for additional costs or delay to the completion of the works will be allowed.
- Undertake the redesign of all engineering services and builders work affected by these equipment changes at no additional cost or extension or delay to the programme.
- Be responsible for ensuring that alternative equipment, materials and variations to the MEP Engineering Services Works do not impact on the Target Emissions Rate and on the 'as constructed' calculation Buildings Emissions Rate not achieving compliance.

Should any alternative item proposed not carry appropriate certification, ensure independent testing is carried out to confirm compliance at no additional cost.

9.7 Technical Submissions

Review of Submittals by consultant:
The consultant will review the contractors Technical Submittals for general conformity with the design intent. Our comments should be fully considered by the contractor before proceeding with any procurement, fabrication, manufacture or installation. These comments do not constitute formal design team approval and do not relieve the Contractor of responsibility for full conformance with the design drawings, specifications and applicable regulations. Reference should also be made to comments by other team members where indicated.

The consultant will give Technical Submittals the following status.

- A - No objections to contractor's proposals
- B - No objections subject to incorporation of comments
- C - Rejected - re-submit revised proposals to reflect comments

Technical submittals for Equipment
Any variations from the specified requirements shall be highlighted on each submittal. Technical submittals must be specific for the equipment in question. Standard literature and extracts from manufacturers catalogues will not be acceptable.

Schedule of Drawings and Submittals:
Provide a schedule of all proposed drawings and submittals required for comment. The schedule shall be provided

- No later than 4 weeks from contract appointment

Indicate as a minimum the following information on the schedule:

- Drawing number and revision number
- Drawing title and service
- Scale
- Latest date required on site and/or for manufacturing purposes
- Date required for final comment
- Date for submission for comment
- Date of commencement of drawing production

The schedule shall be updated as necessary on a regular basis at intervals agreed with the CA/EA during the contract period.

The programme for production of drawings and other submittals should include the necessary time for:

- Submission
- Examination
- Alterations and re-submission in the event of the initial submission not being accepted
- Final issue

Allow adequate time in the programme in order not to cause delays.

The full extent of all submittals shall be indicated in the schedule.

Group submittals for a particular part of the building or building engineering service as agreed with the CA/EA.

Calculations:
All calculations must be presented in a logical format and prepared to a recognised and agreed format and be suitably indexed.

All software programs used in the preparation of designs shall be agreed with the CA/EA prior to commencement of design activities. The use of unverified software must be declared and the initial outputs justified by full and complete hand calculations.

Software used in calculating the energy performance of buildings, as required under Part L of the Building Regulations, shall be as approved by DCLG and agreed with CA/EA prior to commencement of use.

Calculations that are preliminary in nature, i.e. do not form part of the final submittal, are to be referenced independently and clearly indicated 'Preliminary'.

State the methodology, formulae, design criteria, assumptions and all design margins used in the calculations.

Where necessary calculation sheets shall be accompanied by an annotated layout drawing identifying terminals, fittings and the particular sections of ductwork or pipework.

Each calculation sheet, drawing or schedule shall clearly identify the originator, date of production, checker

(who signs or initials) and date of check.

The timescale for review or comment or otherwise on all submittals shall be 14 working days from the date of receipt by the CA/EA

Equipment Performance Details:
Details of the equipment selected for inclusion into the MEP Engineering Services Works shall include the following information:

- Plant item description, reference identification and serial number.
- Electrical input rating - kVA, Volts, Phase.
- Operating mode - duty, standby, generator etc.
- Starting characteristics - starter type, current, starts/hour and starting time.
- Performance characteristics - (full load current and power factor).
- Noise level.
- Weight.

The format of the information shall be as agreed with the CA/EA.

Preparation of Drawings:
Agree with the CA/EA a document numbering system prior to preparing any documents.

All drawings shall be prepared using a computer aided draughting system and the software used to produce drawings shall be approved prior to commencement of drawing production.

Each service shall be represented by a separate layer/overlay, for subsequent easy modification.

Prior to commencement of drawing production agree the sequence of layers, pen colours and sizes.

The medium for transfer of information shall be

AutoCad drawing files shall be

- DWG

Drawing plots shall be "A" size to British Standard, with an agreed logo/title block.

The standard drawing size is to be:

- either A1 or A0 (avoid both)

Scales used on drawings shall be:

- selected to convey clearly the proposals

Review of Submittals:
The CA/EA will take up to 2 weeks to review submittals. The contractor is to allow sufficient time in the programme for this review process along with the time required for any subsequent revisions and comments.

The CA/EA or their appointed representative may review proposals and drawings (including Installation Drawings) submitted by the Contractor for these MEP Engineering Services Works or parts thereof, for general compliance with the design intent and performance criteria. The CA/EA will not 'approve' any drawings or other information submitted for review.

Review will not relieve the Contractor of any responsibilities or obligations under the contract and it will remain the sole responsibility of the Contractor to ensure the contract requirements are met. The Contractor will remain liable for any defects in or omissions from the information supplied by them.

Any changes to drawings or other information that are needed to meet the contract requirements are deemed to have been taken into account within the contract sum and programme.

Mistakes in Submittals:
Examination and/or issue on a CA/EA instruction of submittals shall not be deemed to remove any duties, obligations and responsibilities under the contract.

Be responsible for any error, discrepancy or omission in any submittal, presentation or drawing prepared or where others have prepared these for submittal.

The said indemnity shall be subject to the proviso that such error, discrepancy or omission is not due to any inaccurate data, drawing or information provided by the employer or by the CA/EA.

Revisions to Drawings:
Where revisions take place either under the authority of a CA/EA instruction, or by written agreement with the CA/EA or when revised architectural, structural or services information is issued, all drawings shall be modified accordingly and shall be re-issued for construction purposes subject to examination by the CA/EA.

The issue of revised drawings shall be in accordance with and with regard to the agreed programme for construction and where time is available re-issues shall be grouped together, as agreed with the CA/EA.

Form and Number of Submittals to be Provided:
Drawn information provided by the Contractor is to be produced using the latest version of AutoCAD, or in a CAD package fully compatible with AutoCAD.

Each service shall be represented by a separate layer for subsequent easy modification.

Agree with the CA/EA a document numbering system prior to preparing any documents.

Drawing plots shall be A size to British Standard, with an agreed logo/title block.

Provide drawn information for the design team and client in the following forms:-

Design & Installation drawings:

- Initial copies for comment - print form
- Final copies for distribution - print form
- Provide drawn information for the design team and client in the following numbers
- Initial copies for comment - 2 or as stated in the Main Contract Preliminaries if greater.
- Final copies for design team - 2 or as stated in the Main Contract Preliminaries if greater.

As-installed drawings:

- Maintain site record copy up to date as the work proceeds.

Record drawings:

- Initial copies for comment - 2 or as stated in the Main Contract Preliminaries if greater.
- 2 preliminary sets for use during commissioning.
- One reduced set incorporated into each O&M manual.
- Set as .dwg AutoCAD drawings presented on a CD.

Plant room schedules and schematics:

- Initial copies for comment - 2 or as stated in the Main Contract Preliminaries if greater.
- 2 preliminary sets for use during commissioning.
- One framed set for plantrooms.
- One reduced set incorporated into each O&M manual.

- Set as .dwg AutoCAD drawings presented on a CD.

9.8 Samples

For all contractor design elements, provide samples for all items that will be visible following the completion of the building. In particular, any human interfaces such as building and lighting control interfaces should be provided for comment by the Client. Provide samples at least 3 months prior to the date they need to be ordered to avoid delays to the construction contract. Provide any other samples specifically identified in the MEP specification work sections.

Sample items to be provided include but are not limited to:

- Heating (and cooling) control interfaces;
- Ventilation control interface;
- Lighting control interfaces;
- Light fittings;
- Electrical accessories;
- Grilles;
- Sensors (PIR, daylight, security, etc.);

9.9 RFIs and TQs

Issue Requests for Information and Technical Queries through the agreed procedure for the project as outlined in the Main Contract Prelims.

9.10 BREEAM

Provide information, adopt working practices and complete the works in a manner which ensures that all targeted BREEAM credits are achieved. See Main Contract Prelims for BREEAM requirements.

9.11 Information for Energy Performance Certificate

Prior to PC, provide the CA/EA with all necessary evidence for the Energy Performance Certificate (EPC) including:

- Renewables
    - Photovoltaics
    - Size of array (kWp)
    - Orientation
    - Tilt angle
- Log book – see clause 11.1 for further details on log book requirements;
- Commissioning results

10.0 CONSTRUCTION

10.1 Method Statements

Submit method statements to the CA/EA prior to commencement of the contract works for each item of work, and in particular:

- Develop and issue all method statements listed in the Main Contract Preliminaries
- Any works requiring interruptions of supplies, out of hours working, noisy work, road closures or disruption to other building users or neighbours

10.2 Quality Control

Use or Disposal of Materials:

- Remove from the site any rubbish and debris arising out of the execution of the contract works
    - on a daily basis.
- Clear all rubbish and any debris arising out of the execution of the contract works to a central area where others will remove it from the site
    - on a daily basis.
- Do not discharge any oil, noxious liquids or gases and all water discharged shall be reasonably free from impurities.
- All waste is to be recycled where possible.
- Comply with the requirements of BREEAM where required

Storage:
Weatherproof, safe and secure storage shall be provided for all materials and equipment.

All materials and equipment and materials shall be offloaded, stored and transported in accordance with manufacturer's recommendations.

All electrical equipment and components shall be kept dry and free from dust.

Plug, cap or seal open ends on all ductwork, tubes, conduit, trunking and associated equipment whilst in storage and during transportation to site.

Provide racks to prevent distortion of pipes, conduit and similar materials.

Protection And Packaging:
All plant, equipment, materials and prefabricated elements of the MEP Engineering Services Works shall be properly packaged and protected against damage during delivery, storage and until fully, finally and properly installed and set to work.

Submit to the CA/EA a method statement on protection proposals for both stored and installed plant, equipment and materials.

Protection shall also include adverse effects of environmental conditions prevalent in the stored and installed location.

Any plant or equipment subject to incorrect storage or inadequate protection will be deemed unacceptable for incorporation into the works and new plant or equipment will be required as a replacement.

Damaged plant, equipment and materials or that suffering from deterioration shall be replaced prior to handover.

All plant, equipment and materials shall be protected against ingress of water and dust, formation of condensation, extremes and rapid changes of temperature, building works and operations of others.

All open ends of pipes, ducts, conduit, and trunking etc. shall be capped except when being worked upon.

- After removal of any temporary protection paint parts liable to corrosion.
- Filter media shall only be installed when the plant items concerned are commissioned and tested.

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

Materials Used:
No acoustic insulation or thermal insulation or sound attenuation materials shall be manufactured with any form of animal hair.

All materials supplied shall be a type that will not support bacteria.

Substances publicised by the Health and Safety Executive, Building Research Establishment, British Standards Institution or other authorities or professional bodies as being deleterious to Health and Safety shall not be incorporated into any part of the MEP Engineering Services Works.

Deleterious materials shall not be utilised on any part of the MEP Engineering Services Works. Deleterious materials include but are not limited to:

- halon/CFC's
- asbestos or products containing asbestos
- urea formaldehyde or materials which may release formaldehyde
- materials comprised in whole or part of man-made and/or naturally occurring mineral fibres which have a diameter of 3 microns or less and a length of 200 microns or less or which contain fibres not sealed or otherwise not stabilised to ensure that fibre migration is prevented
- lead where the metal or its corrosion products may be directly ingested, inhaled or absorbed
- polyurethane or polyisocynate foam
- polychlorinated biphenyls (PCBs) or similar compounds
- pentachlorophenol, lindane or tributyltin (TBT) oxide
- extruded polystyrene other than low ozone depletion materials
- any other substances generally known to be deleterious at the time of installation
- The Contractor shall alert the Employer and CA/EA to the risks in respect of any installed material that is subsequently identified as deleterious or potentially deleterious and shall advise as to the best and most economic course of action.

All jointing materials shall be of a type approved by the respective authority.

Warrant that deleterious materials are not incorporated in the MEP Engineering Services Works.

Notify the CA/EA, in writing, as soon as reasonably practicable of any material designated by the Building Research Establishment, British Standards or codes of practice as deleterious at any time during the contract.

Fire Precautions:
Take all reasonable fire precautions in respect of stores, workshops and other installations. Where it is necessary to use any naked flame or welding equipment in executing the contract works and where combustible materials are in use, adequate protection shall be given to other adjacent materials and personnel. Suitable fire extinguishers shall be readily available at the position where such work is proceeding.

Damage to Structure:
- Exercise due care and attention in carrying out the contract works and be fully responsible for any damage caused to the structure or building finishes.
- Obtain permission from the CA/EA before any holes are cut in floors, walls or steelwork, etc.

Equipment Guarantees:
Plant and equipment guarantees shall commence at the date of practical completion and run for a minimum of 12 months after this date.

Any costs associated with this requirement shall be included in the contract price.

Site Modifications:
Site modifications to assemblies shall not be made without written approval of the CA/EA.

Where site modifications to assemblies are authorised undertake in accordance with manufacturer's certified drawings and instructions.

Ensure that all modifications undertaken comply with the relevant standards and all test certification obtained.

Dimensions:

- Where installations are dependent upon site dimensions ensure that these are available before proceeding with the MEP Engineering Services Works.
- Dimensions should not be scaled from drawings.
- Where dimensions are indicated on drawings check these on site, as appropriate, to ensure building construction tolerances and manufacturing tolerances can be accommodated.
- Equipment should not be ordered or manufactured using dimensions indicated on the Tender drawings.

Workmanship and Materials:

- All materials, articles and workmanship shall be of the best quality and execution as detailed in the specification and drawings.
- All equipment and materials to be installed shall be new unless otherwise indicated.
- All equipment shall be installed in accordance with the manufacturer's written instructions and recommendations.
- All materials considered by the CA/EA to be unsound or not in accordance with the specification shall immediately be removed and properly replaced to the satisfaction of the CA/EA at no additional cost. All work carried out imperfectly or with faulty materials must be immediately removed and properly replaced to the satisfaction of the CA/EA at no additional cost.
- The manufactured articles specified shall serve as a quality standard.
- Where manufactured items are not specified by name submit with the tender all necessary details of proposed articles. The CA/EA shall approve these articles before their use is permitted.

10.3 Factory Testing

Carry out factory testing where described within individual work sections in the MEP specification.

10.4 Development of Record Information

Continually mark up a set of drawings on site to ensure ongoing development of Record Information.

10.5 Beneficial Use

- Systems shall not be used before practical completion without prior approval of the CA/EA.
- Systems used before practical completion not for the benefit of the Employer must have all defective consumable elements replaced by new including:
    - lamps and tubes
    - filters
- Replacement of consumable elements shall be not more than 14 days prior to practical completion.

- If instructed by the CA/EA, operate the installations or any part of them prior to practical completion, provided that such operation is practicable and does not prejudice the responsibilities and obligations under the contract.
- All costs arising from the use of such installations will be reimbursed at rates or where no such rates are applicable at reasonable rates agreed with the CA/EA before commencing operation of the installations.

10.6 Snagging

Inspection before Concealment:
Whenever work requiring inspection or testing is subsequently to be concealed give the following the notice to the CA/EA so that inspections may be made or tests witnessed before concealment

- 5 days' notice

11.0 HANDOVER, COMPLETION AND COMMISSIONING

11.1 Record Information

Standards:
Provide operating and maintenance manuals, system records and full documentation in accordance with the following standards:

- BS 5839 - Fire detection and alarms in buildings.
- BS 6701 - Telecommunications equipment and telecommunications cabling.
- BS 7671 - Requirements for electrical installations (IEE Wiring regulations)
- BS EN 62305 - Protection against lightning.
- Building Regulations (Approved Document Part L2)
- Comply with the requirements of the CDM Regulations in providing the appropriate input to the Construction Phase Plan and health and safety file for the contract works.

Record Documents:
Provide:

- Record drawings and schedules.
- Plant room and switch room drawings, schedules and schematics.
- Operating and maintenance manuals.
- Blank maintenance logs.
- Log books
    - in compliance with the Building Regulations.
    - in accordance with CIBSE TM 31.
- Ensure record documents clearly record the arrangements of the various sections of the MEP Engineering Services Works as actually installed and identify and locate all component parts.
- Ensure record documents make it possible to comprehend the extent and purpose of the MEP Engineering Services Works and the method of operation thereof.
- Ensure record documents set out the extent to which maintenance and servicing is required and how, in detail, it should be executed.
- Ensure record documents provide sufficient, readily accessible and proper information to enable spares and replacements to be ordered.
- Correlate record documents so that the terminology and the references used are consistent with those used in the physical identification of the component parts of the installations.
- Demonstrate as required throughout the execution of the contract works that complete and accurate records are being maintained and that the record documents are being progressively compiled as the work on site proceeds.
- Ensure that building log books contain all the information necessary to comply with the Building Regulations Approved Document Part L2.

Record Drawings and Schedules:

- Prepare record drawings and schedules based on the As Installed Drawings maintained on site during the progress of the contract works.
    - The scale of the drawings shall be not less than the scale at which the design or installation drawings were produced.
- Each record drawing shall show the following information:
    - The name of the contract and, where appropriate, the zone or floor designation.
    - Description of drawing, drawing reference and scale.
    - Name and address of the installer and the consultant.
- Endorse all such documents
    - 'Record drawings'
- Where agreed with the CA/EA certain detailed information may be provided in schedule form.

- Where portions of the work are to be concealed, draft copies of record drawings shall be supplied to the CA/EA before the work is concealed in order to facilitate checking and examination.
- Prepare electrical drawings in accordance with BS EN 61082.
- Issue at practical completion the complete approved package of record drawings in the following numbers and format:
    - CAD format on CD disk. Each CD shall be labelled and the CD jewel cases shall be labelled identifying project title, issue date and index of contents.
    - Number of sets of complete record drawings (no) 2
    - 'White' prints.
    - Number of sets of complete record drawings (no) 2
- Provide reduced scale copies for inclusion in the operating and maintenance manuals as stated elsewhere.

Record drawings and schedules must include, but are not limited to:

- Location, including level if buried, of utility service connections, including those provided by the appropriate Authority, indicating points of origin and termination, size and material of service, emergency shut-off isolation locations, pressure and/or other relevant information.
- Disposition and depth of all underground systems.
- Schematic drawings of each system indicating principal items of plant, equipment, zoning, means of isolation, etc. in sufficient detail to make it possible to comprehend the system operation and the inter-connections between various systems.
- Details of the principles of application of automatic controls and instrumentation.
- Diagrammatic dimensioned plans and sections of each system or service showing sizes and locations of all ancillaries, plant, equipment controls, test points, and means of isolation etc. including any items forming an integral part of the engineering systems provided by others (such as plenum ceilings, builders' work shafts, chimneys etc.).
- Identification of all terminals/cables etc. by size/type and duty/rating as recorded from the approved commissioning results.
- Detailed wiring drawings/diagrams/schedules for all systems, including controls, showing origin, route, cable/conduit size, type, number of conductors, length, termination size and identification, and measured conductor and earth continuity resistance of each circuit. Ensure routes indicate if cable/conduit is surface mounted, concealed in wall chase, in floor screed, cast in-situ, above false ceiling etc.
- Details of co-ordination of wiring and connections with cable core identification, notation of fire alarm, security, control and instrumentation and similar systems provided as part of the MEP Engineering Services Works.
- Details to show inter-connections between the MEP Engineering Services Works and equipment or systems provided by others to which wiring and connections are carried out as part of the MEP Engineering Services Works.
- Location and identity of each room or space housing plant, machinery or apparatus.
- Dimensioned plans and sections of plantrooms, service subways, trenches, ducts and other congested areas where in the opinion of the CA/EA smaller scale drawings cannot provide an adequate record. Indicate the location, identity, size and details of each piece of apparatus.
    - The scale of drawings to be the scale at which the design or installation drawings were produced.
- Manufacturer's drawings of equipment indicating
    - general arrangement and assembly of component parts which may require servicing.
    - internal wiring diagrams together with sufficient physical arrangement details to locate and identify component parts.
- Schedules as required to locate, reference and provide details of ratings and duty of all items incorporated into the MEP Engineering Services Works together with all fixed and variable equipment settings established during commissioning.
- For each programmable control item
    - schedules indicating for each input and output point connected
    - full data in respect of that point including reference

        - type of input/output
        - connected equipment reference
        - set values of temperature or pressure etc.
        - set values of start/stop/speed change times etc.
        - alarm priority
        - control specification reference
        - any other such applicable parameters
        - Each spare input and output point including reference, type of input/output and space for future entry of appropriate parameters as listed above.
- Logic flow diagrams for each individual control or monitoring specification and for each building services engineering system to illustrate the logical basis of the software design.
- Schedules setting out details of all initial values of user-defined variables, text statements for alarm messages etc.

Plant Room and Switch Room Drawings, Schedules and Schematics:
Provide good quality plant and switch room drawings, schedules, schematics and instructions and hang in the respective plant room or any other appropriate location or where directed by the CA/EA.

- Protect surfaces of such information by
    - Pressure lamination
    - Framing under glass or other rigid, transparent, cleanable and protective surface
- Hang using suitable fixings and provide backboards if necessary
- A sample shall be submitted for approval to the CA/EA prior to commencing production.
- Schematic drawings of circuit layouts showing:
    - Location, identification and duties of equipment
    - Location of controls devices
    - Circuit layout
- Valve schedules in the form of printed sheets showing the number, type, location, application/service and symbol, and normal operating position of each valve.
- Control schematics.
- Location of mechanical and electrical plant and equipment items.
- First aid instructions for treatment of persons after electric shock.
- Location of isolating switch for electricity supply.
- Location of main incoming gas valve serving gas meter and isolation point.
- Location of main incoming water main and isolation point.
- Location of sprinkler fire main control valve.
- Emergency operating procedures and telephone numbers for emergency call out service applicable to any system or item of plant and equipment.
- Location of metering facilities.
- All other items required under Statutory or other regulations.
- Prepare electrical drawings in accordance with BS EN 61082.

11.2 Operation and Maintenance Manuals

Presentation of the Operating and Maintenance Manuals:

- Agree format and contents with the CA/EA.
- Provide the operating and maintenance manuals in the following form:
    - Encase the manuals in A4 size, plastic-covered, loose leaf, four ring binders with hard covers, each indexed, divided and appropriately cover- titled. Fold drawings larger than A4 and include in the binder so that they may be unfolded without being detached from the rings.
    - Electronic format: a copy each on a CD and memory stick.
- Provide copies of the operating and maintenance manual as follows:
    - Draft copies for comment (no) 1
    - Final copies for Client use (no) 3

- Provide a draft copy of the operating and maintenance manual to the CA/EA for comment
- Timescale:
  - Weeks before the contract completion date (no) no less than 6
- The draft copy of the manual shall conform to the final format required by the specification to enable all relevant comments to be made by the CA/EA.
- Although it will not be necessary for the draft copy to contain testing and commissioning certificates, it will be complete in every other way.

Operating and Maintenance Manuals:
The operating and maintenance manuals must include:

- A full description of each of the systems installed, written to ensure that the Employer's staff fully understand the scope and facilities provided.
- A description of the mode of operation of all systems including services capacity and restrictions.
- Diagrammatic drawings of each system indicating principal items of plant, equipment, valves etc.
- A photo-reduction of all record drawings together with an index. Reduced size of drawings to be A3
- Legend of all colour-coded services.
- Schedules (system by system) of plant, equipment, valves, etc., stating their locations, duties and performance figures. Each item must have a unique number cross-referenced to the record and diagrammatic drawings and schedules.
- The name, address and telephone number of the manufacturer of every item of plant and equipment together with catalogue list numbers.
- Manufacturer's technical literature for all items of plant and equipment, assembled specifically for the project, excluding irrelevant matter and including detailed drawings, electrical circuit details and operating and maintenance instructions.
- A copy of all test certificates, inspection and test Records, commissioning and performance test records including, but not limited to, electrical circuit tests, corrosion tests, type tests, start and commissioning tests, for the installations and plant, equipment, valves, etc., used in the installations.
- A copy of all manufacturer's guarantees or warranties, together with maintenance agreements offered by subcontractors and manufacturers.
- Copies of insurance and inspecting Authority certificates and reports.
- Starting up, operating and shutting down instructions for all equipment and systems installed.
- Control sequences for all systems installed.
- Schedules of all fixed and variable equipment settings established during commissioning.
- Procedures for seasonal change-overs and/or precautions necessary for the care of apparatus subject to seasonal disuse.
- Detailed recommendations for the preventative maintenance frequency and procedures which should be adopted by the Employer to ensure the most efficient operation of the systems.
- Details of lubrication for lubricated items including schedules of lubricant type, frequency, etc.
- Details of regular tests to be carried out (e.g. water analysis for pseudonomas.)
- Details of procedures to maintain plant in safe working conditions.
- Details of the disposal requirements for all items in the works.
- A list of normal consumable items.
- A list of recommended spares to be kept in stock by the Employer, being those items subject to wear or deterioration and which may involve the Employer in extended deliveries when replacements are required at some future date.
- A list of any special tools needed for maintenance cross-referenced to the particular item for which required.
- Procedures for fault finding.
- Emergency procedures, including telephone numbers for emergency services.
- Hospital Operational Policy.
- Back-up copies of any system software.
- Documentation of the procedures for updating and/or modifying software operating systems and control programmes.
- Instructions for the creation of control procedure routines and graphic diagrams.
- Details of the software revision for all programs provided.

- Two back-up copies of all software items, as commissioned.
- Copies of relevant HSE/CIBSE/IET Guidance notes etc.
- Contractual and legal information including but not limited to
    - Details of local and public authority consents
    - Details of design team, consultants, installation contractors and associated subcontractors
    - Start date for installation, date of practical completion and expiry date for the Rectification Period
    - Details of warranties for plant and systems including expiry dates, addresses and telephone numbers.
- A provision for update and modification.

11.3 Testing and Commissioning

General:
The Contractor is to comply with the requirements of Appendix A Table D "Allocation of Commissioning Responsibilities", drawing no J7008-XX-XX-SH-J-00001 "Testing, Commissioning & Handover Schedules", and the following clauses:

Definitions:
Where used in the documentation the following definitions shall apply and shall be interpreted as such:

- Commissioning: The advancement of an installation from the stage of static completion to working order to the specified requirements
- Testing: The measurement and recording of specified quantifiable characteristics of an installation or parts thereof and includes off site testing.
- Setting to work: The process of setting a static system in motion
- Regulation: The process of adjusting the rates of fluid flow in a distribution system to achieve specified values
- Environmental testing: The measurement and recording of internal environmental conditions
- System proving: the measuring, recording, evaluating and reporting on the seasonal performance of the systems against their design values
- System demonstration: Demonstrating the capability of the installation to achieve and maintain the specified performance criteria
- Fine-tuning: The adjustment of the system where usage and system proving has shown such a need and includes the re-assessment of design values and control set points to achieve the required system performance.

Programme:
Prepare comprehensive programmes for the pre-commissioning checks, setting to work, testing, commissioning, system proving and environmental testing of the contract works.

Timescale:

- To be completed and co-ordinated with other trades at least 6 weeks before the start of commissioning.
- Review and update the commissioning programme at agreed intervals and if necessary revise and amend the programme to suit the progress of the contract works.
- Due account shall be taken of any phasing requirements.

Commissioning and Testing:
Generally comply with CIBSE Commissioning Code M.

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

Compile a separate and comprehensive testing and commissioning programme, coordinated with the main project programme, on a system by system basis. Issue to the CA/EA for comment at least 1 month prior to the testing and commissioning commencement date. Due allowance is to be made for, but not limited to, the following:

- issue of method statements and risk assessments;
- review of "commissionability;
- pre-commissioning checks, system cleaning/flushing where relevant, setting to work, testing, commissioning, and performance testing of all engineering services installations;
- any concurrent work by other trades;
- periods for any off-site plant or equipment inspection and/or test;
- demonstration of system(s) performance to the satisfaction of the CA/EA;
- client demonstrations and training;
- any proving periods required;
- preparation and provision of the "Commissioning Plan" (see clause 11.4);
- preparation and provision of Record Drawings and Operating & Maintenance Manuals

Provide formal method statements supported by risk assessments detailing the procedures for carrying-out on (and off) site testing and commissioning.

Review the design of the works in relation to "commissionability" (i.e. the ability of a system to be commissioned satisfactorily).

During the testing and commissioning period provide weekly progress reports detailing the status of each system to be commissioned including results, technical issues, the input of others over the next week, etc. Issue to the CA/EA.

Up-date the commissioning programme as the work proceeds taking into account true progress on site. Issue revised programme as part of the weekly report.

Give notice to the CA/EA of when testing and commissioning is ready for inspection and/or witnessing. Give not less than 5 working days.

The CA/EA will only witness testing and commissioning results once it has been confirmed by the Contractor, in writing, that satisfactory results have been achieved. The purpose of witnessing by the CA/EA is to confirm recorded results and determine if the specified requirements have been satisfied, and in no way relieves the Contractor of their responsibilities under the Contract. If following test or inspection any system or plant item is shown to be defective or not conforming to the specification the CA/EA will reject such defective parts, and after rectification by the Contractor may wish to re-inspect the system or systems involved.

Provide all the necessary labour and facilities to enable tests to be witnessed and inspections carried out on site and/or at manufacturer's works. Provide all specialised personnel (including manufacturer's representatives) and co-ordinate their activities. Allow for all the costs incurred.

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

Complete all tests before any paint, cladding or similar materials are applied or before services are concealed. Ensure all requirements such as cleanliness, protection from harmful external and internal elements etc. are provided prior to commencement of commissioning.

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

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

Provide test equipment subject to a quality assurance procedure complying with ISO9001:2015 .

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

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

Provide all certification documents for review by the CA/EA before any system is offered for final acceptance.

Provide a written statement to the CA/EA confirming that each installation has been correctly tested and commissioned and that the performance requirements can be achieved.

Demonstrate to the CA/EA that all system components are operating correctly, and the completely integrated installation will function in accordance with the specified performance requirements.

Only after a successful demonstration to the CA/EA will the Contractor be able to commence staff training as Section 10.1.

Static Testing:
Progressive static testing shall include the following tests, but other tests may be required and witnessed:

- Insulation resistance
- Earth fault loop impedance
- Earth continuity
- Pressure testing of hydraulic systems
- Air leakage testing of ductwork systems

The CA/EA shall be given the opportunity to witness all static tests.

Advance notice of the tests shall be given to the CA/EA.

Timescale:

- days prior to test (no) 7

Pre-Commissioning Checks:
Ensure all pre-commissioning examinations and tests have been undertaken and that each system, including components, or item of equipment is complete and in a safe condition prior to start-up.

All necessary notices shall be displayed.

Completion for operational purposes implies the bulk of snagging has been offered to the CA/EA and that remedial work has been completed. All fans, pumps etc. tested for operation, polarity, phase sequence and impedance etc.

Finalise commissioning programme, taking into account site progress and availability of related services, with CA/EA and Contractor and agree access required for controls, etc.

Building Regulations Commissioning Plan:
As required by Part L2 of the Building Regulations, Section 2 clauses 2.5 to 2.7 inclusive, it is the Contractors responsibility to demonstrate that the building services installations have been installed, inspected and commissioned in accordance with the requirements of Part L of the Building Regulations.

As part of showing compliance the Contractor is to provide a "commissioning plan" (as defined in clause 2.6(a) of Part L2) and a "commissioning report" (as defined in clause 2.6(b) of Part L2) detailing that the inspection

and commissioning activities necessary to establish that the MEP Engineering Services Works complies with Part L have been completed to a reasonable standard. It is for the Contractor is to demonstrate to the local Building Control office that the person(s) providing this report are suitably qualified. This plan is to be available prior to Practical Completion.

(Note: this clause is not relevant to MEP Engineering Services Works, or those parts of the MEP Engineering Services Works, classed as domestic dwellings under Part L1 of the Building Regulations).

System Demonstration:

Subsequent to the completion of all testing and commissioning to the satisfaction of the CA/EA and when directed operate the plant and demonstrate that the overall systems function correctly in accordance with the requirements of the specification.

- The period of operation shall be:
    - weeks 4
    - allowed in the programme.
- During this period be responsible for the recording of results and the operation and maintenance of the plant.
- Provide the following:
    - An operational report of the demonstration
    - Schedule of the conditions maintained within the space for a period of

Plant And Equipment Performance Testing:
Where stated elsewhere plant and equipment shall be tested at the works of the manufacturer or in a recognised and approved testing facility to demonstrate the performance complies with the stated and specified duties.

These tests shall be in addition to works tests as stated elsewhere.

Performance testing shall demonstrate but not limited to the following:

- Full, partial and minimum load
- Response to load change
- Efficiency
- Noise levels

The tests shall be conducted to simulate design conditions and all ancillary plant and equipment needed to support the tests together with all instrumentation shall be provided and included in the contract cost.

Upon successful completion of the performance tests the plant and equipment shall be thoroughly cleaned and returned to its new condition and correctly packaged for delivery to site.

Test certificate records of the tests shall be issued to the CA/EA as stated elsewhere.

Allow for all expenses of the CA/EA to attend inspections and witness tests. Allow for 2no. persons.

Inspections and Tests:
Submit schedules indicating those parts of the contract works for which inspections and tests are required to substantiate conformity with the specification.

Should any alternative item be proposed that does not carry appropriate certification, ensure independent testing is carried out at no expense to the contract works to confirm compliance.

Provide method statements supported by risk assessments detailing the procedures for carrying out on site tests.

Agree in advance with all parties procedures for inspections and tests including periods of notice.

Where a test indicates non-compliance with the specification submit immediately details of the non-compliance and details for corrective action.

Maintain records of all specified inspections and tests performed including third party and works testing.

Maintain all records on site for inspection.

BMS Witnessing Requirements:

- The CA/EA or nominated representative will implement the following witnessing requirements.
- Ensure that on-site commissioning staff facilitate the following witnessing process.
    - The BMS hardware is installed in accordance with the requirements as stated elsewhere.
    - Verify any operator software and associated graphics.
    - Witness completely the control of any main and/or critical items of plant along with a random sample of other points.
    - Points witnessing
    - If less than 300 points, witness all points.
    - Between 300 and 1000 points witness 50% (minimum of 300 to be witnessed).
    - If more than 1000 points witness 20% (with a minimum of 500 points witnessed).
    - Reserve the right to witness 100% of the points if the failure rate is greater than 5%.
    - Witness the operation of all of the controls logic.
    - Witness one of several identical items of plant in detail with the others witnessed on a random basis.
    - Verify the system security access.
    - Verify that all safety-related functions perform to that specified, e.g. plant shutdown on fire condition.
    - Verify all plant restarts according to that specified after building power failure and local power failure.
    - Witness all power meter data-points to ensure that they match the meters.
    - Ensure that trend logs are used when witnessing points in order to monitor the performance of control actions
    - Verify the handover of all operating manuals and system documentation.
    - Verify the handover of backup copies of software.
    - Verify the completion of any specified system operator training.

11.4 Completion and Handover Procedures - Software, keys, spares, meter readings, etc

Supply of Computer Hardware and Software:
Obtain on behalf of the end user all appropriate licences, permissions, copyright waivers, rights of use and the like from the owners of the software rights. Ensure that the end user is properly registered with the software supplier for support and appropriate updating. Ensure that application software is written in compliance with BS 7649.

Recommended Spare Parts:
Before Practical Completion submit to the CA/EA a schedule of spare parts as stated elsewhere and recommend any that should be obtained and kept in stock by the Employer for maintenance of the installations included in the MEP Engineering Services Works.

- Time scale
    - 4 weeks before Practical Completion

State against each item the manufacturer's current price, including packaging and delivery to site. Identify those items that are additional to those specified for inclusion as stated elsewhere.

Recommended Tools:
Prior to Practical Completion submit to the CA/EA a schedule of tools and portable instruments as stated elsewhere and recommend any that should be obtained and kept in stock by the Employer for maintenance of the installations included in the MEP Engineering Services Works.

- 4 weeks before Practical Completion

Production of Handover Information:
The Contractor is to comply with the requirements of Appendix A Table E "Production of Handover Information" and drawing no J7008-XX-XX-SH-J-00001 "Testing, Commissioning & Handover Schedules", and the following clauses:

Handover Requirements:
As a pre-requisite to Practical Completion in respect of the contract works or part thereof, demonstrate to the satisfaction of the CA/EA that:

- All the contract works are complete.
    - With the exception of minor snags or limited defects as agreed with the CA/EA that could be reasonably completed within an agreed programme without causing disruption to the Employer's use of the building or part thereof.
- All spares, keys, tools and other consumables as stated elsewhere have been supplied and handed over to the Employer.
- The instruction of the Employer's staff in the use and correct operation of the installation has been completed satisfactorily. In particular, safety devices and controls demonstration.
- All commissioning and testing completed
    - including the issue of a final commissioning report signed by an approved competent person
- A complete demonstration of the contract works with fully functional operational controls tested has been undertaken in the presence and to the satisfaction of the CA/EA.
- All necessary certification by the Employer's insurers has been completed.
- All approved record documentation including record drawings, operation and maintenance manuals, etc. is issued
- All information required for the health and safety file is issued to the satisfaction of the CDM Coordinator.

The information shall include:

- A written description of plant operation.
- Basic security access to the system.
- Comprehensive instructions for switching on, operation, switching off, isolation, fault finding and procedures for dealing with emergency conditions.
- Instructions for any precautionary measures necessary.
- All necessary Statutory Authority approvals have been undertaken and written confirmation established
- Completion and issue of log books in accordance with Building Regulations.
- It should be noted that this log-book is in addition to the Operating & Maintenance Manuals and is to be issued as a separate document. The log-book is in effect a summary of the O&M manuals suitable for day-to-day use by the building managers/users.
    - Air permeability test certificate in accordance with Building Regulations.
    - Should adequate record documentation not be available Practical Completion will not be granted.

Reading of Meters:
Record readings of all water, gas, and electricity meters immediately on completion of the MEP Engineering Services Works and forward to the CA/EA

Inspection by Employer's Insurers:
Where indicated elsewhere installations, equipment, plant or materials are to be inspected by a representative acting for the Employer's insurers.

The installations, equipment, plant or materials shall satisfy the insurance company's requirements in all respects.

- Inform the CA/EA when the installation or equipment is ready for examination
- Provide a programme for the inspection and certification by the Employer's insurers.
- All necessary information shall be provided to enable the insurers to approve the design before manufacture.
- Arrange for the attendance of the insurance company's representative at agreed stages of manufacturer and installation.
- All necessary attendance, access and facilities for inspecting and testing as is required shall be provided.
    - Certification shall have been received from the insurers before equipment or installations subject to inspection and certification will be accepted on behalf of the Employer.

Operation of Systems before the Production of Drawings and/or Operating and Maintenance Manuals:

- Provide attendance, at no expense to the Employer, to put into service, operate 24 hours a day and maintain the systems to the Employer's requirements, including the provision of suitable competent labour, in the event that the Record Drawings and/or Maintenance Manuals are not available when the MEP Engineering Services Works would, in the opinion of the CA/EA, otherwise qualify for Practical Completion.
- In the event of the Subcontractor failing to provide this service satisfactorily the Employer shall be entitled to make their own arrangements and recover the full cost through the contract.

12.0 BUILDING OPERATION

12.1 Staff Training

Prior to Practical Completion explain and demonstrate the purpose, function and operation of all the installations including all items and procedures listed in the operation and maintenance manual to Employer's maintenance and operational staff.

All costs associated with the instruction of the Employer's personnel and required attendance following practical completion shall be included in the contract price.

Submit a detailed programme for training the Employer's staff to the CA/EA for approval a month prior to the first proposed training date.

Time to be allowed at Tender for the purpose of staff training. Allow for the presence of all individuals (including specialists) outlined within the schedule under 'Attendance (Contractor Side)'. Allow for the training of 10 Employer's staff at each training session.

This training is to include:

- Training and instruction on the operation and maintenance on all installations within the building.
- Training and instruction from all relevant specialists and suppliers employed by the Contractor during the works.
- Provide each staff member taking part in the training with all appropriate reference and training manuals.
- Review the contents of the Operation and Maintenance manuals along with any Simple Building User Guides with the Employer's staff while carrying out training sessions.

Training on the control and monitoring systems within the building (whether stand-alone or centralised systems) is to include:

- Familiarisation with the interface systems;
- Fault finding demonstrations;
- Instruction on the procedures for testing and routine inspection of sensors and actuators to enable the operator to assess the nature of faults and extent of remedial action required.

Record the training sessions and provide these recordings to the Employer on DVDs. The videos on the DVDs are to be indexed such that the recordings are given a suitable title allowing the desired video to be found quickly.

Following practical completion and occupation of the building, be available for a period as agreed with the CA/EA to assist the Employer's personnel in the operation of the various systems together with the various specialist designers and installers involved in the works (e.g. controls, security, fire alarm, etc.)

The Contractor is responsible for the correct operation and maintenance of the installation during any such periods of instruction.

12.2 Proving Period and Fine Tuning

Requirements for the electrical works contract:
In conjunction with the lighting controls supplier/specialist under take post-occupancy checks of the lighting controls system over the first 12-month period of operation following Practical Completion.
Adjust and fine-tune the operation of the lighting controls (including interfaces with other systems if necessary) to correct and optimise their performance. Carry out further client training/demonstrations if necessary.

Allow for at least 2 suitably qualified and experienced personnel including the lighting controls

supplier/specialist and an electrical engineer.

Agree meeting dates on site with the Services Engineer (Max Fordham LLP) and Employer.

Note: the time to be allowed under this clause is not to be used for the rectification of latent defects. Defects are to be dealt with in the usual way through the Contract.

12.3 Seasonal Commissioning

Carry out seasonal commissioning as required by BREEAM and described by the individual work sections within SPEC-100.

12.4 Maintenance During Rectification Period

During the Rectification Period, carry out all maintenance, fine tuning and adjustments recommended by manufacturers, system specialists and published guidance to ensure that equipment and system warranties are maintained.

13.0 RECTIFICATION OF DEFECTS

Comply with the Rectification of Defect clauses within the Main Contract Prelims.

14.0 APPENDIX A

14.1 Design, Commissioning & Handover Information Responsibilities

Allocation of Design Responsibilities

Table A: the consultant carried out the design
Except where specifically stated in clause 4.2, the Consultant has developed and completed the design of the mechanical & electrical specialist works described within the tender documentation.

TABLE A GENERAL DESIGN ACTIVITIES

	Design Activity	Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
A1	Production of Drawings				See Section 9 of these Preliminaries for definitions and BRSIA BG6/2014 for example drawings and BIM model information.
	Sketch Drawings	✓			
	Schematic Drawings	✓			Issued as tender drawings as reasonably necessary in the opinion of MFLLP to enable the Contractor to prepare Coordination & Installation Drawings.
	Detailed Design Drawings	✓			As above.
	Coordination Drawings		✓		
	Installation Drawings		✓		Including setting out information where not given by MFLLP on the Detailed Design Drawings. This includes setting out of visible equipment & accessories to the approval of the CA/EA. Co-ordination of the Installation Drawings is to be managed by the Mechanical Contractor (see Preliminaries clause 5.0).
	Installation Wiring Diagrams		✓		
	Manufacturer's Drawings		✓		

TABLE A GENERAL DESIGN ACTIVITIES

	Design Activity	Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
	Manufacturer's Certified Drawings		✓		
	As-installed Drawings		✓		To be marked up on site as the work proceeds.
	Record Drawings		✓		
	Builders Work Drawings (design stage)	✓			MFLLP Builders Work Drawings and/or schedules have been prepared to allow development of the structural design and preparation of the bills of quantities only. These drawings and/or schedules may not necessarily be issued for tender purposes.
	Builders Work Drawings (installation stage)		✓		Based on the Installation Drawings prepared by the Contractor. Co-ordination of the Builders Work Drawings is to be managed by the Mechanical Contractor (see Preliminaries clauses 4.4 & 5.0).
	Specialist Drawings		✓	✓	"Other" = Specialist Designer appointed by the Contractor.
A2	Spatial Co-ordination (i.e. overall responsibility for resolving difficult spatial clashes).		✓		Process to be managed by the Mechanical Contractor (see Preliminaries clause 5.0).
A3	Confirmation of plant or system sizing MFLLP is responsible for all installed plant & system sizes/capacities other than those items that are identified below. These items require final confirmation by the party indicated.				
	• Selection of commissioning valves and/or automatic flow balancing valves.		✓		

TABLE A GENERAL DESIGN ACTIVITIES

	Design Activity	Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
	• Alternative plant or equipment suppliers to those specified in the tender documentation.		✓		See Preliminaries clauses 3.6 & 9.5.
A4	On-site Co-ordination.		✓		Process to be managed by the Mechanical Contractor (see Preliminaries clause 5.0).
A5	System Compatibility Confirm the compatibility of plant/equipment specified for use within the same system or where an interface is required between systems.		✓		

Table based on BSRIA Technical Note BG 6/2014 "Allocation of Design Responsibilities for Building Engineering Services"

Table B: the contractor completes the design

The Contractor shall complete the design of the MEP Engineering Services Works or specialist elements listed in clause 4.2.

TABLE B DESIGN & DRAWING PRODUCTION ACTIVITIES

Design Activity		Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
B1	Verify and develop the Consultant's design detailed within the tender documents, to a form agreed with the CA/EA.		✓		
B2	Prepare proposals for the installations for the agreement of the CA/EA. Investigate the options available and describe the performance that can be achieved.		✓		
B3	Design and detail the installations as part of the overall co-coordinated building design allowing for every stage of the design to be brought to a successful conclusion by the process of repeated refinement until it is clear that the Installation and Coordination Drawings can be completed.		✓		
B4	Provide copies of calculations if requested by the CA/EA.		✓		
B5	Provide copies of any risk assessments undertaken in compliance with the requirements of Regulation 13 of the Construction (Design and Management) Regulations 1994.		✓		
B6	If appropriate, negotiate and agree all details with regulatory bodies as necessary.		✓		Where the Contractor's proposals modify or add to the Consultant's tender information.
B7	If appropriate, negotiate and agree all details with the		✓		Where the Contractor's proposals modify or add to the

TABLE B DESIGN & DRAWING PRODUCTION ACTIVITIES

	Design Activity	Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
	Statutory Authorities as necessary.				Consultant's tender information.
B8	If appropriate, meet with Building Control and provide the CA/EA with written confirmation of the various stages including detailed Building Control Approval for the installations proposed, prior to construction.		✓		Where the Contractor's proposals modify or add to the Consultant's tender information.
B9	Modify the design and/or an installation, should the installation not meet the specification and/or agreed proposals, Statutory requirements, etc.		✓		
B10	Production of Drawings				See Preliminaries for definitions and BRSIA BG6/2014 for example drawings.
	Sketch Drawings	✓			Tender drawings provided to indicate the design intent and the performance to be achieved.
	Schematic Drawings		✓		
	Detailed Design Drawings		✓		
	Coordination Drawings		✓		Services co-ordination is to be managed by the Mechanical Contractor (see Preliminaries clause 5.0).
	Installation Drawings		✓		Co-ordination of the Installation Drawings is to be managed by the Mechanical Contractor (see Preliminaries clause 5.0).
	Installation Wiring Diagrams		✓		
	Manufacturer's Drawings		✓		

TABLE B DESIGN & DRAWING PRODUCTION ACTIVITIES

Design Activity		Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
	Manufacturer's Certified Drawings		✓		
	As-installed Drawings		✓		To be marked up on site as the work proceeds.
	Record Drawings				
	Builders Work Drawings		✓		Co-ordination of the Builders Work Drawings is to be managed by the Mechanical Contractor (see Preliminaries clauses 4.4 & 5.0).
	Specialist Drawings		✓		
B11	Spatial Co-ordination (i.e. overall responsibility for resolving difficult spatial clashes).		✓		Process to be managed by the Mechanical Contractor (see Preliminaries clause 5.0)
B12	Confirmation of plant or system sizing.		✓		
B13	On-site Co-ordination.		✓		Process to be managed by the Mechanical Contractor (see Preliminaries clause 5.0).
B14	System Compatibility. Confirm the compatibility of plant/equipment specified for use within the same system or where an interface is required between systems.		✓		

Allocation of Commissioning Responsibilities

TABLE D SPECIFYING SYSTEM COMMISSIONING ACTIVITIES

	Design Activity	Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
Design					
D1	Ensure that the selected systems will meet the employer's brief and that their commissioning requirements are compatible with any project restraint concerning sectional handover/phasing.	✓	✓		The contractor is responsible for those services, systems or work elements design by them and/or specialist sub-contractors appointed by them.
D2	Identify and incorporate into system designs the essential components and features necessary to enable the proper preparation and commissioning of building services.	✓	✓		Note as D1.
D3	Review all designs to ensure that systems can be properly prepared, and are commissionable.	✓	✓		Note as D1.
D4	Prepare the commissioning specification.	✓	✓		Note as D1.
Management					
D5	a) Produce a commissioning method statement and logic diagram for integration into the building contractor's construction and finishes programmes.		✓		
	b) Produce a "commissioning plan" as required by Part L2 of the Building Regulations.		✓		It is for the Contractor is to demonstrate to the local Building Control office that the person(s) providing this report are suitably qualified. See Preliminaries clause 11.3.
D6	Produce a flushing, chemical cleaning and water treatment method statement, logic diagram and programme for integration into the building		✓		

TABLE D SPECIFYING SYSTEM COMMISSIONING ACTIVITIES

Design Activity		Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
	contractor's construction, commissioning and finishes programmes.				
D7	Attend commissioning meetings as necessary OR Arrange and chair commissioning meetings as necessary.		✓		Give notice to MFLLP of when these meetings are taking place. MFLLP will only attend meetings as and when they feel necessary.
D8	Comment on the adequacy of systems for commissioning as detailed on specialists' drawings and manufacturers' shop drawings prior to actual manufacture at works. Ensure comments are incorporated into finished products.		✓		
D9	Carry out site inspections, to ensure that the commissioning facilities are being installed. Check compliance with specified guides and standards.		✓		
D10	Monitor the on-going progress of the procurement, manufacture, installation and commissioning of all plant items.		✓		
D11	Assess the effects of any anticipated delays to the services installation and the completion of interfaces with the building works critical to the commissioning programme. Formulate strategies to overcome potential delays.		✓		
D12	Establish an agreed set of pro forma documentation relating to the commissioning and testing of plant and systems.		✓		Issue to MFLLP for comments.

TABLE D SPECIFYING SYSTEM COMMISSIONING ACTIVITIES

	Design Activity	Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
D13	Approve the proposed set of instruments of the commissioning and testing works.		✓		
D14	Ensure that the instrumentation is periodically calibrated as necessary and records retained.		✓		
D15	Witness the flushing, cleaning and treatment of systems in accordance with the specification.	✓	✓		Contractor is to be fully satisfied with the pre-commissioning cleaning before inviting MFLLP to witness.
D16	Witness pre-commissioning activities in accordance with the specification.	✓			
D17	a) Commission all systems to methods, logic and programme (see 9.4) and record results.		✓		
	b) Witness specified demonstration of system commissioning results.	✓	✓		Contractor is to be fully satisfied with the commissioning results before inviting MFLLP to witness.
D18	Witness and record the specified demonstration and testing of plant items and systems in accordance with the specification.	✓	✓		Contractor is to be fully satisfied with the commissioning results before inviting MFLLP to witness.
D19	Establish procedures to allow the demonstration of normal emergency, shutdown and standby mode operation of plant and systems.		✓	✓	"Other" = manufacturers or suppliers of plant items.
D20	Witness demonstration of same (D19) to specified requirements.	✓	✓		Contractor is to be fully satisfied with the demonstration results before inviting MFLLP to witness.
D21	Demonstrate the partial load testing of plant to the		✓		

TABLE D SPECIFYING SYSTEM COMMISSIONING ACTIVITIES

Design Activity		Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
	employer and designer in accordance with the specification.				
D22	Witness the operation of the BMS on site to the specified requirements.	✓	✓	✓	"Other" = BMS Specialist Designer. Contractor is to be fully satisfied that the performance of the BMS meets the requirements of the contract documents before inviting MFLLP to witness.
D23	Witness the functional testing of all safety interlocks in accordance with the commissioning specification.	✓	✓		Contractor is to be fully satisfied with the commissioning results before inviting MFLLP to witness.
D24	Witness the demonstration of acoustic tests, if any, in accordance with the specification.	✓	✓		Contractor is to be fully satisfied with the commissioning results before inviting MFLLP to witness.
D25	Witness the operation of plant and systems for specified periods of time to prove plant reliability.	✓	✓		
D26	a) Produce commissioning report detailing the results of the commissioning and commenting on the performance of systems		✓		
	b) Produce a "commissioning report" as required by Part L2 of the Building Regulations for submission to the local Building Control office.		✓		It is for the Contractor is to demonstrate to the local Building Control office that the person(s) providing this report are suitably qualified. See Preliminaries clause 11.3.
D27	Ensure that all plant settings are recorded, including appropriate reference to plant items. The records should be incorporated within the		✓		

TABLE D SPECIFYING SYSTEM COMMISSIONING ACTIVITIES

Design Activity		Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
	operating and maintenance manuals.				

Table taken from BSRIA Technical Note TN 21/97 "Allocation of Design Responsibilities for Building Engineering Services"

Production of Handover Information

TABLE E PRODUCTION OF HANDOVER INFORMATION

Design Activity		Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
E1	Define the scope and content of operating and maintenance manuals appropriate to the size of project, the employer's operating and maintenance strategy and the technical capability of the maintenance staff.	✓			
E2	Define the requirement for record drawings appropriate to the employer's operating and maintenance strategy.	✓			
E3	Advise on the need for a specialist author for production of operating and maintenance manuals.	✓			
E4	Advise on the need for a separate survey of installed systems to facilitate production of record drawings.	✓			This survey will only be required if the Contractor has failed in their duty to fully record the installed services as the work proceeds and before it is covered up. The cost of this survey, if required, will be recovered through the Contract.
E5	Prepare a specification for operating and maintenance manuals. Specify the section headings and required technical content.	✓			See Preliminaries for details of the level of information required.

TABLE E PRODUCTION OF HANDOVER INFORMATION

	Design Activity	Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
E6	Prepare a specification for record drawings. Specify content, form of delivery and the method of production of the drawings to be produced.	✓			See Preliminaries for details of the level of information required.
E7	Define what level of documentation, commissioning results and other information must be available prior to practical completion and handover. Take into account possible implications of phased handover and partial possession.	✓			In order to comply with the CDM Regulations the Contractor is to ensure that complete O&M information and Record Drawings are available to the employer prior to Practical Completion. See Preliminaries for further information.
E8	Produce operation and maintenance manuals in accordance with the specified requirements.		✓		
E9	Ensure that information needed for inclusion in the operating and maintenance manuals is obtained as the works progress. Identify individual sources of information.		✓		
E10	Establish target dates for when information must be available to the author of the operating and maintenance manuals. Advise on timescales for production of maintenance information relative to key dates i.e. installation start date, setting to work, start dates for testing and commissioning and handover dates.		✓		
E11	Monitor the programme for production of operating and maintenance manuals and adjust dates to allow for progress of the project.		✓		

TABLE E PRODUCTION OF HANDOVER INFORMATION

Design Activity		Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
E12	Receive, inspect and comment on the contents of the operating and maintenance manuals in order to confirm general compliance with the specified requirements.	✓	✓		The Contractor is to inspect and comment on the manuals where produced by others on their behalf prior to submission to MFLLP. The Contractor is to ensure that drafts of the O&M manual(s) are available for comment at least 8 weeks prior to Practical Completion.
E13	Modify and update operating details to reflect commissioning results.		✓		
E14	Accept the completed operating and maintenance manuals on behalf of the employer.	✓			
E15	Identify key dates and intervals at which draft record drawings will be inspected.		✓		Contractor is to provide schedule of dates for the release of this information.
E16	Modify the record drawings as the works progress so that all alterations from the installation drawings are recorded as work proceeds.		✓		Contractor is to ensure that the As-installed Drawings are maintained on site and updated as the work proceeds. The As-installed Drawings are to be made available for inspection when requested by the CA/EA.
E17	Receive, inspect and comment on the Record Drawings in order to confirm general compliance with the specified requirements.	✓	✓		The Contractor is to inspect and comment on the record drawings where produced by others on their behalf prior to submission to MFLLP.
E18	Accept the completed record drawings on behalf of the employer.	✓			
E.19	Prior to handover, make recommendations for the commencement and carrying out of operation and		✓		When stated in the preliminaries the Contractor is to provide a priced proposal for the maintenance of the installed services during the period concurrent with the

TABLE E PRODUCTION OF HANDOVER INFORMATION

Design Activity		Responsibility			Comments
		MFLLP	**Cont'r**	**Other**	
	maintenance during and after the Defects Liability Period.				Defects Liability Period within their contract price.
E20	Provide the employer with a log-book as required by statute under Part L2 of the Building Regulations.		✓		

Table taken from BSRIA Technical Note TN 21/97 "Allocation of Design Responsibilities for Building Engineering Services"

MAX FORDHAM

Kings College Chapel PV

Reference Specification for the Mechanical, Electrical & Public Health (MEP) Installations

For Client

February 2022

SPEC-300

Status Code	revision	status description	project code		originator		volume		level		type		role		number
D1	**P01**	**Issued for Tender**	**J7008**	**-**	**MXF**	**-**	**XX**	**-**	**XX**	**-**	**SP**	**-**	**J**	**-**	**30300**

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ISSUE HISTORY

Issue	Date	Description
P01	14/02/22	For Tender

MAX FORDHAM LLP TEAM CONTRIBUTORS

Engineer	Role
PA	Senior Partner
EJ	Engineer

CONTENTS

1.0 PR_65_52_00_00 PIPELINES

PR_65_52_00_00.1010 PRE-FABRICATED PIPEWORK:
Supply pre-fabricated pipework in accordance with relevant materials and workmanship clauses.

PR_65_52_00_00.1020 FITTINGS:
For changes in direction use centreline radius/nominal bore of not less than 1.5 unless otherwise directed. For reductions and enlargements, use easy transition type with inclined angle not exceeding 30 degrees.

PR_65_52_00_00. 1030 FABRICATED FITTINGS:
Use only with approval, if manufacturer's standard fittings are not available.

PR_65_52_00_00.1040 PIPE JOINTS:
Obtain approval from the Local Water Authority or Water Research Centre for materials used in water supplies.

PR_65_52_00_00.2010A HEAVY BLACK STEEL PIPES TO BS EN 10255:
- Material - Steel
- Standard - BS EN 10255
- Dimensions - Heavy. Random single lengths, 4m to 7m.
- Ends - Screwed to BS 21 and BS EN 10226-1, taper thread or plain.
- Finish - Varnished.

PR_65_52_00_00.2010B MEDIUM BLACK STEEL PIPES TO BS EN 10255:
- Material - Steel
- Standard - BS EN 10255
- Dimensions - Medium. Random single lengths, 4m to 7m.
- Ends - Screwed to BS 21 and BS EN 10226-1, taper thread or Plain.
- Finish - Varnished.

PR_65_52_00_00.2010C MEDIUM GALVANISED STEEL PIPES TO BS EN 10255:
- Material - Steel
- Standard - BS EN 10255
- Dimensions - Medium. Random single lengths, 4m to 7m.
- Ends - Screwed to BS 21 and BS EN 10226-1, taper thread.
- Finish - Galvanised.

PR_65_52_00_00.2010E HEAVY BLACK STEEL PIPES TO BS EN 10255 - GROOVED ENDS:
- Material - Steel
- Standard - BS EN 10255
- Dimensions - Heavy. Random single lengths, 4m to 7m.
- Ends - Grooved for mechanical joints.
- Finish - Unvarnished, varnished, painted.

PR_65_52_00_00.2010F MEDIUM BLACK STEEL PIPES TO BS EN 10255 - GROOVED ENDS:
- Material - Steel
- Standard - BS EN 10255
- Dimensions - Medium. Random single lengths, 4m to 7m.
- Ends - Grooved for mechanical joints.
- Finish - Unvarnished, varnished, painted.

PR_65_52_00_00.2020A STEEL FITTINGS - SCREWED BENDS AND SPRINGS TO BS EN 10255:
- Material - Steel grade, seamless.

- Standard - BS EN 10255.
- Size range - 6mm to 150mm.
- Dimensions - BS EN 10255, medium weight.
- Ends - Screwed to BS 21 and BS EN 10226-1.
- Finish - Galvanised.

PR_65_52_00_00.2060A HEAVY WEIGHT CARBON STEEL FITTINGS, BUTT WELDED TO BS EN 10253:

- Material
- Carbon steel, grade 430, electric resistance welded.
- Standard - BS EN 10253-1 or BS EN 10253-2.
- Size range - 25mm to 400mm.
- Dimensions - BS EN 10253-1 or BS EN 10253-2 Heavy
- Ends - Bevelled.
- Finish - Varnished.

PR_65_52_00_00.2060B MEDIUM WEIGHT CARBON STEEL FITTINGS, BUTT WELDED TO BS EN 10253:

- Material
- Carbon steel, grade 430, electric resistance welded.
- Standard - BS EN 10253-1 or BS EN 10253-2.
- Size range - 25mm to 400mm.
- Dimensions - BS EN 10253-1 or BS EN 10253-2 Medium.
- Ends - Bevelled.
- Finish - Varnished.

PR_65_52_00_00.2080B BLACK STEEL FITTINGS, GROOVED FOR MECHANICAL JOINTS:

- Material - Steel fittings to ASTM A-53.
- Standard - Manufacturer's.
- Size range - 20mm to 600mm.
- Ends - Grooved for mechanical joints.
- Finish - Black.

PR_65_52_00_00.2080F PAINTED STEEL FITTINGS, GROOVED FOR MECHANICAL JOINTS:

- Material - Steel fittings to ASTM A-53.
- Standard - Manufacturer's.
- Size range - 20mm to 600mm.
- Ends - Grooved for mechanical joints.
- Finish - Painted.

PR_65_52_00_00.2255A STAINLESS STEEL FITTINGS, GROOVED MECHANICAL JOINTS:

- Material - Stainless steel grades 304, 316, 316L, 316T, schedules 5S, 10S, 20S, 40S.
- Standard - Manufacturer's.
- Size range - 20mm to 600mm.
- Dimensions - Manufacturer's standard.
- Ends - Grooved for mechanical joints.
- Finish - Natural.

PR_65_52_00_00.2270A COPPER HALF HARD:

- Kitemarked.
- Material - Copper.
- Standard - BS EN 1057, R250, (Class X).
- Dimensions - BS EN 1057 table 3.
- Ends - Plain, grooved for mechanical joints.

- Finish - Uncoated.

PR_65_52_00_00.2270B CHROMIUM PLATED COPPER, HALF HARD:

- Kitemarked.
- Material - Copper.
- Standard - BS EN 1057, R250, (Class X).
- Dimensions - BS EN 1057 table 3.
- Ends - Plain
- Finish - Chromium plated.

PR_65_52_00_00.2270C POLYETHYLENE SHEATHED COPPER, HALF HARD:

- Kitemarked.
- Material - Copper.
- Standard - BS EN 1057, R250, (Class X).
- Dimensions - BS EN 1057 table 3.
- Ends - Plain
- Finish - Sheathed in profiled white polyethylene.

PR_65_52_00_00.2310A CAPILLARY FITTINGS FOR COPPER TUBING, GENERAL POTABLE RANGE:

- Material - Copper or de-zincifiable resistant copper alloy.
- Standard - BS EN 1254-1.
- Size range - 6mm to 67mm.
- Dimensions - BS EN 1254-1 table 2.
- Ends - Integral (lead-free) solder ring.
- Finish - Natural.

PR_65_52_00_00.2310B CAPILLARY FITTINGS FOR CHROME PLATED COPPER TUBING, POTABLE RANGE:

- Material - Copper or de-zincifiable resistant copper alloy.
- Standard - BS EN 1254-1.
- Size range - 6mm to 67mm.
- Dimensions - BS EN 1254-1 table 2.
- Ends - Integral (lead-free) solder ring.
- Finish - Chrome plated.

PR_65_52_00_00.2310C CAPILLARY FITTINGS FOR COPPER TUBING, HIGH DUTY RANGE:

- Material - Gunmetal (LG2 and LG4) or aluminium brass.
- Standard - BS EN 1254-1.
- Size range - 6mm to 54mm.
- Dimensions - BS EN 1254-1 table 2.
- Ends - Integral (cadmium-free) silver brazing ring.
- Finish - Natural.

PR_65_52_00_00.2310D CAPILLARY FITTINGS FOR COPPER TUBING, WEDGE FITTING RANGE:

- Material - Gunmetal and copper/DZR copper alloy.
- Standard - BS EN 1254-1.
- Size range - 76mm and 108mm.
- Dimensions - BS EN 1254-1 table 2.
- Ends - Integral (lead-free) solder ring.
- Finish - Natural.

PR_65_52_00_00.2310E CAPILLARY FITTINGS FOR COPPER TUBING, WASTE SYSTEM RANGE:

- Material - Copper or DZR copper alloy.
- Standard - BS EN 1254-1.

- Size range - 28mm to 54mm.
- Dimensions - BS EN 1254-1 table 2.
- Ends - Integral (lead-free) solder ring.
- Finish - Natural.

PR_65_52_00_00.2320A TYPE A COMPRESSION FITTINGS FOR COPPER TUBING:

- Kitemarked.
- Material – de-zincifiable resistant copper alloy
- Standard - BS EN 1254-2, type A, non-manipulative.
- Size range - 6mm to 54mm.
- Dimensions - BS EN 1254-2, table 2 and 3.
- Ends - Socket.
- Finish - Natural.

PR_65_52_00_00.2320B TYPE A COMPRESSION FITTINGS FOR CHROME PLATED COPPER TUBING:

- Kitemarked.
- Material – de-zincifiable resistant copper alloy and brass.
- Standard - BS EN 1254-2, type A, non - manipulative.
- Size range - 6mm to 54mm.
- Dimensions - BS EN 1254-2, table 2 and 3.
- Ends - Socket.
- Finish - Chrome plated.

PR_65_52_00_00.2320C TYPE B COMPRESSION FITTINGS FOR COPPER TUBING:

- Kitemarked.
- Material – de-zincifiable resistant copper alloy and brass.
- Standard - BS EN 1254-2, type B manipulative.
- Size range - 6mm to 54mm.
- Dimensions - BS EN 1254-2, tables 2 and 3.
- Ends - Socket.
- Finish - Natural.

PR_65_52_00_00.2322 CAPILLARY FITTINGS, SHORT, FOR BRAZING TO COPPER TUBING:

- Material – de-zincifiable resistant copper alloy.
- Standard - BS EN 1254-5
- Size range - BS EN 1254-5 - 67mm to 159mm.
- Dimensions - BS EN 1254-5, table 2.
- Ends - Plain.
- Finish -Natural.

PR_65_52_00_00.2325A PUSH-FIT FITTINGS FOR COPPER TUBING:

- Material - de-zincifiable resistant copper alloy and brass.
- Standard - Manufacturer's standard.
- Size range - 15mm to 54mm.
- Dimensions - to suit copper tube to BS EN 1057.
- Ends - push-fit with EPDM O ring.
- Finish - Natural.

PR_65_52_00_00.2330A COPPER TO BS EN 12449:

- Material - Copper.
- Standard - BS EN 12449, seamless, round tubes.
- Dimensions - BS EN 12449.

- Ends - Plain or screwed.
- Finish - Uncoated.

PR_65_52_00_00.2332A COPPER TO BS EN 12450:

- Material - Copper.
- Standard - BS EN 12450, seamless, round copper capillary tubes.
- Dimensions - BS EN 12450.
- Ends - Plain or screwed.
- Finish - Uncoated.

PR_65_52_00_00.2350A CAST IRON PIPES AND FITTINGS TO BS 416-1:

- Material - Cast grey or ductile iron.
- Standard - BS 416-1, spun.
- Dimensions - BS 416-1.
- Ends - Socket type A or B.
- Finish - Hot dipped to BS 416-1.

PR_65_52_00_00.2370A CAST IRON PIPES TO BS 437 FOR FLEXIBLE JOINTS:

- Material - Cast iron.
- Standard - BS 437.
- Dimensions - BS 437.
- Ends - For flexible joint to BS EN 877.
- Finish - Hot dipped to BS 437.

PR_65_52_00_00.2390A RED CAST IRON PIPES AND FITTINGS TO BS EN 877:

- Material - Cast iron.
- Standard - BS EN 877.
- Dimensions - BS EN 877, table 1.
- Ends - Plain.
- Finish - Red epoxy.

PR_65_52_00_00.2390B GREY CAST IRON PIPES AND FITTINGS TO BS EN 877:

- Material - Cast iron.
- Standard - BS EN 877.
- Dimensions - BS EN 877, table 1.
- Ends - Plain.
- Finish - Grey epoxy.

PR_65_52_00_00.2410A FLANGED DUCTILE IRON PIPES AND FITTINGS TO BS EN 545:

- Material - Ductile iron.
- Standard - BS EN 545.
- Dimensions - Flanged, class K9.
- Ends - Flanged.
- Finish - External, zinc rich, with polyethylene sleeving, extruded polyethylene, extruded polypropylene or polyurethane.
- Internal, polyurethane to BS EN 15189.

PR_65_52_00_00.2410B DUCTILE IRON PIPES AND FITTINGS TO BS EN 545:

- Material - Ductile iron.
- Standard - BS EN 545.
- Dimensions - Spigot/socket, table 14.
- Ends - Spigot and socket.
- Finish - External, zinc rich, with polyethylene sleeving, extruded polyethylene, extruded polypropylene

or polyurethane.
- Internal, polyurethane to BS EN 15189.

PR_65_52_00_00.2420A FLANGED DUCTILE IRON PIPES AND FITTINGS TO BS EN 598:
- Material - Ductile iron.
- Standard - BS EN 598.
- Dimensions - Flanged, Class K9.
- Ends - Flanged.
- Finish - External, zinc rich, with polyethylene sleeving, extruded polyethylene, extruded polypropylene or polyurethane to BS EN 15189.
- Internal, high alumina cement mortar.

PR_65_52_00_00.2420B DUCTILE IRON PIPE AND FITTINGS TO BS EN 598:
- Material - Ductile iron.
- Standard - BS EN 598.
- Dimensions - Spigot/socket, table 11.
- Ends - Spigot or socket.
- Finish - External, zinc rich, with polyethylene sleeving, extruded polyethylene, extruded polypropylene or polyurethane to BS EN 15189.
- Internal, high alumina cement mortar.

PR_65_52_00_00.2538 POLYETHYLENE FUSION FITTINGS TO BS EN 1555:
- Material - Polyethylene.
- Standard - BS EN 1555-1, BS EN 1555-3 and BS EN 1555-5.
- Dimensions - BS EN 1555-3, Section 6, to suit pipes to BS EN 1555-2.
- Marking - BS EN 1555-3, table 7.
- Ends - Sockets with heating elements for fusion jointing.
- Finish -
    - Black
    - Yellow.

PR_65_52_00_00.2599A PLASTICS PIPING SYSTEMS TO BS EN ISO 15876 - PIPES:
- Plastics piping systems for hot and cold water systems, including heating, within buildings.
- Material - polybutylene (PB).
- Standard - BS EN ISO 15876-5.
- Dimensions - Length - manufacturer's standard range. BS EN ISO 15876-2 - tables 2 to 6.
- Ends - Plain, sockets for fusion fittings, suitable for electrofusion fittings, mechanical fittings, or fittings with incorporated inserts.
- Finish - Natural or coloured.

PR_65_52_00_00.2600A PLASTICS PIPING SYSTEMS TO BS EN ISO 15876 - FITTINGS:
Plastics piping systems for hot and cold water systems, including heating, within buildings.

- Material - polybutylene (PB).
- Standard - BS EN ISO 15876-5.
- Size range - 16mm to 160mm.
- Dimensions - BS EN ISO 15876-3 - tables 3 to 5, and clause 6.3.
- Ends - Plain, sockets for fusion fittings, suitable for electrofusion fittings, mechanical fittings, or fittings with incorporated inserts.
- Finish - Natural or coloured.

PR_65_52_00_00.2705A PLASTICS PIPES TO BS 7291-2 AND BS 7291-3:
- Material - Polybutylene (PB) BS 7291-2; or crosslinked polyethylene (PE-X) BS 7291-3.

- Standard - BS 7291.Classification H unless otherwise indicated.
- Dimensions - BS 7291-2 (PB) or BS 7291-3 (PE-X); Table 1 (CU) or Table 2 in accordance with BS ISO 11922-1, BS ISO 4065 or to BS 2782-11: Method 1121B.
- Ends - Plain.
- Finish - Natural.

PR_65_52_00_00.2708A POLYBUTYLENE (PB) PIPE AND FITTINGS:
- Material - Polybutylene (PB).
- Dimensions - 16mm to 25mm o.d. as flexible pipe-in-sleeve coils; and 16mm to 110mm o.d. in straight lengths.
- Ends - Plain.
- Finish - Natural.

PR_65_52_00_00.3010A CIRCULAR FLANGES FOR PIPES, PN DESIGNATED - WELDED FLANGE:
- Material - BS EN 1092-1.
- Flange type - Weld neck flange or hubbed slip-on flange for welding.
- Flange facings - Raised face - type B.
- Bolting - In accordance with BS EN 1092-1.

PR_65_52_00_00.3010B CIRCULAR FLANGES FOR PIPES, PN DESIGNATED - THREADED FLANGE:
- Material to BS EN 1092-1.
- Facings - Raised face type B.
- Bolting - in accordance with BS EN 1092-1.
- Threaded flanges - BS 21 and BS EN 10226-1 parallel thread.

PR_65_52_00_00.3010C CIRCULAR FLANGES FOR PIPES, PN DESIGNATED - CAST IRON FLANGE:
- Material - BS EN 1092-2 - Ductile cast iron.
- Bolting - In accordance with BS EN 1092-2.

PR_65_52_00_00.3020A JOINTING RINGS - NON-METALLIC FLAT GASKETS:
Non-metallic flat gaskets for flanges to BS EN 1092-4.

- Standard - BS EN 1514-1
- Gasket type - Full face for type B.

PR_65_52_00_00.3020B JOINTING RINGS - METALLIC GASKETS:
Corrugated, flat or grooved metallic and filled metallic gaskets for flanges to BS EN 1092-4.

- Standard - BS EN 1514-4
- Gasket type - Corrugated metal.
- Gasket design - Self centring for type B.

PR_65_52_00_00.3020C JOINTING RINGS FOR CAST IRON:
Non-metallic flat gaskets for flanges to BS EN 1092-2

- Standard - BS EN 1514-1.
- Gasket type - Suitable for flanges to BS EN 545, BS EN 598 and BS EN 969.

PR_65_52_00_00.3030A SCREWED JOINTS TO BS 21 AND BS EN 10226-1:
Use PTFE tape to BS 7786 or use hemp and jointing compound to BS 6956-5, or BS EN 751-2.

PR_65_52_00_00.3030B SCREWED JOINTS TO BS 21 AND BS EN 10226-1 WITH PTFE TAPE:
Use PTFE tape to BS 7786.

PR_65_52_00_00.3030C SCREWED JOINTS TO BS 21 AND BS EN 10226-1 WITH CHEMICAL CLEANING:
Use hemp and jointing compound to BS 6956-5 or BS EN 751-2, prior to chemical treatment and use PTFE tape to BS 7786 after chemical treatment.

PR_65_52_00_00.3040A RAILROAD UNION CONNECTIONS:
Seating - Spherical seating bronze to iron, railroad pattern.

PR_65_52_00_00.3040B NAVY UNION CONNECTIONS:
Seating - Spherical seating bronze to bronze, navy pattern.

PR_65_52_00_00.3050A WELDED JOINTS, WELDING RODS FOR STEEL PIPES:
Gas welding, BS 1453 type A2 or A3; electric arc welding BS 2971.

PR_65_52_00_00.3060A BRAZED JOINTS:
Use filler metals to BS EN 1044.

PR_65_52_00_00.3060B ZINC FREE BRAZED JOINTS:
Use nickel bearing zinc free grades of filler metals to BS EN 1044.

PR_65_52_00_00.3070A CAPILLARY JOINTS FOR COPPER:
Use materials as follows:

- Solder - BS EN ISO 9453.
- Flux - Copper pipe - BS EN 29454-1.

PR_65_52_00_00.3070B CAPILLARY JOINTS FOR POTABLE WATER:
Use materials as follows:

- Solder - Use lead-free fittings in accordance with BS EN 1254-1, on potable water systems.
- Flux - Copper pipe - BS EN 29454-1.

PR_65_52_00_00.3097C JOINTING EQUIPMENT FOR POLYBUTYLENE (PB) PIPES - ELECTROFUSION:
Provide the equipment recommended by the manufacturer to carry out electrofusion jointing on polybutylene pipes and fittings.

PR_65_52_00_00.3105B RED DUCTILE IRON COUPLINGS FOR CAST IRON PIPES TO BS EN 877:
- Material - Ductile iron.
- Finish - Red.
- Gasket - EPDM.

PR_65_52_00_00.3105C GREY DUCTILE IRON COUPLINGS FOR CAST IRON PIPES TO BS EN 877:
- Material - Ductile iron.
- Finish - Grey.
- Gasket - EPDM.

PR_65_52_00_00.3105D BLACK DUCTILE IRON COUPLINGS FOR CAST IRON PIPES TO BS EN 877:
- Material - Ductile iron.
- Finish - Black.
- Gasket - EPDM.

PR_65_52_00_00.3140A MECHANICAL JOINTS, GROOVED STEEL PIPES:
- Material - Ductile cast iron to ASTM A-536, grade 54-45-12.
- Joint - Standard, flexible or rigid; or reducing joint.
- Size range - 20mm to 600mm.

- Gaskets - Grade 'E' EPDM.
- Finish - Painted to manufacturer's standard.

PR_65_52_00_00.3170A FLEXIBLE COUPLINGS, SLEEVE TYPE:
- Joint - Bolted, sleeve type, with wedge type elastomeric gaskets.
- Type - Non-end load capable.
- Dimensions - Manufacturer's standard.
- Material - Ductile cast iron to BS EN 1564, or to BS EN 1563.
- Finish - Manufacturer's standard.
- Gaskets - In accordance with BS EN 681-1, BS EN 681-2 or BS EN 682.

PR_65_52_00_00.3180A FLEXIBLE FLANGE ADAPTERS, SLEEVE TYPE:
- Joint - Bolted, sleeve type, with wedge type elastomeric gaskets, flanged on end.
- Type - Non-end load capable.
- Dimensions - Manufacturer's standard.
- Material - Ductile cast iron to BS EN 1564.
- Flange - To connect to BS EN 1092-2, PN10 flange.
- Finish - Manufacturer's standard.
- Gaskets - In accordance with BS EN 681-1, BS EN 681-2 or BS EN 682.

PR_65_52_00_00.3190A WALL, FLOOR AND CEILING CHROMIUM PLATED MASKING PLATES:
- Material - Copper alloy, chromium plated.
- Type - Heavy, split on the diameter, close fitting to outside of pipe.
- Fixing - Chrome raised head fixing screws.

PR_65_52_00_00.3190B WALL, FLOOR AND CEILING PLASTIC MASKING PLATES:
- Material - Plastic.
- Fixing - Clipped with plastic lug.

PR_65_52_00_00.3200A PIPE RINGS AND CLIPS, STEEL PIPEWORK:
Use suitable pipe, hangers, slider and roller type supports, taking into account the pipe load, material and pipe/insulation surface temperature.

PR_65_52_00_00.4010 APPEARANCE:
Arrange all exposed pipe runs to present neat appearance, parallel with other pipe or service runs and building structure, subject to gradients for draining or venting.

Ensure all vertical pipes are plumb or follow building line.

PR_65_52_00_00.4020 SPACING:
Space pipe runs in relation to one another, other services runs and building structure, allow for specified thickness of thermal insulation and ensure adequate space for access to pipe joints, etc.

The following are recommended as minimum clearances in spacing of pipe runs:-

Between	and	Clearance (mm)
Pipeline insulated or uninsulated	Wall Finish	25
	Ceiling Finish	50
	Soffit Floor Finish	150

Insulated Pipeline	Adjacent service runs	25
Uninsulated pipeline	Adjacent service runs	50
Adjacent pipelines	Both uninsulated	150
	One uninsulated	75
	Both insulated	25

PR_65_52_00_00.4030 GRADIENTS:
Install pipework with gradients to allow drainage and/or air release, and to the slopes where indicated.

PR_65_52_00_00.4040A AIR BOTTLES:
Provide a means of venting the pipe system at all high points.

Provide a vertical extension from the pipe approximately 100mm long, at the bore of the pipe, with a copper extension pipe with a manual vent cock located in an easily accessible position.

PR_65_52_00_00.4040B AUTOMATIC AIR VENTS:
Provide a means of venting the pipe system at all high points.

Provide an automatic air vent valve with a copper outlet pipe from the valve to a tundish in an adjacent drain line or to another suitable location.

PR_65_52_00_00.4050 DRAIN REQUIREMENTS:
Grade pipework to allow system to be drained. Provide a means of draining the system at all low points.

PR_65_52_00_00.4060 EXPANSION AND CONTRACTION:
Arrange supports and fixings to accommodate pipe movement caused by the thermal changes; generally allow the flexure at changes in direction. Allow for movement at branch connections.

PR_65_52_00_00.4070A PIPE FITTINGS, BENDS/SWEPT TEES:
Use eccentric type reductions and enlargements on horizontal pipe runs to allow draining and venting, concentric on vertical pipes, with easy transition and an included angle not exceeding 30 degree. Do not use bushes, except at radiators and at fittings where required size is not of standard manufacture. Where required, use eccentric bushes to allow draining or venting; maximum aspect ratio not to exceed two pipe sizes; above this ratio use reducing fittings. Use square tees at venting and draining points. Square elbows are not acceptable. Use bends and swept tees where practical.

PR_65_52_00_00.4070B PIPE FITTINGS, ELBOWS/SQUARE TEES:
Use eccentric type reductions and enlargements on horizontal pipe runs to allow draining and venting, concentric on vertical pipes, with easy transition and an included angle not exceeding 30 degree. Do not use bushes, except at radiators and at fittings where required size is not of standard manufacture. Where required, use eccentric bushes to allow draining or venting; maximum aspect ratio not to exceed two pipe sizes; above this ratio use reducing fittings. Use square tees at venting and draining points. Square elbows are not acceptable. Use elbows and square tees.

PR_65_52_00_00.4110 PIPES THROUGH WALLS AND FLOORS:
Where no other form of a seal is installed, such as fire batt or fire wrap, enclose pipes passing through building elements, (walls, floors, partitions, etc.) concentrically within purpose made sleeves. Fit masking plates where visible pipes pass through building elements, including false ceilings of occupied rooms. Masking plates are only suitable for small-bore pipework such as final connection to radiators etc. Install the pipework insulation continuously through non-fire rated walls and then sleeved around and mastic/mortar around sleeve to wall. Where pipework is fire stopped with batt then the batt should be TIGHT around pipework, and the broken pipe insulation should then be tight against the Batt.

PR_65_52_00_00.4120A PIPE SLEEVES:
Where pipe insulation is not carried through pipe sleeve, cut sleeves from material same as pipe one or two sizes larger than pipe to allow clearance. Do not use sleeves as pipe supports.

Install sleeves flush with building finish. In areas where floors are washed down install with a 100mm protrusion above floor finish.

PR_65_52_00_00.4120B PIPE SLEEVES WITH INSULATION CARRIED THROUGH:
Where pipe insulation is carried through pipe sleeve, cut sleeves from material same as pipe one or two sizes larger than pipe and insulation to allow clearance. Do not use sleeves as pipe supports.

Install sleeves flush with building finish. In areas where floors are washed down install with a 100mm protrusion above floor finish.

PR_65_52_00_00.4125 PIPE SLEEVES THROUGH FIRE BARRIERS:
Pack annular space between pipe and sleeve or insulation and sleeve with non-flammable and fire resistant material to form a fire/smoke stop of required rating. Apply 12mm deep cold mastic seal at both ends within sleeve.

PR_65_52_00_00.4130 CONNECTIONS TO EQUIPMENT:
Make final connections to equipment in accordance with manufacturer's instructions and as indicated.

PR_65_52_00_00.4140 DISTRIBUTION HEADERS:
Terminate ends with a cap, a blank flange, a grooved blank end or as indicated.

PR_65_52_00_00.4150A TEMPORARY PLUGS, CAPS AND FLANGES:
Seal all open ends as installation proceeds by plugs, caps or blank flanges, to prevent ingress of foreign matter.

Use plugs of metal, plastic or wood to suit pipework material.

In the event of such precautions not being taken, strip out pipework adjacent to open ends to demonstrate that fouling of bores has not occurred.

PR_65_52_00_00.4160 FLANGED JOINTS GENERAL:
Use number and diameters of bolts to standard. Fit bolts of length to give not less than one thread, or more than 3mm protrusion beyond nut when joint is pulled up.

Fit washers under each nut.

PR_65_52_00_00.4170 DISSIMILAR METALS:
Take appropriate means to prevent galvanic action where dissimilar metals are connected together.

PR_65_52_00_00.4180 PIPE RINGS AND CLIPS:
Select type according to the application and material compatibility; give particular attention where pipes are subject to axial movement due to expansion or contraction.

PR_65_52_00_00.4190 ANCHORS:
Construct to resist axial stress transmitted by flexure of horizontal and vertical pipe runs or loading on vertical pipes assuming that unbalanced forces exist at all anchor points, even when these are situated in intermediate positions between two expansion loops or bellows. Use similar or compatible materials to the attached pipe.

Provide and fix all associated backing plates, nuts, washers and bolts for attachment to or into building structure; ensure structure is suitable for transmitted stress. Set out and line up anchors accurately in position. Inspect final grouting into building structure.

PR_65_52_00_00.4200 SLIDE GUIDES:
Direct movement of expansion and contraction from pipe anchor points towards loops, bellows or flexible inserts. Ensure that thrust is linear relative to the axis of pipe.

Apply a friction reducing material between metal faces subjected to movement.

PR_65_52_00_00.4205 PIPE SUPPORTS:
Arrange supports and accessories for equipment, appliances or ancillary fitments in pipe runs, so that no undue strain is imposed upon pipes.

Ensure that materials used for supports are compatible with pipeline materials.

PR_65_52_00_00.4220 SUPPORT SPACING:
Provide pipe supports at spaces required by the manufacturer and such that the pipework is secure and does not result in movement caused by water hammer.

Vertical support spacing
Check total self-weight and pressure loading against manufacturer's recommendations when using mechanical joints or end load capable flexible couplings. Ensure adequate pipe support when using non-end load capable flexible couplings.

Space vertical supports for plastics pipe at not greater than twice horizontal intervals tabulated.

Where multiple pipe runs of differing bores are supported from a common point, use support spacing of pipe requiring closest spacing.

Spacings for PVC-U pipe; refer to BS EN 1452.

PR_65_52_00_00.4230A ISOLATION AND REGULATION:
Provide valves, cocks and stop taps for isolation and/or regulation where indicated, and on:-

- Mains to isolate major sections of distribution;
- The base of all risers and drops except in cases where one item of apparatus only is served which has its own local valve or stop tap;
- Points of pipe connection of all items of apparatus and equipment except where the item could conveniently be isolated or regulated by valves provided for other adjacent items;
- Draw-off fittings except where ranges of fittings are served by a common float, the isolator then being fitted with the float.

PR_65_52_00_00.4240 MAINTENANCE AND RENEWAL:
Arrange pipework, valves, drains, air vents, demountable joints, supports, etc., for convenient routine maintenance and renewals. Provide all runs with a regularly spaced pattern of demountable joints in the form of unions, flanges, etc., and also at items of equipment to facilitate disconnection.

Locate valves, drains, flanges etc. in groups.

PR_65_52_00_00.4250 CLEANING:
Remove cement and clean off all pipework and brackets.

PR_65_52_00_00.4260 NON-FERROUS COMPONENTS:
Thoroughly clean and degrease.

PR_65_52_00_00.5010B WELDING GENERAL, CLASS 2:
Use skilled craftsman in possession of a current Certificate of Competence appropriate to type and class of work, issued by an approved authority. Mark each weld to identify operative. Submit specimen welds, representative of joints and conditions of site welding, for each craftsman, test non-destructively, approximately 10% of butt weld joints and 5% of all other joints.

Weld pipeline joints to BS 2971 and to HVCA Code of Practice TR/5, Welding of Carbon Steel Pipework, as appropriate.

PR_65_52_00_00.5020 WELDED JOINTS, STEEL PIPES:
Preparation, Making and Sealing - Arc welding, conforming to BS 2971 as appropriate for system temperature and pressure. Use arc welding process on piping greater than 100mm.

PR_65_52_00_00.5030 PAINTING WELDED JOINTS, STEEL PIPES:
Unless pipework is being prepared for galvanizing after manufacture, wire brush and paint all welds with red oxide paint when welds are complete.

PR_65_52_00_00.5040 FLANGED JOINTS, STEEL PIPES:
Welded Flanges - Weld neck and bore of 'slip on' flange. Butt weld neck of welding neck flange.

Screwed Flanges - Apply jointing materials. Screw on flange and expand tube into flange with roller expander where necessary.

Preparation - Ensure that flange mating faces are parallel; flange peripheries are flush with each other; and bolt holes are correctly aligned.

Making and Sealing - Insert jointing between flange mating faces. Pull up joint equally all round.

PR_65_52_00_00.5050 SCREWED JOINTS, STEEL PIPES:
Preparation - Ensure that plain ends are cut square. Reamer out bore at plain ends. Screw plain ends, taper thread.

Making and Sealing - Coat male pipe threads with jointing compound and hemp, or PTFE tape on small sizes. Immediately after applying coating, connect with female end of socket or fitting, and tighten ensuring that coating does not intrude into pipe. Leave joint clean.

PR_65_52_00_00.5070A ANCHORS, STEEL PIPES, U-BOLTS:
Provide anchors constructed using mild steel over-straps or heavy U-bolts. Secure to channel section, adequately attached to or grouted into building structure; weld longitudinal edges of strap to pipe.

PR_65_52_00_00.5070B ANCHORS, STEEL PIPES, SLIP-ON FLANGES:
Provide anchors constructed by passing two slip-on flanges over pipe to anchor point. Bolt together through an interposed mild steel channel section attached to or grouted into building structure, and finally weld flanges to pipe.

PR_65_52_00_00.5090 STEEL PIPEWORK PAINTING:
Remove scale, rust or temporary protective coating by chipping, wire brushing or use of approved solvents and paint with one coat of red oxide primer, as work proceeds.

PR_65_52_00_00.5100 COMPRESSION JOINTS, STAINLESS STEEL PIPES:
Use BS EN 1254-2 Type 'A' fittings.

Preparation - Ensure that plain ends are cut square. Reamer out bore at plain ends to full bore size. Clean plain ends with fine steel wool.

Making and Sealing - In accordance with fitting manufacturer's instructions.

PR_65_52_00_00.5120 BRAZED JOINTS, STAINLESS STEEL JOINTS:
Preparation - Prepare for brazing in accordance with BS EN 14324.

Making and Sealing - Use flame heat and make in accordance with BS EN 14324. Use nickel bearing zinc free filler metals.

PR_65_52_00_00.6030 COMPRESSION JOINTS, COPPER PIPES, LIGHT GAUGE:
Preparation for fittings to BS EN 1254-2.

Type `A' fitting - Ensure that plain ends are cut square. Reamer out bore at plain ends to full bore size. Clean plain ends with fine steel wool or fine sandpaper.

Type `B' fitting - Ensure that plain ends are cut square. Reamer out bore at plain ends to full bore size. Clean plain ends with fine steel wool or fine sandpaper. Then comply with manufacturer's instructions.

Making and Sealing - As manufacturer's instructions.

PR_65_52_00_00.6040 CAPILLARY JOINTS, COPPER PIPES, LIGHT GAUGE:
Preparation - Ensure that plain ends are cut square. Reamer out bore at plain ends to full bore size. Clean plain ends with fine steel wool.

Making and sealing - Use specified flux ensuring no excess material used. Make joint in accordance with manufacturer's instructions. Clean off traces of flux when joint is completed.

PR_65_52_00_00.6060A ANCHORS, COPPER PIPES, SADDLE CLAMPS:
Provide anchors constructed by fitting two flanges to copper female adapters in pipe run at anchor point. Bolt together through an interposed mild steel channel section attached to or grouted into building structure.

PR_65_52_00_00.6060B ANCHORS, COPPER PIPES, SADDLE CLAMPS:
Anchor pipework using saddle clamps to mild steel channel section attached to or built into building structure.

PR_65_52_00_00.7010 FLANGED JOINTS, CAST IRON/DUCTILE IRON PIPES:
Preparation - Ensure that flange mating faces are parallel, flange peripheries are flush with each other and bolt holes are correctly aligned.

Making and Sealing - Coat both sides of joint ring with jointing compound to BS 6956-5 or BS EN 751-2. Insert joint ring between flange mating faces. Pull up joint with bolts, nuts and washers, ensuring that excess compound does not intrude into the pipe. Leave joint clean.

PR_65_52_00_00.7030 FLEXIBLE JOINTS, CAST IRON PIPES:
Preparation - Ensure that cut ends are square. Form groove to manufacturer's detail. Assemble joint in accordance with manufacturer's instructions.

Making and Sealing - Ensure joint ring is suitable for service. Thoroughly lubricate joint ring. Slip ring over pipe end and bring ends together. Slide ring into central position over both pipe ends. Position metal half housings over joint ring and insert bolts and nuts. Tighten bolts to manufacturer's instructions. Check alignment of joint

and pipework.

PR_65_52_00_00.8020 FUSION JOINTS, POLYETHYLENE PIPES:
Preparation - Square cut plain ends. Form pipe ends for socket type joints.

Making and Sealing - In accordance with fitting manufacturer's instructions.

PR_65_52_00_00.8030 MECHANICAL FITTINGS FOR POLYETHYLENE PIPE:
Preparation - Ensure that cut ends are square. Check wall thickness/pressure rating of fitting.

Making and sealing - Ensure correct gasket type is used for service (e.g. water or gas). Assemble fitting in accordance with manufacturer's instructions.

PR_65_52_00_00.9030 PROTECTION OF UNDERGROUND PIPEWORK:
Protect where indicated against corrosion by the application of a compatible anti-corrosive, non-cracking, non-hardening waterproof sealing tape.

Apply, after cleaning pipework, by wrapping contra wise with two layers spirally around the pipe, ensuring a 50% minimum overlap.

PR_65_52_00_00.9040A PROTECTION OF BURIED PIPES, UNMARKED:
Provide earth cover as follows:

- Water pipework - 900 mm minimum; 1200 mm maximum where practicable.
- Fuel oil and gas - 500 mm minimum.
- Under roadways provide minimum cover of 900 mm.

PR_65_52_00_00.9040B PROTECTION OF BURIED PIPES, MARKED:
Provide earth cover as follows:

- Water pipework - 900 mm minimum; 1200 mm maximum where practicable.
- Fuel oil and gas - 500 mm minimum.
- Under roadways provide minimum cover of 900 mm.

Provide a marker tape to identify buried pipe services.

2.0 PR_20_85_00_00 PIPELINE ANCILLARIES

PR_20_85_00_00.1000 GENERAL
PR_20_85_00_00.1010 SAFETY AND RELIEF VALVES, SELF OPERATED, APPLICATION:
Safety - To discharge with rapid opening action to prevent pre-determined safe pressure being exceeded.

Relief - To discharge with opening action proportional to increase in pressure above set pressure.

PR_20_85_00_00.1020 EXPOSED VALVES:
Fit easy-clean covers over glands and bonnets to small copper alloy valves exposed in areas other than plant rooms. Fit thermoplastic valve wheels. Fit dust caps to lockshield valves.

PR_20_85_00_00.1030 TESTING:
Ensure that valves and cocks are pressure tested at manufacturer's works, in accordance with appropriate British Standards specification. Test valves in accordance with BS EN 12266-1 and BS EN 12266-2.

PR_20_85_00_00.2015A STOP VALVES TO BS EN 1213 FOR POTABLE WATER SUPPLIES - COMPRESSION ENDS FOR COPPER:
- Pattern - Straight.
- Material - copper alloy.
- Flow rate class - VA (straight and angle pattern stopvalves).
- End connections - Compression to BS EN 1254-2.

PR_20_85_00_00.2015C STOP VALVES TO BS EN 1213 FOR POTABLE WATER SUPPLIES - CAPILLARY:
- Pattern - Straight.
- Material - copper alloy.
- Flow rate class VA (straight and angle pattern stop valves).
- End connections - Capillary to BS EN 1254-1.

PR_20_85_00_00.2080A THREADED END BALL TYPE VALVES - SCREW DRIVER/KEY OPERATED:
- Materials - Bronze or DZR copper alloy body.
- Ends - Threaded to BS 21 and BS EN 10226-1.
- Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-blowout stem.
- Operation - Screw driver operated or key operated.

PR_20_85_00_00.2080B COMPRESSION END BALL TYPE VALVES - SCREW DRIVER/KEY OPERATED:
- Materials - Bronze or DZR copper alloy body.
- Ends - Compression fittings to BS EN 1254-2.
- Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-blowout stem.
- Operation - Screw driver operated or key operated.

PR_20_85_00_00.2080C THREADED END BALL TYPE VALVES - LEVER OPERATED:
- Materials - Bronze or DZR copper alloy body.
- Ends - Threaded to BS 21 and BS EN 10226-1.
- Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-blowout stem.
- Operation - lever operated.

PR_20_85_00_00.2080D COMPRESSION END BALL TYPE VALVES - LEVER OPERATED:
- Materials - Bronze or DZR copper alloy body.

- Ends - Compression fittings to BS EN 1254-2.
- Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-blowout stem.
- Operation - lever operated.

PR_20_85_00_00.2080E THREADED END BALL TYPE VALVES - LOCKSHIELD:

- Materials - Bronze or DZR copper alloy body.
- Ends - Threaded to BS 21 and BS EN 10226-1.
- Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-blowout stem.
- Operation - lockshield.

PR_20_85_00_00.2080F COMPRESSION BALL TYPE VALVES - LOCKSHIELD:

- Materials - Bronze or DZR copper alloy body.
- Ends - Compression fittings to BS EN 1254-2.
- Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-blowout stem.
- Operation - lockshield.

PR_20_85_00_00.2090A LEVER OPERATED BUTTERFLY VALVES TO BS EN 593 BETWEEN FLANGES:

- Construction - Provide controlled elastomer compression on flange faces; semi-lugged wafer type design, for installation between flanged pipework connections, body to suit BS EN 1092-2.
- Provide lever and gear operated valves with long body neck for lagging clearance.
- Seat - Bonded.
- Materials - Cast iron body; stainless steel shaft; aluminium bronze disc; EPDM seat.
- Operation - Lever and graduated notch plate.

PR_20_85_00_00.2090B GEAR OPERATED BUTTERFLY VALVES TO BS EN 593 BETWEEN FLANGES:

- Construction - Provide controlled elastomer compression on flange faces; semi-lugged wafer type design, for installation between flanged pipework connections, body to suit BS EN 1092-2.
- Provide lever and gear operated valves with long body neck for lagging clearance.
- Seat - Bonded.
- Materials - Cast iron body; stainless steel shaft; aluminium bronze disc; EPDM seat.
- Operation - gear operated.

PR_20_85_00_00.2090C LEVER OPERATED BUTTERFLY VALVES BETWEEN MECHANICAL JOINTS:

- Construction - Wafer type design, for installation between mechanical joints, body with grooved ends.
- Provide lever operated valves with long body neck for lagging clearance.
- Seat - Bonded.
- Materials - Ductile iron body; stainless steel shaft; electroless nickel coated ductile iron disc; EPDM seat.
- Operation - Lever and graduated notch plate.

PR_20_85_00_00.2090D GEAR OPERATED BUTTERFLY VALVES BETWEEN MECHANICAL JOINTS:

- Construction - Wafer type design, for installation between mechanical joints, body with grooved ends.
- Provide gear operated valves with long body neck for lagging clearance.
- Seat - Bonded.
- Materials - Ductile iron body; stainless steel shaft; electroless nickel coated ductile iron disc; EPDM seat.
- Operation - gear operated.

PR_20_85_00_00.2210A LEVER OPERATED REGULATING BUTTERFLY VALVES TO BS EN 593 BETWEEN FLANGES:

- Construction - Provide controlled elastomer compression on flange faces; semi-lugged wafer type design, for installation between flanged pipework connections, body to suit BS EN 1092-2.
- Provide lever and gear operated valves with long body neck for lagging clearance.
- Seat - Bonded seat.
- Materials - Cast iron body; stainless steel shaft; aluminium bronze disc; EPDM seat.
- Operation - Infinitely variable setting with travel stops and indicator, lever operation.

PR_20_85_00_00.2210B GEAR OPERATED REGULATING BUTTERFLY VALVES TO BS EN 593 BETWEEN FLANGES:

- Construction - Provide controlled elastomer compression on flange faces; semi-lugged wafer type design, for installation between flanged pipework connections, body to suit BS EN 1092-2.
- Provide lever and gear operated valves with long body neck for lagging clearance.
- Seat - Bonded seat.
- Materials - Cast iron body; stainless steel shaft; aluminium bronze disc; EPDM seat.
- Operation - Infinitely variable setting with travel stops and indicator, gear operation.

PR_20_85_00_00.2210C LEVER OPERATED REGULATING BUTTERFLY VALVES TO BS EN 593 BETWEEN MECHANICAL JOINTS:

- Construction - Installation between mechanical joints with grooved ends.
- Provide lever operated valves with long body neck for lagging clearance.
- Seat - Bonded seat.
- Materials - Ductile iron body; stainless steel shaft; rubber coated ductile iron disc; EPDM seat.
- Operation - Infinitely variable setting with travel stops and indicator, lever operation.

PR_20_85_00_00.2210D GEAR OPERATED REGULATING BUTTERFLY VALVES TO BS EN 593 BETWEEN MECHANICAL JOINTS:

- Construction - Installation between mechanical joints with grooved ends.
- Provide gear operated valves with long body neck for lagging clearance.
- Seat - Bonded seat.
- Materials - Ductile iron body; stainless steel shaft; rubber coated ductile iron disc; EPDM seat.
- Operation - Infinitely variable setting with travel stops and indicator, gear operation.

PR_20_85_00_00.2220A THREADED END DOUBLE REGULATING VALVES TO BS 7350, COPPER ALLOY:

- BS 7350, section 3.1.
- Ends - Threaded to BS 21 and BS EN 10226-1.
- Material - Bronze or DZR copper alloy to BS 5154.
- Series B; oblique or Y pattern; inside screw non-rising stem; manufacturer's standard trim material.
- Options - Provide drain plug facility; independent means for positive isolation on pressure tapping or adapter; and test and manufacturer's certificates.

PR_20_85_00_00.2220B FLANGED DOUBLE REGULATING VALVES TO BS 7350, COPPER ALLOY:

- BS 7350, section 3.1.
- Ends - Flanged to BS EN 1092-2.
- Material - Bronze or DZR copper alloy to BS 5154.
- Series B; oblique or Y pattern; inside screw non-rising stem; manufacturer's standard trim material.
- Options - Provide drain plug facility; independent means for positive isolation on pressure tapping or adapter; and test and manufacturer's certificates.

PR_20_85_00_00.2220C FLANGED DOUBLE REGULATING VALVES TO BS 7350, CAST IRON:

- BS 7350, section 3.1.
- Ends - Flanged to BS EN 1092-2.

- Material - Cast iron to BS EN 13789.
- Oblique or Y pattern; copper alloy, nickel alloy or resilient valve face; rising stem outside screw or non-rising stem inside screw; manufacturer's standard materials.
- Options - Provide drain plug facility; independent means for positive isolation on pressure tapping or adapter; and test and manufacturer's certificates.

PR_20_85_00_00.2230A THREADED ENDS FLOW MEASUREMENT DEVICES TO BS 7350, COPPER ALLOY:

- BS 7350, section 3.2 - type 3
- A fixed orifice either integral with or as a fixed orifice fitting close coupled to a double regulating globe valve.
- Ends - Threaded to BS 21 and BS EN 10226-1.
- Material - Double regulating globe valve, bronze or DZR copper alloy to BS 7350 table 6.
- Options - Independent means for positive isolation on pressure tapping or adapter.

PR_20_85_00_00.2230B FLANGED ENDS FLOW MEASUREMENT DEVICES TO BS 7350 TYPE 3, COPPER ALLOY:

- BS 7350, section 3.2 - type 3
- A fixed orifice either integral with or as a fixed orifice fitting close coupled to a double regulating globe valve.
- Ends - Flanged to BS EN 1092-3.
- Material - Double regulating globe valve, bronze or DZR copper alloy to BS 7350 table 6.
- Options - Independent means for positive isolation on pressure tapping or adapter.

PR_20_85_00_00.2230C FLANGED FLOW MEASUREMENT DEVICE TO BS 7350 CAST IRON, TYPE 3:

- BS 7350, section 3.2 - type 3
- A fixed orifice either integral with or as a fixed orifice fitting close coupled to a double regulating globe valve.
- Ends - Flanged to BS EN 1092-2.
- Material - Double regulating globe valve to BS EN 13789 and close coupled fixed orifice fitting to BS 7350, table 6.
- Options - Independent means for positive isolation on pressure tapping or adapter.

PR_20_85_00_00.2230E THREADED ENDS FLOW MEASUREMENT DEVICES TO BS 7350 TYPE 4, COPPER ALLOY:

- BS 7350, section 3.2 - type 4, variable orifice valve.
- Ends - Threaded to BS 21 and BS EN 10226-1.
- Material - Variable orifice, double regulating globe valve, bronze or DZR copper alloy to BS 5154 series B.
- Options - Independent means for positive isolation on pressure tapping or adapter.

PR_20_85_00_00.2230F FLANGED FLOW MEASUREMENT DEVICES TO BS 7350 TYPE 4, COPPER ALLOY:

- BS 7350, section 3.2 - type 4, variable orifice valve.
- Ends - Flanged to BS EN 1092-3.
- Material - Variable orifice, double regulating globe valve, bronze or DZR copper alloy to BS 5154 series B.
- Options - Independent means for positive isolation on pressure tapping or adapter.

11.2230G FLOW MEASUREMENT DEVICES TO BS 7350 TYPE 4, CAST IRON:

- BS 7350, section 3.2 - type 4, variable orifice valve.
- Ends - Flanged to BS EN 1092-2.
- Material - Variable orifice, double regulating globe valve, cast iron to BS EN 13789.
- Options - Independent means for positive isolation on pressure tapping or adapter.

PR_20_85_00_00.2260A RADIATOR VALVES TO BS 2767 (TYPE 4):

- Finish
    - Natural.
    - Chromium plated.
- Material - Bronze or brass copper alloy body.
- Pattern - Angle or straight to suit application.
- Straight - Threaded to BS 21 and BS EN 10226-1 or compression to BS EN 1254-2 to suit pipework.
- Angle - Threaded to BS 21 and BS EN 10226-1 with one end internal and other end external with union nut and tail pipe; or compression joint to BS EN 1254-2 one end and other end externally threaded to BS 21 and BS EN 10226-1 with union nut and tail pipe to suit pipework.
- Options - Fit wheel valves on flow connections to radiators, and other heat emitters, without thermostatic radiator valves. Fit lockshield valves on return connections.

PR_20_85_00_00.2270A THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.1:

- Pattern
    - Straight
    - Angle
- Material to A.1.
- Pattern - Straight or angle pattern to suit application.
- Dimensions - Table A.1 series D.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

PR_20_85_00_00.2270B THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.2:

- Pattern
    - Straight
    - Angle
- Material to Annex A.
- Pattern - Straight or angle pattern to suit application.
- Dimensions - Table A.2 series F.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

PR_20_85_00_00.2270C THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.3:

- Pattern
    - Straight
    - Angle
- Material to Annex A.
- Pattern - Straight or angle pattern to suit application.
- Dimensions - Table A.3 series S.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

PR_20_85_00_00.2270D THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.4:

- Pattern
    - Straight
    - Angle
- Material to Annex A.
- Pattern - Straight or angle pattern to suit application.
- Dimensions - Table A.4 series GB.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

PR_20_85_00_00.2270E TAMPER PROOF THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.1:

- Pattern
    - Straight
    - Angle

- Material to Annex A.
- Pattern - Straight or angle pattern to suit application.
- Provide tamper proof TRV's.
- Dimensions - Table A.1 series D.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

PR_20_85_00_00.2270F TAMPER PROOF THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.2:

- Pattern
    - Straight
    - Angle
- Material to Annex A.
- Pattern - Straight or angle pattern to suit application.
- Provide tamper proof TRV's.
- Dimensions - Table A.2 series S.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

PR_20_85_00_00.2270G TAMPER PROOF THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.3:

- Pattern
    - Straight
    - Angle
- Material - Annex A.
- Pattern - Straight or angle pattern to suit application.
- Provide tamper proof TRV's.
- Dimensions - Table A.3 series S.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

PR_20_85_00_00.2270H TAMPER PROOF THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.4:

- Pattern
    - Straight
    - Angle
- Material -Annex A.
- Pattern - Straight or angle pattern to suit application.
- Provide tamper proof TRV's.
- Dimensions - Table A.4 series GB.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

PR_20_85_00_00.2280A FLOAT OPERATED VALVES TO BS 1212-1, COPPER FLOAT:
Piston type float operated valve to BS 1212-1.

- Connection - Side or bottom entry to suit application.
- Float - Copper to BS 1968.

PR_20_85_00_00.2280B FLOAT OPERATED VALVES TO BS 1212-1, PLASTIC FLOAT:
Piston type float operated valve to BS 1212-1.

- Connection - Side or bottom entry to suit application.
- Float - Plastic to BS 2456.

PR_20_85_00_00.2290A THREADED END FLOAT OPERATED VALVES, BALANCED EQUILIBRIUM:

- WRAS approved.
- Bronze or DZR copper alloy body.
- Inlet - Threaded to BS 21 and BS EN 10226-1.
- Spindle and head effectively guided and arranged with stops to engage with valve body and prevent

over travel. Linkage fulcrum adjustable relative to vertical plane, securely locked to body tapping when set.
- Screwed plug from access cover.
- Float and lever arm.
- Spun copper float, halves brazed or welded together, with centre sleeve connecting to lever arm. For feed and expansion application use long arm type arranged to close when tank contains 150mm depth.

PR_20_85_00_00.2315A OPEN/CLOSE CONTROL BALL VALVES:
- Valve - Open/Close valve.
- Rotary Actuator - Open/close.
- Material - Nickel-plated brass; stainless steel ball; PTFE seal; stainless steel spindle; EPDM spindle seal.
- Connections - Threaded to BS 21 and BS EN 10226-1.
- Ancillaries - Lever for manual operation.

PR_20_85_00_00.2315B TWO WAY CONTROL BALL VALVES:
- Valve - Two way control valve.
- Rotary Actuator - Modulating.
- Material - Nickel-plated brass; stainless steel ball; PTFE seal; stainless steel spindle; EPDM spindle seal.
- Connections - Threaded to BS 21 and BS EN 10226-1.
- Ancillaries - Lever for manual operation.

PR_20_85_00_00.2315C THREE WAY CONTROL BALL VALVES:
- Valve - Three way control valve.
- Rotary Actuator - Modulating.
- Material - Nickel-plated brass; stainless steel ball; PTFE seal; stainless steel spindle; EPDM spindle seal.
- Connections - Threaded to BS 21 and BS EN 10226-1.
- Ancillaries - Lever for manual operation.

PR_20_85_00_00.2320A THREADED ENDS SWING CHECK VALVES TO BS 5154:
- Series B; horizontal pattern.
- Ends - Threaded to BS 21 and BS EN 10226-1.
- Trim material - Manufacturer's standard.

PR_20_85_00_00.2320B FLANGED SWING CHECK VALVES TO BS 5154:
- Series B; horizontal pattern.
- Ends - Flanged to BS EN 1092-3.
- Trim material - Manufacturer's standard.

PR_20_85_00_00.2330A FLANGED SWING CHECK VALVES TO BS EN 12334
- Check valve type to BS EN 736-1 - Swing.
- Body type - Flanged.
- Ends - Flanged to BS EN 1092-2.
- Body and cover materials - Grey cast iron or SG cast iron.
- Orientation of pipework - Horizontal or vertical.

PR_20_85_00_00.2330B WAFER BODY SWING CHECK VALVES TO BS EN 12334:
- Check valve type to BS EN 736-1 - Swing.
- Body type - Wafer.
- Body and cover materials - Grey cast iron or SG cast iron.
- Orientation of pipework - Horizontal or vertical.

PR_20_85_00_00.2330C FLANGED LIFT CHECK VALVES TO BS EN 12334:

- Check valve type to BS EN 736-1 - Lift.
- Body type - Flanged.
- Ends - Flanged to BS EN 1092-2.
- Body and cover materials - Grey cast iron or SG cast iron.
- Orientation of pipework - Horizontal or vertical.

PR_20_85_00_00.2330D WAFER BODY LIFT CHECK VALVES TO BS EN 12334:

- Check valve type to BS EN 736-1 - Lift.
- Body type - Wafer.
- Body and cover materials - Grey cast iron or SG cast iron.
- Orientation of pipework - Horizontal or vertical.

PR_20_85_00_00.2340A FLANGED SWING CHECK VALVES TO BS EN 12334:

- Wafer pattern design suitable for installation between flanged pipework, body to suit BS EN 1092-2.
- Disc - Double disc.
- Type - Light spring type.
- Seat - Bonded.
- Materials - Cast iron body; bronze disc; EPDM seat.

PR_20_85_00_00.2430A SAFETY VALVES TO BS EN ISO 4126-1, COPPER ALLOY, SINGLE SPRING:

- Material - Bronze or DZR copper alloy body.
- Ends - Threaded to BS 21 and BS EN 10226-1.
- Spring type - Single spring loaded, high lift type.

PR_20_85_00_00.2430B SAFETY VALVES TO BS EN ISO 4126-1, COPPER ALLOY, DOUBLE SPRING:

- Material - Bronze or DZR copper alloy body.
- Ends - Threaded to BS 21 and BS EN 10226-1.
- Spring type - Double spring loaded, high lift type.

PR_20_85_00_00.2430C SAFETY VALVES TO BS EN ISO 4126-1, CAST IRON, SINGLE SPRING:

- Material - Cast iron body.
- Ends - Flanged to BS EN 1092-2.
- Spring type - Single spring loaded, high lift type.

PR_20_85_00_00.2430D SAFETY VALVES TO BS EN ISO 4126-1, CAST IRON, DOUBLE SPRING:

- Material - Cast iron body.
- Ends - Flanged to BS EN 1092-2.
- Spring type - Double spring loaded, high lift type.

PR_20_85_00_00.2440A DRAIN COCKS, THROUGHWAY GLAND COCK:

- Bronze body threaded male to BS 21 and BS EN 10226-1.
- Tapered plug with square shank for loose lever; bolted gland; strap and blank cap screwed on hand tight.
- Outlet to accept hose union.

PR_20_85_00_00.2450 DRAIN COCKS - SCREWDOWN TO BS 2879, TYPE 1:

- Bronze body threaded male to BS 21 and BS EN 10226-1.
- Screw down plug with square shank for loose lever.
- Serrated outlet to accept hosepipe, fixed or union pattern. Lockshield to accept key.

PR_20_85_00_00.2460 DRAIN COCKS - BALL TYPE:

- Bronze or DZR copper alloy body; chrome-plated DZR ball; PTFE seats and stem seals; blow-out proof

stem; strap and blank cap screwed on hand tight; serrated outlet to accept hose pipe. Lockshield key operated.

PR_20_85_00_00.2470 VENT COCKS - TWO WAY GLAND COCK TYPE:

- Bronze body threaded to BS 21 and BS EN 10226-1; tapered plug with square shank for loose lever; plug position indicator; bolted gland.

PR_20_85_00_00.2480 VENT COCKS - BALL TYPE:

- Bronze or DZR copper alloy body; chrome-plated DZR ball; PTFE seats and stem seals; blow-out proof stem.
- Permanently identified ports in T-configuration.
- Lever operated.

PR_20_85_00_00.2490 VENT COCKS - THREE WAY GLAND COCK TYPE:

- Bronze body threaded to BS 21 and BS EN 10226-1; tapered plug with square shank for loose lever; plug position indicator; port markings to indicate inlet,vent, waste; bolted gland.
- Port configuration, T port.

PR_20_85_00_00.2500A THREE WAY PLUG VALVE VENT COCKS - WRENCH OPERATED:

- Cast iron body, plug and bottom cover. PTFE thrust washer.
- Ends - Flanged to BS EN 1092-2.
- T port configuration. Wrench operation.

PR_20_85_00_00.2500B THREE WAY PLUG VALVE VENT COCKS - GEAR OPERATED:

- Cast iron body, plug and bottom cover. PTFE thrust washer.
- Ends - Flanged to BS EN 1092-2.
- T port configuration. Gear operation.

PR_20_85_00_00.2510A AUTOMATIC AIR VENTS, FLOAT TYPE:

- Construction - Bronze or DZR copper alloy body with threaded inlet to BS 21 and BS EN 10226-1. Solid polypropylene float and air release valve. Ensure valve is self-closing.
- Operating Conditions - Maximum temperature 130oC. Maximum pressure 10 bar.
- Options - Provide connection for piping away released air and integral non-return valve where indicated.

PR_20_85_00_00.2520A LTHW PRESSURE DIFFERENTIAL DEAERATORS:

- Unit - Provide a self-circulating unit connected to the system by two 15mm connections at least 500mm apart.
- Isolation - Provide valves to isolate the vessel from the main system.
- Operating conditions - Maximum temperature 110oC, maximum pressure 10 bar.

PR_20_85_00_00.2520B CHILLED WATER PRESSURE DIFFERENTIAL DEAERATORS:

- Unit - Provide a self-circulating unit connected to the system by two 15mm connections at least 500mm apart. Insulate to prevent condensation.
- Isolation - Provide valves to isolate the vessel from the main system.
- Operating conditions - Maximum temperature 110oC, maximum pressure 10 bar.

PR_20_85_00_00.2522A GRAVITATION DIRT SEPARATORS:

- Construction - Vertical mild steel housing with internal reservoir, sludge pipe, perforation plate and automatic air release mechanism.
- Ends - Line size with flanges to BS EN 1092-1, PN 16.
- Operating conditions - Maximum temperature 110oC, maximum pressure 10 bar.

PR_20_85_00_00.2620 EXPANSION LOOPS - COPPER:

- Provide expansion loop in material and finish of associated pipeline. Size to limit total stress set up in material of pipe wall to less than 51.5 MPa.
- Forge bend from a single length of pipe.

PR_20_85_00_00.2670A TEST PLUGS, SELF SEALING:

- Provide DZR copper alloy self-sealing test plugs for measurement of temperature and pressure, complete with captive cap for sealing when not in use. Ensure test plugs are suitable for system operating temperature and pressure.
- Provide one thermometer and pressure gauge for each range of conditions, for use with test plugs.

PR_20_85_00_00.2670B TEST PLUGS, VALVE CONTROLLED:

- Provide DZR copper alloy self-valve controlled test plugs for measurement of temperature and pressure, complete with captive cap for sealing when not in use. Ensure test plugs are suitable for system operating temperature and pressure.
- Provide one thermometer and pressure gauge for each range of conditions, for use with test plugs.

PR_20_85_00_00.2680A THREADED PIPELINE STRAINERS, BRONZE:

- Material - Bronze to BS EN 1982.
- Ends - Threaded to BS 21 and BS EN 10226-1.
- Pattern - Y pattern body.
- Screen free area - Not less than 250% of pipe bore.
- Screen perforations
- 15 to 50mm nominal size, within range 0.7 - 0.9 mm diameter.
- 65mm and over nominal size, within range 1.5 - 1.8mm diameter.
- Internal to external flow through screen. Provide plugged connections for drain, air vent and differential pressure monitoring, threaded to BS 21 and BS EN 10226-1.

PR_20_85_00_00.2680B FLANGED PIPELINE STRAINERS, BRONZE:

- Material - Bronze to BS EN 1982.
- Ends - Flanged to BS EN 1092-3.
- Pattern - Y pattern body.
- Screen free area - Not less than 250% of pipe bore.
- Screen perforations
- 15 to 50mm nominal size, within range 0.7 - 0.9 mm diameter.
- 65mm and over nominal size, within range 1.5 - 1.8mm diameter.
- Internal to external flow through screen. Provide plugged connections for drain, air vent and differential pressure monitoring, threaded to BS 21 and BS EN 10226-1.

PR_20_85_00_00.2680C COMPRESSION PIPELINE STRAINERS, BRONZE:

- Material - Bronze to BS EN 1982.
- Ends - Compression fittings to BS EN 1254-2.
- Pattern - Y pattern body.
- Screen free area - Not less than 250% of pipe bore.
- Screen perforations
- 15 to 50mm nominal size, within range 0.7 - 0.9 mm diameter.
- 65mm and over nominal size, within range 1.5 - 1.8mm diameter.
- Internal to external flow through screen. Provide plugged connections for drain, air vent and differential pressure monitoring, threaded to BS 21 and BS EN 10226-1.

PR_20_85_00_00.2680D PIPELINE STRAINERS, CAST IRON:

- Material - Cast iron.
- Ends - Flanged to BS EN 1092-2.

- Pattern - Y pattern body.
- Screen free area - Not less than 250% of pipe bore.
- Screen perforations
- 15 to 50mm nominal size, within range 0.7 - 0.9 mm diameter.
- 65mm and over nominal size, within range 1.5 - 1.8mm diameter.
- Internal to external flow through screen. Provide plugged connections for drain, air vent and differential pressure monitoring, threaded to BS 21 and BS EN 10226-1.

PR_20_85_00_00.2690A TUNDISHES, COPPER:

- Provide tundishes located adjacent to equipment.
- Use 3mm minimum thickness copper sheet. Form sheet into a tapered reducing cone with a minor diameter to suit drain line.
- Major diameter nominally 50 mm larger than minor diameter, tapering at approximately 30 degrees.

PR_20_85_00_00.2700A GAUGES, GENERAL:

150mm black stove enamel finish

- 150MM DIAMETER, FLUSH PANEL:
    - Dial case - 150mm diameter, heavy pattern, finished in black stove enamel for flush mounting.
    - Mount gauges with dial face in vertical plane flush to panel and conceal casing within a steel metal cubicle.
- 150MM DIAMETER, DIRECT MOUNTING:
    - Dial case - 150mm diameter, heavy pattern finished in black stove enamel, for direct connection to instrument.
    - Mount gauges with dial face in vertical plane and support casing by connection to instrument.
- 150MM DIAMETER, FLANGED:
    - Dial case - 150mm diameter, heavy pattern finished in black stove enamel, with annular mounting flange.
    - Mount gauges with dial face in vertical plane and surface mount casing to equipment or building element, as required.

100mm - finish

- 100MM DIAMETER, FLUSH MOUNTING:
    - Dial case - 100mm diameter for flush mounting to steel panel.
    - Mount gauges with dial face in vertical plane flush to panel and conceal casing within a steel metal cubicle.
- 100MM DIAMETER, DIRECT MOUNTING:
    - Dial case - 100mm diameter for direct connection to instrument.
    - Mount gauges with dial face in vertical plane and support casing by connection to instrument.
- 100MM DIAMETER, FLANGE MOUNTING:
    - Dial case - 100mm diameter with annular mounting flange.
    - Mount gauges with dial face in vertical plane and surface mount casing to equipment or building element, as required.

Use dial type gauges of robust construction, enclosed in dust tight metal cases. Retain dial glass with bezels screwed to case. Finish with chromium plating.

Use white dial scales indelibly and clearly marked with black lettering to indicate measured values. Select scale ranges which indicate `Normal' when pointer is vertical or central on scale.

PR_20_85_00_00.2700B GAUGES, 150MM DIAMETER, FLUSH PANEL:

- Dial case - 150mm diameter, heavy pattern, finished in black stove enamel for flush mounting.

- Mount gauges with dial face in vertical plane flush to panel and conceal casing within a steel metal cubicle.

PR_20_85_00_00.2700C GAUGES, 150MM DIAMETER, DIRECT MOUNTING:

- Dial case - 150mm diameter, heavy pattern finished in black stove enamel, for direct connection to instrument.
- Mount gauges with dial face in vertical plane and support casing by connection to instrument.

PR_20_85_00_00.2710A TEMPERATURE GAUGES, GENERAL:

- MERCURY IN STEEL:
  - Provide mercury in steel temperature gauge, mounted direct in pocket.
  - Vapour pressure to BS EN 13190
- VAPOUR PRESSURE TO BS 5235 FOR DIRECT MOUNTING:
  - Vapour pressure type to BS EN 13190, mounted direct in pocket, with horizontal or vertical stem as appropriate.
- VAPOUR PRESSURE TO BS 5235 FOR REMOTE MOUNTING:
  - Vapour pressure type to BS EN 13190, for remote mounting with capillary tube of sufficient length to allow slack run to immersion bulb. Protect capillary along full length by a flexible sheath jointed to dial case and bulb.
- TEMPERATURE GAUGES GENERALLY:
  - Use temperature gauges with pocket and provided with gland attachment on thermometer stem.
  - Type:
    - Mercury in steel, mounted direct in pocket.
    - Vapour pressure to BS EN 13190, mounted direct in pocket with horizontal or vertical stem as appropriate.
    - Vapour pressure to BS EN 13190, for remote mounting with capillary tube of sufficient length to allow slack run to immersion bulb. Protect capillary along full length by a flexible sheath jointed to dial case and bulb.
  - Use separable type pockets, threaded 15/19mm BSP and manufactured from stainless steel.
  - Screw pockets into tapped bosses or stools set in pipelines or vessels. Fill pockets with oil to BS 7207 to ensure contact with thermometer bulb.
  - Provide gauges with dial graduation in degrees Celsius marked on a logarithmic scale. Ensure pointer movement is clockwise for increase in temperature.
  - Provide sensing elements for air and gas systems, where indicated, and fix to provide airtight joints.
  - Provide with metal shielding around sensing element to prevent effects of local radiation from equipment.

PR_20_85_00_00.2720 PRESSURE AND ALTITUDE GAUGES:

- Use vapour pressure type gauges to BS EN 837-1. Connect to pipeline systems via matched gauge cocks and cock connectors.
- Ensure dial graduation is from zero to between 1.5 and 3.0 times normal working pressure. Graduate in bar (gauge) on gauges reading head or working pressure, or in Pascals where pressure differences across plant items are to be established. Where fitted on boilers and pressure vessels, clearly mark with operating and maximum permissible working heads in accordance BS 759. Elsewhere provide gauges with normal working pressure. Ensure dial movement is clockwise for an increasing in head.
- Fit syphons on steam systems.
- Provide flexible piping where gauge is subject to noticeable vibration.
- Fit gauge cocks preceding all connections to altitude and pressure gauges. Copper alloy, tapered ground plug, with ebonite lever. Unless flanged joints are required, screw inlet ends female and fit outlet ends with union connections allowing removal of gauges.

PR_20_85_00_00.2730 VACUUM GAUGES:

- Use vacuum gauges complying with BS EN 837-1. Calibrate in mm of mercury.

PR_20_85_00_00.2750A GAUGE MOUNTING BOARDS, HARDWOOD:

- Manufacture from 12mm thick, polished hardwood.
- Mount on walls or purpose made steel frames at a height approximately 1.3m above floor level.

PR_20_85_00_00.3010A LOOSE ITEMS, KEYS FOR SPINDLE SHANK VALVES:
Provide tee handled short shank keys suitable for each size of valve spindle shank.

PR_20_85_00_00.3010B LOOSE ITEMS, FOR DRAIN COCKS:
Provide lever pattern keys suitable for each drain cock and loose hose unions for drain cocks.

PR_20_85_00_00.4010 INSTALLATION:
Install pipeline ancillaries in accordance with manufacturer's recommendations and BS 6683.

PR_20_85_00_00.4020 LOCATION:
Ensure valves, cocks, traps, strainers, test plugs, tundishes and other ancillary equipment are located in positions which facilitate access and maintenance.

PR_20_85_00_00.4025 LOCATION OF THERMOSTATIC RADIATOR VALVES:
Install thermostatic radiator valves in an area which reflects the space temperature. Ensure that they are not behind curtains or enclosed in heating or radiator panels.

PR_20_85_00_00.4030 POSITIONING OF COMPONENTS:
Locate flow and pressure measurement valves to ensure manufacturer's recommended straight length of pipe upstream and downstream of valve is provided.

PR_20_85_00_00.4040 POSITIONING OF DOUBLE REGULATING VARIABLE ORIFICE VALVE:
Install double regulating variable orifice valve to ensure equivalent of 10 diameters of straight pipe upstream and 5 diameters downstream of double regulating valve.

PR_20_85_00_00.4045 INSTALLATION OF CONTROL BALL VALVES:
Install control ball valves in accordance with manufacturer's recommendations.

PR_20_85_00_00.4060 VENT COCKS:
Provide outlets of vent cocks with discharge pipes.

PR_20_85_00_00.4070 VALVE STUFFING BOXES:
Adjust glands of all stuffing boxes at normal plant operating temperature and pressure in accordance with manufacturer's instructions. Ensure that valve action is not impaired by over tightening.

PR_20_85_00_00.4080A DISCHARGE CONNECTIONS, SAFETY VALVES:
Fit pipework connections, where indicated, to provide discharge connection to Safety and Relief valves terminating at a safe discharge point.

PR_20_85_00_00.4080B DISCHARGE CONNECTIONS, VENT COCKS:
Fit pipework connections, where indicated, to provide discharge connection to vent cocks terminating 150mm above floor level.

PR_20_85_00_00.4080C DISCHARGE CONNECTIONS, AIR BOTTLES:
Fit pipework connections, where indicated, to provide bleed connection from air bottles terminating with air

cock or needle valve in a convenient position.

PR_20_85_00_00.4080D DISCHARGE CONNECTIONS, AUTOMATIC AIR VENTS:
Fit pipework connections, where indicated, to provide discharge pipe to automatic air vents terminating over a suitable gully or drain line in a visible location.

PR_20_85_00_00.4090 EXPANSION DEVICES:
Where expansion and contraction cannot be accommodated by selected route, provide pipework loops as required. Limit total stress set up in material of pipe wall, taking into account components due to internal pressure, tension and bending to less than 69 MPa for steel pipelines and less than 51.5 MPa for copper pipe lines.

Where location does not permit sufficient flexibility, provide proprietary devices as required.

PR_20_85_00_00.4100 EXPANSION COMPENSATORS INSTALLATION:
Provide anchors and guides to contain all movement and resist maximum loads imposed. Install expansion compensators strictly in accordance with manufacturer's instructions.

PR_20_85_00_00.4110 FLEXIBLE CONNECTIONS INSTALLATION:
Fit rubber bellows as close to source of vibration as practicable. Ensure the pipe at other end of bellows is a fixed point. Install flexible connections strictly in accordance with manufacturer's instructions.

Ensure flexible connections are tied when the plant is on vibration isolation mountings.

PR_20_85_00_00.4120 TERMINAL UNIT CONNECTIONS INSTALLATION:
Install hose connections strictly in accordance with manufacturer's instructions.

3.0 PR_65_53_00_00 PUMPS

PR_65_53_00_00.1000 GENERAL
PR_65_53_00_00.1010 PUMPS:
Provide pumps manufactured and tested in accordance with appropriate British Standard, in particular BS EN 809, BS EN 60335-2-41 and BS EN 60335-2-51 where applicable.

PR_65_53_00_00.1020 PUMP SELECTION:
Select pump at or near most efficient part of performance curve for duty required.

PR_65_53_00_00.1030 SAFETY GUARDS:
Fit safety guards around revolving parts on close coupled and belt drive pumps.

PR_65_53_00_00.1040 PUMP TESTING:
Ensure pumps comply with BS EN ISO 5198 and BS EN ISO 9906 as appropriate.

PR_65_53_00_00.2010C CENTRIFUGAL PUMP - CLOSE COUPLED:
- Configuration
  - Pump casing and motor mounted on a bedplate in line (close coupled).
- Casing
  - Provide casing with drain connection fitted with plug.
  - Provide threaded connections in accordance with BS 21 and BS EN 10226-1 for drains, vents, water jackets, cooling lines, etc.
  - Provide pump with split casing to allow access to the impeller for service and maintenance.
- Impeller
  - Ensure impellers are accurately machined and finished smooth, free from blowholes and other defects and designed to be in dynamic balance at all speeds.
  - Provide open or semi-open type impellers for removal of sludge or other foreign material to prevent clogging.
  - Fix impellers to shafts to ensure that they remain firm if direction of rotation is reversed.
  - Indicate direction of rotation on pump casing.
- Shaft
  - Ensure shaft is of adequate diameter to withstand all imposed loading and has a critical speed when assembled with its impeller at least 10% above normal operating speed.
- Material
  - Casing - Cast iron to BS EN 1561.
  - Impeller - Manufacturer's standard.
  - Shaft - Manufacturer's standard.
  - Seal Housing - Cast iron to BS EN 1561.
- Bearings - Sleeve.
- Glands and seals - Mechanical.

PR_65_53_00_00.2010D CENTRIFUGAL PUMP - DIRECT DRIVE IN-LINE:
- Configuration
  - Direct driven unit with pump body incorporating inlet and outlet connections in line, to allow pump to be mounted in pipework.
- Casing
  - Provide casing with drain connection fitted with plug.
  - Provide threaded connections in accordance with BS 21 and BS EN 10226-1 for drains, vents, water jackets, cooling lines, etc.
  - Provide pump with split casing to allow access to the impeller for service and maintenance.
- Impeller
  - Ensure impellers are accurately machined and finished smooth, free from blowholes and

other defects and designed to be in dynamic balance at all speeds.
    - Provide open or semi-open type impellers for removal of sludge or other foreign material to prevent clogging.
    - Fix impellers to shafts to ensure that they remain firm if direction of rotation is reversed.
    - Indicate direction of rotation on pump casing.
- Shaft
    - Ensure shaft is of adequate diameter to withstand all imposed loading and has a critical speed when assembled with its impeller at least 10% above normal operating speed.
- Material
    - Casing - Cast iron to BS EN 1561.
    - Impeller - Manufacturer's standard.
    - Shaft - Stainless steel to BS EN 10088.
    - Seal Housing - Cast iron to BS EN 1561.
- Bearings
    - Sealed-for-life or pre-packed type requiring no maintenance (in-line pumps).
- Glands and seals - Mechanical.

PR_65_53_00_00.2020A POSITIVE DISPLACEMENT PUMP - HELICAL:

- Material
    - Casing - Cast iron to BS EN 1561 or SG cast iron to BS EN 1563 and BS EN 1564.
    - Seal Housing - Cast iron to BS EN 1561.
- Bearings - Spherical roller.
- Glands - Mechanical.

PR_65_53_00_00.4010 GENERAL:

Comply with manufacturer's recommendations for installation of pumps. For in-line pumps ensure that motor is positioned in accordance with manufacturer's requirements.

PR_65_53_00_00.4020 PIPELINE CONNECTIONS:

Support pumps independently from connecting pipework to ensure no load is transmitted from pipework to pump casing on pump suction and discharge.

PR_65_53_00_00.4030 MOUNTINGS:

Mount motors and pumps for belt drive pumps resiliently.

PR_65_53_00_00.4040 ALIGNMENT:

Align pump to prevent undue restraint and thrust on interconnecting pipework. Align drives to prevent undue wear and restraint on pump shaft. For belt drives, align pulleys and tension belts to prevent undue wear and out of balance forces.

PR_65_53_00_00.4050 ACCESS:

Locate pump within the system with adequate space around it for service and maintenance.

PR_65_53_00_00.4060 MAINTENANCE REQUIREMENTS FOR SEWAGE PUMPS:

For ease of service and maintenance, install submersible sewage pumps on guide rails or with lifting cables. Fit pumps with automatic discharge connections, which locate on to permanent pipework at low level in chamber.

4.0 PR_60_50_96_00 WATER TANKS/CISTERNS

PR_60_50_96_00.1000 GENERAL
PR_60_50_96_00.1010 TANK DESIGN:
Design and fabricate tanks/cisterns in accordance with British Standards.

PR_60_50_96_00.1020 DOMESTIC STORAGE WATER CISTERNS:
Ensure storage cisterns for domestic water purposes comply with the Water Supply (Water Fittings) Regulations 1999 and amendment.

PR_60_50_96_00.2020A SECTIONAL A1 GLASS FIBRE REINFORCED SECTIONAL TANK TO BS EN 13280:
Class A1 - for potable water incorporating screened air inlet, vent pipe entry device for the cover, screened warning and overflow pipes and particle ingress limitation between a one-piece cistern or sectional tank, cover and fittings.

Sectional tanks - External flanges.

PR_60_50_96_00.4010 GENERAL:
Store, handle and erect all in accordance with manufacturer's recommendations and relevant British Standards.

Make due allowance for valves, fittings, access, etc., to accommodate insulation and weathering where indicated.

PR_60_50_96_00.4020 PROTECTION AND CLEANING:
Ensure adequate protection from damage and ingress of foreign matter to tanks and cisterns during storage, erection and commissioning. Thoroughly clean out all tanks and cisterns prior to site testing and commissioning.

21.4030 INSPECTION AND ACCESS:
Install tanks and cisterns to allow internal and external surfaces to be easily inspected and cleaned.

PR_60_50_96_00.4040 INSTALL MOULDED PLASTIC CISTERNS: IN ACCORDANCE WITH APPENDIX
Install moulded plastic cisterns in accordance with Appendix R of BS 4213.

PR_60_50_96_00.4050 INSTALL SECTIONAL STEEL TANKS:
Install sectional steel tanks in accordance with manufacturer’s recommendations.

PR_60_50_96_00.4060 INSTALL GLASS REINFORCED PLASTICS CISTERNS:
Install glass reinforced plastics cisterns in accordance with BS EN 13280.

5.0 PR_60_60_38_00 HEAT EXCHANGERS

PR_60_60_38_00.1000 GENERAL
PR_60_60_38_00.1010 HEAT EXCHANGER DESIGN:
Supply heat exchangers designed in accordance with British Standards.

PR_60_60_38_00.2010B COPPER CALORIFIER TO BS 853:
Where copper calorifiers are used, ensure:

- Sacrificial aluminium protector rod/anode
- Incorporates inspection openings in cylinders over 200 litres
- Material test certificates to BS 853 clause 5.3.
- Hydraulic test certificates to BS 853 clause 11.2.
- Provide connections and supports as shown on drawings as required to meet the manufacturer's requirements.
- Mountings to BS 853
- Pressure relief devices as BS 853 clause 10.2; stop valves as clause 10.3; pressure gauge as clause 10.4; thermometer as clause 10.5; draining taps as clause 10.6; and vacuum breaker valve as clause 10.7.

PR_60_60_38_00.3010A THERMAL INSULATION:
Provide heat exchanger pre-insulated at manufacturer's works.

PR_60_60_38_00.3020A SPARES:
Provide spare tube and plate assembly. Provide spare jointing rings for chest and tube assembly.

PR_60_60_38_00.4010 GENERAL:
Store, handle and erect all equipment in accordance with manufacturer's recommendations and relevant British Standards. Make due allowance for valves, fittings, access etc., to accommodate insulation where specified. Support equipment such that all component parts, connections or insulation have clearance from supports.

PR_60_60_38_00.4020 FLANGE DRILLINGS:
Ensure flange drillings are uniform to facilitate interchange of tube assemblies.

PR_60_60_38_00.4030 PROTECTION AND CLEANING:
Provide protection from damage and ingress of foreign matter to heat exchangers and condense coolers during storage, installation and testing.

PR_60_60_38_00.4040 INSPECTION:
Install heat exchangers and condense coolers such that internal and external surfaces can be readily inspected and cleaned.

PR_60_60_38_00.4050 RUST PROTECTION:
Ensure heat exchanger and condense cooler shells are completely free of rust and corrosion and coated with factory applied primer.

6.0 PR_60_60_38_00 STORAGE CYLINDERS AND CALORIFIERS

PR_60_60_38_00.1000 GENERAL
PR_60_60_38_00.1010 STANDARDS:
Comply with British Standards indicated.

- Unvented hot water storage systems to be completed with "unvented kits" and pressure regulating valve to comply with Building Regulations safety requirements. Indirectly heated storage water heaters to comply with BS EN 12897.¬

PR_60_60_38_00.1020 DEFINITIONS:
- Direct cylinder - a closed cylindrical vessel with domed ends.
- Indirect cylinder - a closed cylindrical vessel with domed ends having separate integral means of heating contents by annular or coil type element.
- Calorifier - a closed cylindrical vessel having separate integral means of heating contents by 'U' tube chest type element.
- Primary heater - a heater mounted inside a cylinder or calorifier for transfer of heat to stored water from primary medium.
- Capacity - the volume of water storage excluding contents of any primary heater.
- Secondary working head - the vertical distance between bottom of cylinder or calorifier and water line of cistern supplying cylinder or calorifier.

PR_60_60_38_00.2010 STEEL DIRECT CYLINDERS:
Where steel direct cylinders are used, ensure:

- Standard - BS 853-1:1990+A3:2011
- Incorporates inspection openings in cylinders over 200 litres
- Connections as BS 853-1:1990+A3:2011
- Material test certificates to BS 853 clause 5.3.
- Hydraulic test certificates to BS 853 clause 11.2.
- Provide connections and supports as shown on drawings as required to meet the manufacturer’s requirements.
- Mountings to BS 853
- Pressure relief devices as BS 853 clause 10.2; stop valves as clause 10.3; pressure gauge as clause 10.4; thermometer as clause 10.5; draining taps as clause 10.6; and vacuum breaker valve as clause 10.7.

PR_60_60_38_00.2020 COPPER DIRECT CYLINDERS:
Where copper direct cylinders are used, ensure:

- Sacrificial aluminium protector rod/anode
- Incorporates inspection openings in cylinders over 200 litres
- Standard - BS 853-1:1990+A3:2011
- Connections as BS BS 853-1:1990+A3:2011
- Material test certificates to BS 853 clause 5.3.
- Hydraulic test certificates to BS 853 clause 11.2.
- Provide connections and supports as shown on drawings as required to meet the manufacturer’s requirements.
- Mountings to BS 853
- Pressure relief devices as BS 853 clause 10.2; stop valves as clause 10.3; pressure gauge as clause 10.4; thermometer as clause 10.5; draining taps as clause 10.6; and vacuum breaker valve as clause 10.7.
- Provide protective isolation material to prevent electrolytic action where mild steel is used.

PR_60_60_38_00.2030 COPPER DOUBLE FEED INDIRECT CYLINDERS:
Where copper double feed indirect cylinders are used, ensure:

- Standard - BS 1566-1
- Connections as BS 1566-1
- Test certificates to BS 1566-1
- Provide connections and supports as shown on drawings as required to meet the manufacturer's requirements.
- Mountings to meet the manufacturer's requirements.
- Provide protective isolation material to prevent electrolytic action where mild steel is used.

PR_60_60_38_00.2040 COPPER SINGLE FEED INDIRECT CYLINDERS:
Where copper single feed indirect cylinders are used, ensure:

- Standard - BS 1566-2
- Connections as BS 1566-2
- Test certificates to BS 1566-2
- Provide connections and supports as shown on drawings as required to meet the manufacturer's requirements.
- Mountings to meet the manufacturer's requirements.
- Provide protective isolation material to prevent electrolytic action where mild steel is used.

PR_60_60_38_00.2045 STAINLESS STEEL INDIRECT CYLINDER:

- Standard - BS 853-1:1990+A3:2011
- Connections as BS 853-1:1990+A3:2011
- Material test certificates to BS 853 clause 5.3.
- Hydraulic test certificates to BS 853 clause 11.2.
- Provide connections and supports as shown on drawings as required to meet the manufacturer's requirements.
- Mountings to BS 853
- Pressure relief devices as BS 853 clause 10.2; stop valves as clause 10.3; pressure gauge as clause 10.4; thermometer as clause 10.5; draining taps as clause 10.6; and vacuum breaker valve as clause 10.7.

PR_60_60_38_00.2060 GALVANIZED STEEL CALORIFIER/STORAGE VESSEL TO BS853-1:

- Standard - BS 853-1:1990+A3:2011
- Connections as BS BS 853-1:1990+A3:2011
- Material test certificates to BS 853 clause 5.3.
- Hydraulic test certificates to BS 853 clause 11.2.
- Provide connections and supports as shown on drawings as required to meet the manufacturer's requirements.
- Mountings to BS 853
- Pressure relief devices as BS 853 clause 10.2; stop valves as clause 10.3; pressure gauge as clause 10.4; thermometer as clause 10.5; draining taps as clause 10.6; and vacuum breaker valve as clause 10.7.

PR_60_60_38_00.2065 COPPER CALORIFIER/STORAGE VESSEL TO BS853-1:

- Standard - BS 853-1:1990+A3:2011
- Connections as BS BS 853-1:1990+A3:2011

- Material test certificates to BS 853 clause 5.3.
- Hydraulic test certificates to BS 853 clause 11.2.
- Provide connections and supports as shown on drawings as required to meet the manufacturer's requirements.
- Mountings to BS 853
- Pressure relief devices as BS 853 clause 10.2; stop valves as clause 10.3; pressure gauge as clause 10.4; thermometer as clause 10.5; draining taps as clause 10.6; and vacuum breaker valve as clause 10.7.

PR_60_60_38_00.4010 GENERAL:
Store, handle and erect all equipment in accordance with manufacturer's recommendations and relevant British Standards. Make due allowance for valves, fittings, access etc., to accommodate insulation where specified. Support equipment such that all component parts, connections or insulation have clearance from supports.

PR_60_60_38_00.4020 FLANGE DRILLINGS:
Ensure flange drillings are uniform to facilitate interchange of tube assemblies.

PR_60_60_38_00.4030 PROTECTION AND CLEANING:
Provide protection from damage and ingress of foreign matter to storage cylinders and calorifiers during storage, installation and testing.

PR_60_60_38_00.4040 INSPECTION:
storage cylinders and calorifiers such that internal and external surfaces can be readily inspected and cleaned.

PR_60_60_38_00.4050 RUST PROTECTION:
Ensure storage cylinder and calorifier shells are completely free of rust and corrosion and coated with factory applied primer.

7.0 PR_65_52_61_28 TRACE HEATING

PR_65_52_61_28.1000 GENERAL
PR_65_52_61_28.1010 STANDARDS:
Comply with BS 7671 (IEE Wiring Regulations) and

- BS 6351.
- BS EN 62395-1.

PR_65_52_61_28.2010C ELECTRIC TRACE HEATING, SELF REGULATING TAPE, RCD PROTECTION:
Supply electric trace heating complete with fixing tape, shrink sleeves, crimps, junction boxes and controls.

- Tape - Self-regulating heating tape.
- Insulation - Thermoplastic elastomer or modified polyolefin.
- Jacket - Tinned copper braid.
- Electrical protection - Provide MCB and RCD protection.

PR_65_52_61_28.2010D ELECTRIC TRACE HEATING, SELF REGULATING TAPE, MCB PROTECTION:
Supply electric trace heating complete with fixing tape, shrink sleeves, crimps, junction boxes and controls.

- Tape - Self-regulating heating tape.
- Insulation - Thermoplastic elastomer or modified polyolefin.
- Jacket - Tinned copper braid.
- Electrical protection - Protect circuits with MCB's.

PR_65_52_61_28.3010 INSTALLATION OF ELECTRIC TRACE HEATING:
Install electric surface heating in accordance with BS 6351-3 and manufacturer's instructions. Ensure pipe is cleaned of all abrasive material prior to application.

PR_65_52_61_28.3040 THERMAL INSULATION:
Enclose pipework to be heated and trace heating elements in common thermal insulation.

8.0 PR_60_55_96_00 CLEANING AND CHEMICAL TREATMENT

PR_60_55_96_00.1000 GENERAL
PR_60_55_96_00.1010 CONDITIONS FOR CLEANING AND CHEMICAL TREATMENT:
Ensure treatment complies with statutory authority and health and safety regulations.

Notify manufacturers and suppliers of equipment of proposed system cleaning and chemical treatment processes. Establish if any manufacturer or supplier of equipment requires any particular cleaning and chemical treatment process due to size of waterways or materials used.

All chemicals used are to be compatible with the metallurgy of the systems.

PR_60_55_96_00.1015 METHOD STATEMENT:
Provide a method statement covering the sequence of events, chemicals to be used etc. Statement to be provided at least two months prior to the start of any flushing and/or chemical cleaning works.

PR_60_55_96_00.2010 CLEANING AND CHEMICAL TREATMENT SPECIALIST:
Use a specialist for analysis and for design, supply, installation and operation of any system cleaning and chemical treatment process.

PR_60_55_96_00.2020A MAINS WATER ANALYSIS:
Obtain an analysis of mains water taken from site supply point. Check with local water authority to ensure analysis results are typical for site area and report variances for instruction; or submit a sample of water to water treatment specialist as appropriate.

Carry out tests to establish total viable counts and Pseudomonas and sulphate reducing bacteria.

PR_60_55_96_00.2030A PRELIMINARY CHECKS:
- Prior to carrying out cleaning or chemical treatment process, ensure that
    - All foreign matter is removed.
    - Certified pressure tests have been carried out in the parts of the system to be cleaned. Carry out further pressure tests on the isolated sections of the system independently.
    - All water used for pressure testing is inhibited. Leave remaining pipework sections full after testing.
    - Where there is a risk of freezing inhibited mono-ethyleneglycol is used.
    - Circulation has been demonstrated and approval obtained on all parts of the system. Manipulate and leave fully open all valves other than those used to isolate sections. Carry out balancing and certification after the flushing, cleaning and passivation operations.
    - No damage can occur to any item of plant or equipment due to cleaning and chemical processes.
    - Chemicals used are compatible with system materials.
    - All items of plant and equipment subject to damage or blockage due to cleaning and chemical treatment processes are isolated or removed.
    - Permanent or temporary by-passes are provided as indicated on drawings.
    - Dirt pockets are installed at low points to facilitate solids removal. Supply dirt pockets with drain valves sized to pipework size.
    - All drains provided have been tested and approved and that any pumping equipment associated with the drainage system is fully commissioned.
    - Dead legs, that are more than 3 pipe diameters in length are looped to allow effective cleaning.
    - Strainer baskets and filter media, incorporated within systems, are removed; and where necessary spool or stool pieces are installed.
    - Temporary strainers and filters are installed as required for removal of solids during cleaning

and chemical treatment processes.
    - Strainers are clean prior to the start of the cleaning process, throughout the cleaning and on completion.
    - Suitable supply and drainage points are provided with 50mm minimum connections, properly sited and installed, either valved or plugged.
    - All automatic/manual air vents are fully commissioned.
    - All requirements of COSHH regulations are complied with during the chemical cleaning and chemical treatment of the system.
- Where required by local water authority, provide effluent tanks for storage of all waste products of cleaning and chemical treatment processes.
- Following local water authority approval, either neutralize and dispose to drain of all waste products or ensure authorised disposal at registered sites.
- Comply with Waste Management Duty of Care: A Code of Practice and The Hazardous Waste (England & Wales) Regulations 2005 where appropriate.

PR_60_55_96_00.2040A PROCEDURAL PRECAUTIONS FOR CLEANING AND CHEMICAL TREATMENT:

- Carry out tests to ensure that cleaning and chemical treatment processes are operating as required.
- Carry out tests to ensure that cleaning and chemical treatment processes are operating as required. and detailed in the Method Statement.
- Submit all test and sample results for certification and approval.

PR_60_55_96_00.2040B PROCEDURAL PRECAUTIONS FOR CLEANING AND CHEMICAL TREATMENT INCLUDING TAKING SAMPLES:

- Take samples during and following chemical treatment and/or cleaning.
- Submit samples to an independent analyst.
- Use sterile containers to take samples.
- Carry out tests to ensure that cleaning and chemical treatment processes are operating as required.
- Submit all test and sample results for certification and approval.
- Ensure all samples are witnessed.

PR_60_55_96_00.2060A CHEMICAL INJECTION AND DOSING METHODS FOR CLOSED SYSTEMS:

- Method of introducing chemicals:
    - Dosing pots; manually initiated timer controlled dosing; or proportional dosing as appropriate.

PR_60_55_96_00.2060B CHEMICAL CLEANING AND DOSING METHODS FOR OPEN RECIRCULATING SYSTEMS:

- Method of introducing chemicals
    - Chemical dosing for scale and corrosion inhibitors
    - Continuous; timer controller; or proportional dosing as appropriate.
    - Bleed-off control.
    - Biocide dosing - automatic dosing control.

PR_60_55_96_00.2060C PACKAGED CHEMICAL INJECTION AND DOSING PLANT:

Provide packaged monitoring and treatment plants.

PR_60_55_96_00.2060D DOSING - CLOSED SYSTEMS:

- Chemical feed:
    - Provide feeder (dosing pots) with a tundish for filling; separate air vent with discharge tube; drain and isolating valves.
- Install in each water system a means of taking a sample as follows:
    - Chilled water systems - provide a gate valve and discharge.
    - Heating systems - provide a sample cooler with a copper coil and cooling jacket with cooling water valve and drained to waste.

PR_60_55_96_00.2060E DOSING - OPEN SYSTEMS:

- Chemical dosing
    - Provide an interface between water treatment plant and system pumps to allow the initiation of water circulation in addition to the requirements of the building services.
    - Where control by-passes are used, set valves to allow reduced circulation but not complete isolation of the equipment.
    - Provide control of chemical inhibitors by linking the dosing pump control unit to operate on a signal from a water meter.
    - Provide skid mounted packaged equipment to feed chemical inhibitors including pre-wired controls and dosing pump, high density polyethylene tank, chemical diaphragm pump complete with all necessary valves and tubing.
    - Provide control of total dissolved solids by linking a solenoid purge valve to operate by a signal automatically received from a conductivity sensor.
- Biocide dosing
    - Provide skid mounted packaged equipment to feed two types of biocides on an automatically alternating basis including pre-wired timer controls and twin biocide diaphragm pumps complete with all necessary valves and tubing. Draw biocide chemical direct from the chemical supply drums located on the skid.
- Control
    - Provide low level alarms for all dosing units.
    - Provide BMS connections to monitor dosing and show run and alarm conditions.
- Injection manifold
    - Provide an injection manifold for use with the above water treatment equipment.
    - Connect the manifold across flow and return pipework and mount above the dosing plant modules, unless otherwise indicated.

PR_60_55_96_00.2065 CHEMICALS - DOSING:
Provide biocides effective against Legionella Pnueumophilia, algae, fungi, moulds and slime forming bacteria including pseudomonas and sulphate reducing bacteria.

Supply biocides as recommended by water treatment specialist.

Incorporate a bio dispersant in the programme to break up and disperse any slime masses, where required.

The water treatment specialist shall select the appropriate corrosion inhibitors, to minimise corrosion, and biocides to prevent any proliferation to mild steel, copper and copper alloys.

Provide a specific inhibitor to protect aluminium when it is present in the system.

The cleaning agent is to be specified by the water treatment specialist.

PR_60_55_96_00.2070A MONITORING:
Provide monitoring system to enable on-line analyses, system alarms and chemical stock levels to be monitored by water treatment specialist.

Where indicated, provide facility for system to be monitored by water treatment specialist at remote location.

PR_60_55_96_00.2070B SAMPLING:
Provide testing equipment to carry out tests for all inhibitors used in treatment programme indicated.

PR_60_55_96_00.2070C SAMPLING KITS:
Provide the following test kits as appropriate.

- Boiler water test kit for steam boilers; conductivity test kit; pH test kit; inhibitor test kit; hardness test

kit where a softener is installed; chloride level test kit.
- Install a corrosion test rig to enable corrosion rates to be monitored using corrosion coupons.
- Bacteriological monitoring with use of dipslides.
- Log sheets for recording of test results, bacteriological analysis and any actions required or taken.

PR_60_55_96_00.2080A CHEMICAL PROVISION, STANDARD ARRANGEMENT:
Provide consumables for a period of 12 months.

Where indicated, provide for supply of chemicals from containers refilled by drumless delivery system.

Include for supply of chemicals for all systems using the basis of:

- Open circuit systems operating at 100 % load for 2080 hours per annum.
- Closed circuit systems make-up 1% system volume/month.

PR_60_55_96_00.3010A FLUSHING:
Fill the system by one of the following methods:

- Temporary connection from mains in compliance with the Water Supply (Water Fittings) Regulations 1999, and the Water Supply (Water Fittings) (Amendment) Regulations 1999.
- Temporary connection from fire hydrant pipework.
- By installation of temporary tank and pump arrangement.

Carry out flushing of water systems in accordance with BSRIA BG 29/2021 Pre-commission cleaning of pipework systems. In particular:

- Section 2 Installation considerations
- Section 3 System dynamic flushing.
- C1 Flushing objectives
- C2 Dynamic flushing procedure.
- Inspection and witnessing, as section 1.4.

PR_60_55_96_00.3010B FLUSHING:
All water used for pressure testing, flushing and system filling is of good quality. Leave remaining pipework sections full and treated after pressure testing.

Install all necessary pipework ancillaries to enable a specialist to carry out flushing, inspection and witnessing of water systems in accordance with BSRIA BG 29/2021 Pre-commission cleaning of pipework systems.

Temporary connection from the mains must be in compliance with the Water Supply (Water Fittings) Regulations 1999 and amendment, or by installation of a temporary tank and pump arrangement.

Domestic water systems are to be flushed and disinfected in accordance with the requirements of BS EN 806 and BS 8558, and to the satisfaction of the local water supply authority. Flush systems using mains water until the water is clear.

PR_60_55_96_00.3030 CHEMICAL CLEANING AND SOLIDS REMOVAL
Carry out chemical cleaning procedure in accordance with BSRIA BG 29/2021 Pre-commission cleaning of pipework systems. In particular:

- 4.1 Introduction.
- 4.2 Cleaning options.
- 4.2.1 Degreasing.
- 4.2.2 Biocide wash.

- 4.2.3 Removal of surface oxides - Inhibited acid cleaning.
- 4.2.4 Effluent disposal/final flushing.
- 4.2.5 Neutralisation.
- 4.2.6 Passivation
- 4.2.7 Corrosion inhibitor/biocide dosing.
- 4.2.8 Treatment up to system handover.
- 4.3 On-going water treatment.
- Inspection and witnessing, as section 1.4.

PR_60_55_96_00.3040 STERILIZATION - GENERAL:
After flushing process, carry out sterilization in accordance with BS EN 806 and BS 8558.

Prior to sterilization ensure each system is flushed, cleaned and drained.

Provide temporary connections to system terminal points suitable for introduction of sterilization chemicals and fluids and 22mm minimum valved drain connection on incoming main immediately downstream of mains isolating valve.

Fill system with clean, fresh water.

PR_60_55_96_00.3050 STERILIZATION - MAINS WATER SYSTEM:
Carry out the following operations in accordance with BS EN 806 and BS 8558.

- Flush system and introduce sterilisation chemical.
- Take samples from all sentinel points to ensure correct chlorine concentration.
- Leave system to stand for period of time indicated.
- Repeatedly flush system with clean water until all traces of chlorine have been removed - leave system filled.
- Submit samples to registered laboratory for microbiological analysis and report.

Certificate of conformity

- Immediately prior to handover, retake samples and submit for analysis and report.

Where necessary, repeat sterilisation of potable water system immediately prior to handover.

PR_60_55_96_00.3060 STERILIZATION - WATER STORAGE SYSTEMS:
Carry out the following operations in accordance with BS EN 806, BS 8558 and HSE L8 Legionnaires' disease - control of legionella bacteria in water systems ACOP and guidance.

- Carry out operations on all water storage tanks and cisterns, cold and hot.
- Carry out procedures as for mains water systems.

PR_60_55_96_00.3080 SERVICE VISITS:
Provide monthly service visits for one full year by a fully qualified chemist, to carry out the following:-

- Review water analysis records, correspondence and reports since previous visit.
- Test water samples on site for hardness; all inhibitors; dissolved solids; pH; total alkalinity.
- Check performance of feeding equipment, softeners, and testing equipment on site.
- Submit a written report.
- Carry out micro-biological analysis using dipslides.
- Special requirements as indicated.

25.3090 DOCUMENTATION:
Provide an electronic copy and one copy in a hard cover binder containing details of:

- Programme outlines.
- Purpose of chemical treatment.
- Chemicals used and quantity.
- On site testing procedures.
- Control limits of tests.
- Equipment data and drawings.
- Product notes and material safety data sheets for all chemicals used.

Provide a complete training programme for site operatives covering

- Methods of basic water testing.
- Explanation of results obtained.
- Actions to be taken on test results.

9.0 PR_65_65_00_00 AIR DUCTLINES AND ANCILLARIES

PR_65_65_00_00.1000 GENERAL
PR_65_65_00_00.1010 DUCTWORK INSTALLATION STANDARDS:
Carry out construction and installation of ductwork in accordance with DW 144, DW 154, DW 172, DW 191 and BS 9999 as appropriate.

PR_65_65_00_00.1020 DUCTWORK DIMENSIONS:
Sizes of ductwork are internal dimensions. Where applicable make allowance for any internal lining.

PR_65_65_00_00.1030 ELECTRICAL BONDING TERMINAL:
Ensure an electrical bonding terminal is provided, suitable for connection of a main protective conductor complying with BS 7671, clause 544.1.

PR_65_65_00_00.2010 PRESSURE CLASIFICATION OF DUCTWORK
Select the right ductwork classification for the system and the air leakage testing procedure in accordance with DW 144 Table 1 and DW 154 Table 1.

PR_65_65_00_00.2030B MEDIUM PRESSURE DUCTWORK AIR LEAKAGE TESTING:
Test medium pressure ductwork in accordance with DW 144, A5.

Test indicated sections of duct system for air leakage. Test at the pressure recommended in DW 144 Table 17 for the classification of the selected ductwork. Carry out the tests as the work proceeds and prior to application of thermal insulation.

If the test fails, pressure test two further sections. If the further tests fail, apply remedial action to the complete ductwork system.

Provide documented evidence of the calculations used to arrive at the allowable loss for the section to be tested and ensure the client or his agent witnesses and signs the results of the tests.

Testing plant items, DW 144, Part 8, A.8.

PR_65_65_00_00.2035 STRENGTH AND LEAKAGE TESTING OF CIRCULAR SHEET METAL DUCTWORK:
Carry out ductwork strength and air leakage testing on circular sheet metal ductwork in accordance with BS EN 12237.

Test procedure shall be as detailed in BS EN 12237, Section 7.

Produce a test report as detailed in BS EN 12237, Section 8.

PR_65_65_00_00.2036 STRENGTH AND LEAKAGE TESTING OF RECTANGULAR SHEET METAL DUCTWORK:
Carry out ductwork strength and air leakage testing on circular sheet metal ductwork in accordance with BS EN 1507.

Test procedure shall be detailed in BS EN 1507, Section 5.

Produce a test report as detailed in BS EN 1507, Section 6.

PR_65_65_00_00.2040A ZINC-COATED DUCTWORK MATERIAL:
DW 144 Part 2 - Standards, paragraph 7, zinc-coated steel.

PR_65_65_00_00.2060A RECTANGULAR CONSTRUCTION:
Rectangular ductwork - DW 144 Part 3.

PR_65_65_00_00.2060B CIRCULAR CONSTRUCTION:
Circular ductwork - DW 144 Part 4, spirally wound or straight seamed.

PR_65_65_00_00.2070 MAN ACCESS AND SAFETY BARS:
Man access is required where indicated on drawings. Ensure that duct floor is of sufficient strength to comply with safety standards.

Provide safety bars where indicated at the top of risers.

PR_65_65_00_00.2110A FIRE PROTECTION WITH FIRE DAMPERS:
Ensure complete ductwork system complies with the requirements of BS 476-24.

Supply and install fire rated ductwork. Method of protection DW 144 Appendix D using fire dampers.

PR_65_65_00_00.2110B FIRE PROTECTION WITH FIRE RESISTING ENCLOSURES:

Ensure complete ductwork system complies with the requirements of BS 476-24.

Supply and install fire rated ductwork. Method of Protection DW 144 Appendix D using fire resisting enclosures.

PR_65_65_00_00.2110C FIRE RATED AND SMOKE EXTRACT DUCTWORK:
Ensure complete ductwork system complies with the requirements of BS 476-24 and BS 9999.

Supply and install fire rated ductwork. Method of Protection BS 476-24 and BS 9999.

Drop rods and exposed bearers to be insulated in accordance with manufactures recommendations and instructions.

Where a vapour barrier is required, all exposed edges and penetrations through the foil should be sealed using soft self-adhesive aluminium foil tape.

PR_65_65_00_00.2110D FIRE RATED DUCTWORK:
Ensure complete ductwork system complies with the requirements of BS 476-24 and BS 9999.

Supply and install fire rated ductwork. Method of Protection DW144 Appendix D using fire resisting ductwork. Ductwork to be in accordance with HVCA Specification DW 144. Ducts to be fire protected with the correct thickness of high density single layer mineral wool fire rated ductwork slab in accordance with manufacturers recommendations and instructions. Insulation system to be independently tested and carry current valid certification to provide fire protection fully in accordance with the requirements of duct 'Type A' and duct 'Type B' of BS 476-24 and BS 9999.

Fire classification of fire resisting ductwork to be accordance with BS EN 13501-3.

Drop rods and exposed bearers to be insulated in accordance with manufacturers recommendations and instructions.

Where a vapour barrier is required, all exposed edges and penetrations through the foil should be sealed using soft self-adhesive aluminium foil tape.

PR_65_65_00_00.2130A PREINSULATED EXTERNAL THERMAL/ACOUSTIC DUCTWORK:
Supply pre-insulated ductwork where indicated.

PR_65_65_00_00.2140A HANGERS AND SUPPORTS:
Provide hangers and supports throughout in accordance with DW 144 Part Six Section 19; DW 154 Part 5; or DW 191 Section 7 as appropriate.

Comply with BS EN 12236.

PR_65_65_00_00.2150A SUPPORT OF AIR TERMINAL UNITS:
Support air terminal units and their plenums in accordance with the manufacturer's requirement/ recommendation

PR_65_65_00_00.3010 CONSTRUCTION AND FINISHES:
Ensure that materials of accessories are compatible with ductwork and that finishes of accessories comply with any special requirements for ductwork.

Ensure casing losses of components are compatible with ductwork in which they are incorporated.

PR_65_65_00_00.3020A METAL DUCTWORK INSPECTION/SERVICING ACCESS OPENINGS:
Provide access/inspection openings in accordance with DW 144 Part Seven Section 20 and Appendix M Table 25 Level 1.

PR_65_65_00_00.3020D DUCTWORK INSPECTION/SERVICING ACCESS OPENINGS:
Provide access/inspection openings in accordance with HVCA TR/19, Section 3.

PR_65_65_00_00.3030A METAL DUCTWORK TEST HOLES:
Provide test holes in ductwork system as required to allow complete testing and balancing of system in accordance with CIBSE Commissioning Code A.

Site drill test holes in accordance with DW 144 paragraph 20.6.

PR_65_65_00_00.3040 HOLES FOR CONTROLS/INSTRUMENTS - METAL DUCTWORK:
Provide holes in ductwork, in accordance with DW 144 Part Seven, paragraph 20.7, to accommodate thermostats, humidistats and other control sensors as required.

PR_65_65_00_00.3042 INSTALLATION OF INSTRUMENTS AND CONTROLS:
Instruments and controls should be installed to manufacturers or specialist supplier's requirements. The installation must be checked by the manufacturer or specialist supplier, and rectified as necessary.

PR_65_65_00_00.3050A CLEANING ACCESS - LEVEL 2:
Provide access for cleaning in accordance with DW 144 Part Seven, paragraph 20.8 and Appendix M Table 25 Level 2.

PR_65_65_00_00.3050C CLEANING ACCESS - HVCA TR/19:
Provide access/inspection openings in accordance with HVCA TR/19, Section 3.

PR_65_65_00_00.3060B STEEL MULTI-BLADE BALANCING DAMPERS - METAL DUCTS:
Provide single or double skin steel multi-blade balancing dampers in accordance with DW 144 Part Seven Section 21. Parallel or opposed blade, manual operation. Locations and size as shown on drawings.

PR_65_65_00_00.3060D STEEL MULTI-BLADE CONTROL DAMPERS - METAL DUCTS:
Provide single or double skin steel multi-blade control dampers in accordance with DW 144 Part Seven Section 21. Parallel or opposed blade, automatic operation. Locations and size as shown on drawings.

PR_65_65_00_00.3070C STEEL CURTAIN FIRE DAMPERS - BLADES OUT OF AIR STREAM:
Supply and install steel folding curtain fire dampers, with blades out of the air stream in accordance with DW 144 Part Seven Section 22, size and location as shown on the drawings.

PR_65_65_00_00.3070I INTUMESCENT FIRE DAMPERS:
Supply and install intumescent fire dampers in accordance with DW 144 Part Seven Section 22, size and location as shown on the drawings.
Fire resistance tests for intumescent dampers shall be in accordance with BS ISO 10294-5.

PR_65_65_00_00.3070J FIRE DAMPERS ACCESSORIES:
Provide accessories compatible with fire dampers. Electrical cut-out switches and external visual indication of fire damper blade position.

Supply spare fusible links for fire dampers to fuse at 72^{o}C as specified in DW 144.

PR_65_65_00_00.3075 FIRE DAMPERS - GENERAL:
Provide fire dampers generally in accordance with DW 144 Section 22 and DW 154 Part 6 paragraph 17.

Types to be as identified elsewhere in the specification, in schedules or on drawings.

Fire dampers shall be supplied and fixed in accordance with the manufacturer's recommendations and installation methods which conform to the prevailing Building Regulations and are acceptable to the District Surveyor/Building Control Officer and Fire Officer generally in accordance with DW 144 . The proposed installation method must be supported by a valid test report or assessment provided by an approved third party notified body.

The construction shall allow for all additional framing supports, bracing and fire stopping as may be necessary to adequately attach/install the fire dampers to the structure. The assembly is to be approved by the Building Control Officer/District Surveyor and Fire Officer.

Each fire damper and associated installation method shall have at least the same standard of fire integrity as the wall or floor through which the duct passes.
The classification of fire dampers is to be in accordance with BS EN 13501-3 and shall have an integrity classification 'E' to meet that of the wall or floor.
When a fire integrity of 4 hours is required, either two dampers (classified E120) factory assembled in series (if acceptable to the local authority) or a single damper having a classification E240, may be used.
To achieve these classifications, fire resistance tests shall be in accordance with BS EN 1366-2, undertaken by a notified body.

Shutter dampers shall be provided with the shutter blades located outside the air stream (unless otherwise indicated). Each damper shall have a stainless steel curtain in all-welded galvanized steel casing with stainless steel side seal gaskets. The damper blade curtain shall be held in the folded position by a dual safe thermal actuator and fusible link.

All damper blades shall be tensioned to ensure instantaneous closure on thermal activation at 72^{0}C (unless specified elsewhere). A self-latching reset mechanism shall be provided for easy re-setting of the damper curtain.

On completion of the installation, the contractor shall be responsible for ensuring the inspection and testing of all fire dampers installed are carried out. Upon completion of the tests, the certificates must be issued for confirming that the dampers have been inspected and that they function correctly in accordance with the manufacturer's data sheets.

Access panels with chains shall be provided adjacent to the access side of all fire dampers.

In no instances shall flexible duct connections be allowed onto fire dampers through walls or floors. Approved flexible connectors for breakaway joints, or duct expansion in case of fire, may be used in association with fire dampers.

Provide local external visual indication of fire damper blade position, unless indicated otherwise.

PR_65_65_00_00.3079 SMOKE DAMPERS - GENERAL
Provide smoke dampers in accordance with DW 144 Part 7, Section 23 and DW 154 Part 6.

Types to be as identified elsewhere in the specification, in schedules or on drawings.

Smoke dampers shall be supplied and fixed in accordance with the manufacturer's recommendations with installation mounting frames which conform to the prevailing Building Regulations (ADB) and are acceptable to the District Surveyor/Building Control Officer and Fire Officer generally in accordance with DW 144. The proposed installation method must be supported by a valid test report or assessment provided by an approved third party notified body.

The construction shall allow for all additional framing supports, bracing and fire stopping as may be necessary to adequately attach/install the smoke dampers to the structure. The assembly is to be approved by the Building Control Officer/District Surveyor and Fire Officer.

Smoke dampers shall be of the single blade or multi-blade type as indicated within the ductwork schedule. Damper blades shall be mechanically connected to an actuator to hold the blades in either the open or closed position dependant on the control mode chosen.

On completion of the installation, the contractor shall be responsible for ensuring the inspection and testing of all smoke dampers installed are carried out. Upon completion of the tests, the certificates must be issued for conforming that the dampers have been inspected and that they function correctly in accordance with the manufacturer's data sheets.

Access panels with chains shall be provided adjacent to the access side of all smoke dampers.

In no instances shall flexible duct connections be allowed onto smoke dampers, or through floors or walls. Approved flexible connectors for breakaway joints, or duct expansion in case of fire, may be used in association with smoke dampers.

Provide installation frames, and local external visual indication of smoke damper blade position, unless indicated otherwise.

PR_65_65_00_00.3080B STEEL MULTI-BLADE SMOKE DAMPERS:
Supply and install steel multi-blade smoke dampers in accordance with DW 144 Part Seven Section 23, size and location as shown on the drawings.

PR_65_65_00_00.3089 COMBINATION FIRE AND SMOKE DAMPERS - GENERAL:
Provide combination smoke and fire dampers generally in accordance with DW 144, Part 7, Section 24 and DW 154 Part 6.

Types to be as identified elsewhere in the specification, in schedules or on drawings.

Combination smoke and fire dampers shall be supplied and fixed in accordance with the manufacturer's recommendations and installation methods which conform to the prevailing Building Regulations (ADB) and are acceptable to the District Surveyor/Building Control Officer generally in accordance with DW 144. The proposed installation method must be supported by a valid test report or assessment provided by an approved third party notified body.

The construction shall allow for all additional framing supports, bracing and fire stopping as may be necessary to adequately attach/install the fire dampers to the structure. The assembly is to be approved by the Building Control Officer/District Surveyor and Fire Officer.

Each combination smoke and fire damper and associated installation method shall have at least the same standard of fire integrity as the wall or floor through which the duct passes.
The classification of combination fire and smoke dampers is to be in accordance with BS EN 13501-3 and shall have an integrity classification 'E' to meet that of the wall or floor supported with an 'ES' classification of at least 60 minutes, unless the wall or floor requires less than this (e.g. 30 minutes).
When a fire integrity of 4 hours is required, either two dampers (classified E120, ES60 (min) factory assembled in series (if acceptable to the local authority) or a single damper having a classification E240, ES60 (min), may be used.
To achieve these classifications, fire resistance tests shall be in accordance with BS EN 1366-2 undertaken by a notified body.
Combination fire and smoke dampers tested ad-hoc to BS 476-20 and BS 476-22 shall be permitted only under conditions where the Building Regulations (ADB) specifically allow. This requirement shall be confirmed before supplying such tested product.

Combination smoke and fire dampers shall be of the single blade or multi blade type as indicated within the ductwork schedule. Damper blades shall be released from their open position by means of either a thermal release device rated at a temperature indicated elsewhere in this specification, or via a mechanical actuator connected to a smoke alarm or control system, or a combination of both dependant on the control mode selected.
On completion of the installation, the contractor shall be responsible for ensuring the inspection and testing of all combination smoke and fire dampers installed are carried out. Upon completion of the tests, the certificates must be issued for conforming that the dampers have been inspected and that they function correctly in accordance with the manufacturer's data sheets.
Access panels with chains shall be provided adjacent to the access side of all combination smoke and fire dampers.
In no instances shall flexible duct connections be allowed through walls or floors. Approved flexible connectors for breakaway joints, or duct expansion in case of fire, may be used in association with combination smoke and fire dampers.
Provide local external visual indication of combination smoke and fire damper blade position, unless indicated otherwise.

PR_65_65_00_00.3090 COMBINATION SMOKE AND FIRE DAMPERS:
Supply and install smoke and fire dampers in accordance with DW 144 Part Seven section 24, size and location as shown on the drawings.

PR_65_65_00_00.3090A STEEL SINGLE BLADE COMBINATION SMOKE AND FIRE DAMPERS:
Supply and install single blade combination smoke and fire dampers in accordance with DW 144 Part Seven Section 24, size and location as shown on the drawings.

PR_65_65_00_00.3090B STEEL MULTI-BLADE COMBINATION SMOKE AND FIRE DAMPERS:
Supply and install multi-blade combination smoke and fire dampers in accordance with DW 144 Part Seven Section 24, size and location as shown on the drawings.

PR_65_65_00_00.3100A COATED STEEL FLEXIBLE DUCTS:
Supply and fasten coated steel flexible duct connections as DW 144 Part Seven Section 25. Use flexible duct connections in applications listed in DW 144 paragraph 25.1.

Comply with BS EN 13180.

Maximum length 600mm.

PR_65_65_00_00.3110A FLEXIBLE JOINT CONNECTIONS:
Supply and install flexible joint connections as detailed in DW 144 Section 26 or DW 154 Section 18, as appropriate.

Use flexible joints, as shown on drawings; on fan inlet/outlets; and on building expansion joints.

Comply with BS 476-24.

PR_65_65_00_00.3120A BIRD WIRE GUARDS:
Fit bird screens of 13mm square mesh wire on all intake and extract louvres to atmosphere. Wire gauge to be not less than 1mm.

Finish - Plastic coated wire.

PR_65_65_00_00.3130A INSECT GUARDS:
Provide manufacturers standard insect guards where indicated. Screens to be factory fitted by the manufacturer.

- Material: Woven wire cloth
- Mesh: 16
- Gauge: 28
- Wire diameter: 0.375mm
- Aperture: 1.212mm2
- Free area: 58%

PR_65_65_00_00.4010 GENERAL WORKMANSHIP:
Install ductwork in accordance with DW 144, DW 154 and DW 191 as appropriate.

Ensure that there are no sharp edges or corners on cut edges on ductwork, flanges and supports.

Install pre-insulated ductwork in accordance with manufacturer's instructions.

PR_65_65_00_00.4020 DUCTWORK SUPPORTS:
Support ductwork in accordance with DW 144 Part Six Section 19; DW 154 Part 5; or DW 191 Section 7 as appropriate. Install supports to ensure insulation can be applied unless otherwise indicated.

PR_65_65_00_00.4025 COMPONENT SUPPORT ON PRE-INSULATED ALUMINIUM DUCTWORK:
Support ducts with dimensions less than 1m at intervals of no more than 4m. Support ducts with dimensions over 1m at intervals of no more than 2m.

Provide independent support for all accessories.

PR_65_65_00_00.4030A DUCT SUPPORT FOR VAPOUR SEAL CONTINUITY:
Where a vapour seal is required, use method of support detailed on drawing as indicated.

PR_65_65_00_00.4040 EXTERNAL DUCTWORK SUPPORT:
Support ductwork external to building in accordance with the ductwork, ductwork fittings and façade finish manufacturers' recommendations/requirements.

PR_65_65_00_00.4050 DUCTWORK FLOOR SUPPORT:
Support ductwork from floor in accordance with the ductwork and ductwork fittings manufacturers' recommendations/requirements.

PR_65_65_00_00.4060 DRAINAGE OF DUCTWORK:
Arrange ductwork to drain any entrained moisture and ensure the lapping of joints minimises moisture leakage.

PR_65_65_00_00.4070A CONNECTIONS TO BUILDERS WORK - METAL DUCTWORK:
Comply with DW 144 Part Seven Section 28.

PR_65_65_00_00.4090A INTERNAL CLEANLINESS - LEVEL 1:
Provide Level 1 of protection, delivery and installation (PDI) as defined in HVCA TR/19, Section 2.

PR_65_65_00_00.4100A WEATHERPROOFING:
Fit ductwork with trimming angle and weather cravat, skirt, flashing plate and cowl where ductwork passes through or terminates in roof, to ensure a weatherproof seal to building structure, as required.

PR_65_65_00_00.4110B DUCTWORK SLEEVES WITH FLANGES:
Where indicated, enclose ducts passing through building elements, (walls, floors, partitions, etc.) within purpose made sleeves. Cut sleeves of the same material as the duct and pack with mineral fibre or similar non-flammable and fire resistant material to form a fire/smoke stop of adequate rating and to prevent air movement and noise transmission between duct and sleeve.

Provide flanges on either side of wall where ductwork is exposed in rooms.

Where finished insulation is carried through duct sleeves. Pack space between insulation finish and sleeve with non-flammable and fire resistant material to form fire stop.

PR_65_65_00_00.4120 FIRE RATED DUCTWORK SLEEVES:
Provide fire rated ductwork sleeves as required.

PR_65_65_00_00.4130 INSTALLATION OF CONTROL EQUIPMENT:
Fit sensors, damper motors and other control equipment as required.

All control equipment should be installed to manufacturers or specialist supplier's requirements. The installation must be checked by the manufacturer or specialist supplier, and rectified as necessary.

PR_65_65_00_00.4140 INSTRUMENT CONNECTIONS:
Provide instrument connections where required.

All instrument connections should be installed to manufacturers or specialist supplier's requirements. The installation must be checked by the manufacturer or specialist supplier, and rectified as necessary.

PR_65_65_00_00.4150 FIRE PRECAUTIONS:
Install fire dampers as indicated/required.

PR_65_65_00_00.4160 DAMPER ACCESS:
Ensure access is provided to damper mechanisms on fire dampers; smoke dampers; combined smoke and fire dampers; and volume control dampers through access doors, false ceilings etc..

Demonstrate that damper blades close completely.

Demonstrate that fire links can be replaced. Where more than one fire damper is installed in a frame ensure access is provided to all fire dampers.

PR_65_65_00_00.4170 POSITIONING:
Position components in accordance with manufacturer's instructions and as shown on the following drawings.

- Contract drawings
- Manufacturer's drawings
- Specialist supplier's drawings

- Specialist contractor's drawings

10.0 PR_60_65_03_00 AIR HANDLING UNITS

PR_60_65_03_00.1000 GENERAL
PR_60_65_03_00.1010A AIR LEAKAGE:
Ensure air handling unit is sealed to prevent air leakage at design pressure. Determine air leakage in accordance with HEVAC Guide to Air Handling Unit Leakage Testing, Figure 3 at 400 Pa negative pressure.

PR_60_65_03_00.1010B AIR LEAKAGE:
Ensure air handling unit is sealed to prevent air leakage at design pressure. Determine air leakage in accordance with BS EN 1886, Table 2 at 400 Pa negative pressure and table 3 at 700 Pa positive pressure.

PR_60_65_03_00.1010C AIR LEAKAGE - FILTER BYPASS:
Determine air bypass around filter cells in accordance with BS EN 1886.

Ensure air leakage rates do not exceed the values given in table 4 of BS EN 1886 at a test pressure of 400Pa.

PR_60_65_03_00.2020B MANUFACTURER'S STANDARD DOUBLE SKIN CASING AIR HANDLING UNITS:
- Outer skin material - Manufacturer's standard.
- Inner skin material - Manufacturer's standard.
- External casing finish - Manufacturer's standard.
- Internal casing finish - Manufacturer's standard.

PR_60_65_03_00.2030A AIR HANDLING UNIT CONSTRUCTION:
- Insulation to provide
    - Thermal treatment.
    - Structural treatment.
    - Acoustic treatment.

General construction

- Construct unit to withstand maximum fan static pressure without plastic deformation.
- Ensure panels do not deflect by more than 1/120 of maximum panel dimension when unit is in operation.
- Use corrosion resistant fastenings throughout.
- Do not use self-tapping screws.
- Provide panel gaskets to give a durable seal between panels and frames to prevent excessive air leakage.
- Construct unit to avoid thermal bridging.
- Provide stacking units where indicated.

Casing thermal performance

- Ensure the casing thermal performance is tested in accordance with the requirements of BS EN 1886.

Casing Insulation

- Ensure insulation complies with BS 476-7. Ensure insulation is fixed securely to panel, and protected to prevent migration of fibre into air flow.
- Provide insulation to provide thermal, structural or acoustic treatment as required.
- Ensure insulation is vapour sealed throughout and incorporate thermal breaks.
- Provide insulation that is inorganic, vermin proof and non-hygroscopic.
- Use mineral fibre, minimum of 50mm thick, or CFC free rigid polyurethane foam, minimum of 25 mm

thick or CFC free injected polyurethane foam, minimum 25 mm thick.

Framework

- Ensure framework is rigid enough to prevent distortion during transportation and after final assembly on site.
- Seat panels into folded, rolled or extruded frame with purpose made corner joints; or pentapost type frame with purpose made corner joints.
- Ensure framework is self-supporting.
- For vertical units strengthen framework to support additional weight.

Base

- Provide feet under each section; formed base; or RSC base.

PR_60_65_03_00.2040A AIR HANDLING UNIT ACCESS:
Provide access openings and covers complete with opening devices, and sealed to prevent air leakage.

Ensure seals are designed for normal maintenance operations for a minimum of 10 years.

Provide hinged access doors, 400mm minimum width.

Provide key operated door locks.

Provide access to fans, dampers, filters, spray coils, humidifiers and within air handling unit for inspection of nozzles and tanks.

PR_60_65_03_00.2050A WALK-IN AIR HANDLING UNITS:
Ensure floor is double skin with internal framework to support weight of two men, tools and equipment.

Provide weatherproof bulkhead luminaire and switches.

Provide non-slip floor surface.

Ensure insulation is protected.

Ensure access doors can be operated from inside and outside.

Provide walk ways in large units over 2m high.

PR_60_65_03_00.2060A EXTERNAL AIR HANDLING UNITS:
Construct air handling units for external use. Provide weatherproof isolators.

Where indicated provide connection for Lightning protection.

PR_60_65_03_00.3010A FAN SECTION:
Provide frame for motor and fan and comply with fire regulations.

Ensure frame is isolated from casing.

For blow through units ensure air flow in downstream sections of unit has relatively uniform velocity profile.

Supply fan guards to BS EN ISO 12100.

Accessories

- Provide flexible connection between fan discharge and casing spigot. Ensure flexible connections comply with fire regulations.
- Provide manometer connections to measure static pressure at fan inlet eye.
- Provide manometer connections to measure static pressure at fan discharge.

PR_60_65_03_00.3020 FILTER SECTION:
Provide frames to allow withdrawal of filters.

PR_60_65_03_00.3030 HEATER BATTERIES:
Provide slide rails to allow each coil section to be removed independently for access.

Fit baffle plates to prevent air bypass of coil.

PR_60_65_03_00.3040 COOLING COIL SECTION:
Provide slide rails to allow each coil section to be removed independently for access.

PR_60_65_03_00.3050A DRAINAGE FROM AIR HANDLING UNIT COMPONENTS:

Provide drainage pipework from cooling coils, humidifiers and components where water may collect. Comply with recommendations in CIBSE Technical Memorandum TM13 in connection with Legionnaires' disease.

Material - Glass drainage system.

PR_60_65_03_00.3060A CONTROL DAMPERS:
Provide manufacturer's standard control dampers in accordance with DW 144 Part 7 Section 21.

Provide motorized control dampers complete with extended spindle; motor; motor linkage; and motor support.

PR_60_65_03_00.4010A COMPONENT ASSEMBLY:
Assemble air handling units using gaskets to prevent air leakage from casing.

PR_60_65_03_00.4020 ACCESS:
Ensure air handling units are positioned to allow adequate space for maintenance and access.

PR_60_65_03_00.4030 HUMIDIFIER INSTALLATION:
Comply with manufacturer's installation instructions.

PR_60_65_03_00.4040 DUCT CONNECTIONS:
Ensure air is straightened as it leaves unit discharge. Ensure ductwork connection is long enough to ensure the aerodynamic performance of the fan is not affected.

PR_60_65_03_00.4050 SERVICES CONNECTIONS:
Ensure panels are sealed around electrical cable and pipework service entry points to prevent air leakage, using suitable and approved methods to suit individual services applications.

Provide flexible cables between fan motor and local isolator.

PR_60_65_03_00.4060 ISOLATION OF UNITS:
Provide means of isolating air handling units electrically to allow maintenance and repairs to be carried out.

Provide means of isolating pipework to air handling units to allow maintenance and repairs to be carried out.

Provide means of isolating steam to humidifier when access door is opened.

Unit lighting to be isolated separately to be from all other power so that unit can be inspected.

PR_60_65_03_00.4070 DRAINAGE OF FREE WATER:
Make provision for free water to be caught, collected and drained away. Provide U-traps on all drains suitable for the negative/positive pressure created by the fan.

11.0 PR_65_67_29_00 FANS

PR_65_67_29_00.1000 GENERAL
1010 DESIGN DUTIES:
Air Volume - Ensure scheduled volume is provided when operating against resistance of system corrected for changes between specified and selected component resistances.

System Resistance - Adjust scheduled resistance to compensate for actual resistance of selected components.

Operating Point - Select operating point on pressure/volume curve to provide stable and efficient operation.

Guaranteed Performance - Provide fan performance figures in accordance with BS 848-1, BS 848-9.

1020 PROTECTION:
Protect casings, impellers and shafts against corrosion.

Protect bearings against dirt and moisture.

PR_65_67_29_00.2010A NORMAL OPERATING CONDITIONS WITH CIBSE NOISE REQUIREMENTS
Sound Power Level - Select fan, motor, drive and speed control system not to exceed typical fan noise level spectra as given in CIBSE Guide. Provide sound power data in accordance with BS EN ISO 5136, BS ISO 13347-1, BS ISO 13347-2, BS ISO 13347-3, BS ISO 13347-4.

Air Density - Relate fan performance to air density 1.20kg/m^3.

Temperature Range - Minimum to maximum operating temperatures -5^{o}C to 30^{o}C.

PR_65_67_29_00.2010B POTENTIALLY EXPLOSIVE ATMOSPHERES
Constructional requirements - The constructional requirements for fans constructed to Group IIG (of explosion groups IIA, IIB and hydrogen) categories 1, 2 and 3, and Group IID categories 2 and 3, intended for use in explosive atmospheres shall be in accordance with BS EN 14986 and BS EN 13463-1.

Ambient atmosphere pressure - Absolute pressure ranging from 0.8bar to 1.1bar.

Temperature range - Minimum to maximum operating temperatures of -20^{0}C to 60^{0}C inlet gas temperature, 10% to +20% of nominal gas flow.

PR_65_67_29_00.2020A CONSTRUCTION AND HANDLING:
Casings - Construct rigid casing free from drumming under operating conditions. Supply in sections as required for access or handling. Flange dimensions in accordance with BS 848-4.

Safety standards - to BS EN 60335-2-80.

Rotating assemblies - Balance in accordance with BS ISO 1940-1; BS ISO 11342; or BS 7854-1; as appropriate.

Shafts and hubs - Machine impeller bosses and shafts to BS 4500 and key in accordance with BS 4235-1. Hold impeller to shaft with set screw or taper lock fitting.

Shaft bearings - Sealed for life.

Drives and guards - Provide guards over shaft, couplings and rope in accordance with BS EN ISO 12100 and Factory Inspectorate requirements.

Material - galvanized or sheet steel.

Lifting - Provide lifting eyebolts or similar facilities on fans or sections heavier than 20kg.

PR_65_67_29_00.2030 TESTING:
Provide results of aerodynamic performance tests in accordance with BS ISO 14695.

PR_65_67_29_00.2050A MATERIALS, GALVANIZED SHEET STEEL:
Construct casing from galvanized sheet steel in accordance with BS EN 10327 or BS EN 10143.

PR_65_67_29_00.2070A AXIAL FLOW FANS
Aerodynamic efficiency not less than seventy per cent.

Bearings - Provide bearings suitable for mounting and direction of flow.

Casing - enclosing impeller and motor.

PR_65_67_29_00.2070B BIFURCATED AXIAL FLOW FANS:
Aerodynamic efficiency not less than seventy per cent.

Bearings - Provide bearings suitable for mounting and direction of flow.

Casing - Bifurcated unit.

PR_65_67_29_00.2080A SINGLE INLET SINGLE WIDTH CENTRIFUGAL FANS:
Aerodynamic efficiency:

- Backward curved type, not less than 75%.
- Forward curved type, not less than 65%.

Operation - single.

Impeller Design - Supply fan with impeller to suit operating conditions.

Casing - single inlet single width.

Mounting - channel frame.

Drain - Fit drain connection at lowest point of scroll unless indicated otherwise.

PR_65_67_29_00.2080C DOUBLE INLET DOUBLE WIDTH CENTRIFUGAL FANS:
Aerodynamic efficiency

- Backward curved type, not less than 75%.
- Forward curved type, not less than 65%.

Operation - single.

Impeller Design - Supply fan with impeller to suit operating conditions.

Casing - double inlet double width.

Mounting - channel frame.

Drain - Fit drain connection at lowest point of scroll unless indicated otherwise.

PR_65_67_29_00.2090A PROPELLER FANS:
Drives - When motor spindle is extended for mounting blade hub, connect motor to casing, diaphragm plate or mounting ring with support arms.

Impellers - Supply profile blades designed to give uniform airflow.

Mountings - Support fans on plate with circular opening sized and located in accordance with fan manufacturer's requirements.

PR_65_67_29_00.2100A MIXED FLOW FANS:
Operation - single.

Provide bearings suitable for mounting and position indicated on drawings.

PR_65_67_29_00.2120A IN LINE SINGLE FANS:
Operation - single centrifugal fans.

PR_65_67_29_00.2120B IN LINE TWIN FANS:
Operation - twin centrifugal fans with automatic changeover.

PR_65_67_29_00.3010 INSPECTION DOORS - AXIAL FANS:
Fit air-tight inspection doors giving access to drive motors and other components requiring regular servicing or maintenance.

PR_65_67_29_00.3020 INSPECTION DOORS - CENTRIFUGAL FANS:
Fit air-tight doors in scroll and cover.

PR_65_67_29_00.3030 INSPECTION DOORS - PROPELLER FANS:
For diaphragm mounted fans fit an air-tight inspection door positioned to give access to drive, or other sub-components requiring regular servicing or maintenance.

PR_65_67_29_00.3040 INSPECTION DOORS - MIXED FLOW FANS:
Fit air-tight inspection doors giving access to drive motors and other components requiring regular servicing or maintenance.

PR_65_67_29_00.3050A GUARDS:
Provide guards in accordance with BS EN ISO 12100.

Fit safety guards on air inlet and air outlet connections where these are freely accessible to personnel in accordance with BS 848-5.

Provide bird guards where indicated.

PR_65_67_29_00.3060A CONNECTIONS TO DUCT:

Provide matching flanges and flexible connections where indicated.

PR_65_67_29_00.3100A SHUTTERS:
Fit shutters to prevent reverse flow through fan where indicated.

PR_65_67_29_00.3110 AIR FLOW SENSORS:
Fit air flow sensors or pressure switches on twin fan units to sense fan failure and provide automatic changeover to standby fan.

PR_65_67_29_00.3120A ACCESS:
Provide access via hinged casing or removable panel.

PR_65_67_29_00.3130 MOUNTING:
Provide base frames/mounting brackets when this is integral part of fan set.

PR_65_67_29_00.3140 SPEED CONTROLLER:
Provide speed controller to match fans.

PR_65_67_29_00.4010 LOCATION:
Install fans in positions indicated, in accordance with manufacturer's instructions and recommendations in the HEVAC Fan Application Guide.

PR_65_67_29_00.4020 ATTITUDE:
Mount impeller shaft horizontally unless otherwise indicated.

PR_65_67_29_00.4030 ALIGNMENT:
Ensure fan is installed aligned to allow optimum air flow path.

PR_65_67_29_00.4040 TESTING:
Ensure fan is isolated from installation during air leakage testing of ductwork.

PR_65_67_29_00.4050 DRAIN CONNECTION:
Fit trap to drain connection at lowest point of scroll on centrifugal fans where indicated.

12.0 PR_65_57_02_00 AIR FILTRATION

PR_65_57_02_00.1000 GENERAL
PR_65_57_02_00.1010 PRESSURE LOSS DATA:
Provide pressure data as initial pressure loss at rated airflow and recommended final pressure loss.

PR_65_57_02_00.1020 AIR FLOW THROUGH MEDIA:
Provide filter media surface of area and layout to achieve optimum air velocity through media.

PR_65_57_02_00.1030 SEALS:
Provide filters with edge seals as appropriate to prevent air by-passing. Ensure seals remain effective after removal and replacement of cells.

PR_65_57_02_00.2010A CASINGS WITH BOLTS, NUTS AND WASHERS FIXING:
Ensure casings are robust to prevent distortion. Drill steel section end frames for bolts, nuts and washers, and rivets.

PR_65_57_02_00.2010B CASINGS WITH CAPTIVE NUTS OR TAPPED HOLES FIXING:
Ensure casings are robust to prevent distortion. Drill steel section end frames for captive nuts or tapped holes.

PR_65_57_02_00.2010C CASINGS WITH CLIPS:
Ensure casings are robust to prevent distortion. Drill steel section end frames for clips.

PR_65_57_02_00.2020A FILTER TESTING TO BS EN 779
Test filters in accordance with BS EN 779.

Testing for ignitability to BS 9999.

PR_65_57_02_00.2040A PANEL FILTERS, CARDBOARD FRAME:
Ensure filter media is retained in frame.

Provide disposable filter media of glass fibre with scrim or composite fibre material.

Filter frame - Water resistant cardboard.

PR_65_57_02_00.2050A BAG FILTERS:
Ensure media retains its shape during full air-flow conditions.

Material - Provide synthetic or micro-fine glass fibre with reinforced backing mat.

Supply holding frame from material suitable for application complete with sealing gasket located in holding frame.

PR_65_57_02_00.2080A ACTIVATED CARBON FILTERS:
- Disposable media.
- Reactivated media.

Provide absorbent bed filled with uniform thickness of activated carbon granules constructed to prevent settlement and pinholing.

Media type - disposable or reactivated as indicated.

Casing - Supply casing with removable panels, manufactured from mild steel with epoxy resin finish.

PR_65_57_02_00.3010B PRESSURE GAUGE, INCLINED MANOMETER:
Inclined manometer type differential pressure gauge. Clearly mark scale with positions equivalent to "Filter Dirty" and "Filter Clean" conditions. Connect gauge to duct mounting with PVC tubing. Fix external to unit to allow easy observation. Mount within 3m of filter.

PR_65_57_02_00.3010C PRESSURE GAUGE, PRESSURE DIFFERENTIAL SWITCH:
Pressure differential switch for visual or audio warning of "Filter Blocked Condition".

PR_65_57_02_00.3020 FILTER HOUSING:
Provide filter housing to hold banks of filters rigidly in place.

PR_65_57_02_00.3050 SPARES:
Supply sufficient filter media to allow one complete replacement for each filter.

PR_65_57_02_00.3060 CLEANING:
Supply cleaning materials for metal plate filters, supply sufficient coating solution for one complete cleansing operation.

PR_65_57_02_00.4010 LOCATION: ASSEMBLE FILTER IN LOCATION INDICATED.
Assemble filter

PR_65_57_02_00.4020A ACCESS FOR MAINTENANCE:

- Provide access
    - on upstream side of media.
    - on side of filter casing.
    - on bottom of filter casing.
    - from chamber on upstream side of media for front withdrawal.

Provide access for changing filter media. Provide access for maintenance of motor drive and associated control equipment without disturbing filter media. Provide access for total duct maintenance.

13.0 PR_60_65_37_00 HEATING/COOLING COILS

PR_60_65_37_00.1000 GENERAL
PR_60_65_37_00.2010A HOT WATER HEATING COILS, COPPER WITH ALUMINIUM FINS:
Materials:

- Tubes - copper to BS EN 12451.
- Fins - aluminium.
- Headers - Manufacturer's standard.
- Casing - Manufacturer's standard.

Casing - Make provision for coil expansion. Enclose body of coil, headers and bends within casing.

Draining and venting - Provide plugged connections in headers to allow fitting of drain cocks/air vents and provide coil complete with venting and draining devices.

Coil Testing - Pressure test coils to a minimum of 1.5 times design working pressure to ensure leak tight manufacture, and provide signed test certificates. Base coil design and sizing on performance test figures in line with BS 5141-2 for heating coils.

Packaging:

- Fit protection for fins prior to despatch.
- Protect coils from dirt after manufacture by fitting blank flanges/caps to pipe connections.

PR_60_65_37_00.2010D CHILLED WATER COOLING COILS, COPPER WITH ALUMINIUM FINS:
Materials:

- Tubes - copper to BS EN 12451.
- Fins - aluminium.
- Headers - Manufacturer's standard.
- Casing - Manufacturer's standard.

Casing - Make provision for coil expansion. Enclose body of coil, headers and bends within casing.

Draining and venting - Provide plugged connections in headers to allow fitting of drain cocks/air vents and provide coil complete with venting and draining devices.

Arrangement - Supply fins in vertical plate arrangement for cooling coils.

Drain pan - Provide drainage facility to avoid standing water.

Coil Testing - Pressure test coils to a minimum of 1.5 times design working pressure to ensure leak tight manufacture, and provide signed test certificates. Base coil design and sizing on performance test figures in line with BS 5141-1 for cooling coils.

Packaging:

- Fit protection for fins prior to despatch.
- Protect coils from dirt after manufacture by fitting blank flanges/caps to pipe connections.

PR_60_65_37_00.3010 DRIP TRAYS:

- Provide removable drip trays.

Incorporate drip tray into base of casing to collect condensate. Fit at a small gradient towards drain socket provided in bottom of tray. Extend tray under external headers/return bends where these are not insulated/vapour sealed. Extend tray, or provide additional tray, where eliminator plates are fitted.

- Provide removable drip trays.

Where coils are over 1200mm high provide additional drip trays at 1200mm centre intervals maximum over height of coils, piped in copper or plastic to discharge into base tray.

Paint internal surfaces with two coats of epoxy resin or alternative water proofing compound.

PR_60_65_37_00.3020A GLASS DRAIN TRAPS UNDER SUCTION:
Provide drain trap at least twice working air pressure in depth. Provide an air break between trap outlet and drainage system.

Ensure traps under suction have outlet lower than inlet by depth equivalent to at least one and a half times working pressure.

Material - Glass.

PR_60_65_37_00.3020B GLASS DRAIN TRAPS UNDER PRESSURE:
Provide drain trap at least twice working air pressure in depth. Provide an air break between trap outlet and drainage system.

Ensure traps under positive pressure have inlet and outlet at same level.

Material - Glass.

PR_60_65_37_00.3030 ELIMINATOR PLATES:
Install bank of eliminator plates downstream of coils to prevent carry over of condensate at design air face velocity. Fit plates to allow independent removal from coil casing. Ensure material of eliminators is compatible with casing.

PR_60_65_37_00.3040 MOUNTING FRAME:
On heating coils provide mounting frame for grouting into wall.

PR_60_65_37_00.3050A AHU DUCT CONNECTIONS:
To match air handling unit and specified method of assembly.

PR_60_65_37_00.3050B EXTERNAL FLANGE DUCT CONNECTIONS:
With external flanges drilled for bolting to counter flanges on adjacent plant or ductwork.

PR_60_65_37_00.3050C INTERNAL FLANGE DUCT CONNECTIONS
With internal flanges drilled for bolting to counter flanges on adjacent plant or ductwork.

PR_60_65_37_00.3050D SPIGOT DUCT CONNECTIONS:
With spigot duct connections.

PR_60_65_37_00.3060 MATCHING FLANGES - DUCTWORK:
Provide matching flanges for ductwork connections, to suit coil.

PR_60_65_37_00.3070 MATCHING FLANGES - PIPEWORK:
Provide matching flanges for pipework connections, to suit coil.

PR_60_65_37_00.3080 ANTI-FREEZE THERMOSTAT:
Provide antifreeze thermostat where required.

PR_60_65_37_00.3090 AUTO AIR PURGING VALVE:
Provide an auto purging valve, where required.

PR_60_65_37_00.3100 ACCESS DOORS:
Provide hinged airtight and watertight access door to allow adequate access for maintenance purposes.

PR_60_65_37_00.3110 ACCESS WALKWAY:
Provide walkway for maintenance access.

PR_60_65_37_00.4010 POSITION/LOCATION:
Install coils in air distribution system as indicated. Locate coils in positions where air velocity is substantially equal over face of approach duct.

Arrange steam coils for horizontal air flow.

Ensure equipment, controls and instruments positioned adjacent to heating coils are not adversely affected by thermal radiation.

PR_60_65_37_00.4020A COOLING COIL CONNECTIONS:
Provide a drain line incorporating deep seal trap.

PR_60_65_37_00.4020B HEATING COIL CONNECTIONS:
Arrange pipe connections to take up thermal expansion movement without imposing stress on coil.

PR_60_65_37_00.4030 COIL SUPPORT:
Ensure that coils are fully supported independently of adjacent ductwork.

PR_60_65_37_00.4040 PROTECTION:
Protect coils from damage and ingress of dirt during the course of contract. Restore fins and other parts of coils to original condition if any damage has occurred. Ensure all connected ductwork is thoroughly clean before removing protection and passing air through system.

PR_60_65_37_00.4050 EQUIPMENT INSTALLATION:
Install equipment in accordance with manufacturer's recommendations.

Ensure maintenance requirements are incorporated.

14.0 PR_65_67_78_00 SILENCERS/ACOUSTIC TREATMENT

PR_65_67_78_00.1000 GENERAL
PR_65_67_78_00.1010 PERFORMANCE:
Ensure that specified performance is met where protection is applied to infill to protect from moisture and grease.

PR_65_67_78_00.1020 TESTING:
Provide certified insertion loss data in accordance with BS EN ISO 7235. Provide generated sound power levels with insertion loss data.

Where equipment is manufactured in modules ensure performance ratings apply to complete unit.

PR_65_67_78_00.1030 PROTECTION:
Protect silencers where they are installed in positions exposed to external weather conditions.

Block ends of silencers prior to delivery to site to prevent damage.

PR_65_67_78_00.1040 DIRECTION OF FLOW:
Clearly mark direction of air flow on silencers.

PR_65_67_78_00.2010A FIRE PROPERTIES, BS 476-7, CLASS 1:
Use non-flammable adhesives. Ensure that all insulating materials and coverings are non-combustible material covered with a material that complies with flame spread requirements of BS 476-7, Class 1.

PR_65_67_78_00.2010B FIRE PROPERTIES, BUILDING REGULATIONS, CLASS O:
Use non-flammable adhesives. Ensure that all insulating materials and coverings are to Class O surface rating of Building Regulations.

PR_65_67_78_00.2040A RECTANGULAR SILENCERS - CASING TO DW144 WITH CONNECTIONS TO MATCH AHU:
Provide rectangular silencers compatible with ductwork installation. Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.

Construct splitters with manufacturer's standard ends.

Construct casing to DW 144 with duct connections to match the air handling unit and specified method of assembly.

PR_65_67_78_00.2040B RECTANGULAR SILENCERS - CASING TO DW144 WITH EXTERNAL FLANGES:
Provide rectangular silencers compatible with ductwork installation. Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.

Construct splitters with manufacturer's standard ends.

Construct casing to DW 144 with external flanges drilled for bolting to counter flanges on adjacent plant or ductwork.

PR_65_67_78_00.2040C RECTANGULAR SILENCERS - CASING TO DW144 WITH INTERNAL FLANGES:
Provide rectangular silencers compatible with ductwork installation.

Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.

Construct splitters with manufacturer's standard ends.

Construct casing to DW 144 with internal flanges drilled and threaded for bolting to counter flanges on adjacent plant or ductwork.

PR_65_67_78_00.3010 GENERAL:
Install acoustic treatment equipment in positions indicated/as required to achieve noise levels, in accordance with manufacturer's instructions.

PR_65_67_78_00.3040 SUPPORTS:
Supply steel section supporting frames or brackets where silencers are fixed to the walls of air chambers.

PR_65_67_78_00.3060 SOUND PRESSURE LEVEL READINGS:
Measure sound pressure levels at the positions as required using equipment in accordance with BS EN 61672-1 and BS EN 61672-2.

PR_65_67_78_00.3070 MEASURE SOUND INSULATION OF BUILDING ELEMENTS IN ACCORDANCE
Measure sound insulation of building elements in accordance with BS EN ISO 140-14 as appropriate.

15.0 PR_70_65_04_00 GRILLES/DIFFUSERS/LOUVRES

PR_70_65_04_00.1000 GENERAL
PR_70_65_04_00.1010 PERFORMANCE:
Air Supply - Ensure air velocity at occupied level is not greater than 0.45 m/s.

Blades - Supply grilles and diffusers with blade profile to ensure correct aerodynamic performance and minimal noise generation.

Louvres - Ensure air velocities through face area of louvres minimises "carry-over" of rain, snow or other precipitation into ducts, shafts or plant rooms.

PR_70_65_04_00.1020 SIZE:
Sizes indicated are "Nominal".

Provide site dimensions of linear diffusers and grilles before manufacture.

PR_70_65_04_00.1030 NOISE LEVELS:
Ensure sound power levels indicated are not exceeded. Ensure accessories for grilles and diffusers have low noise generation characteristics, and cause minimum disturbance to airflow.

PR_70_65_04_00.1033 PROTECTIVE WRAPPING:
Apply protective wrapping to exposed architectural finishes prior to despatch to site.

PR_70_65_04_00.1035 TESTING:
Provide air terminal devices tested in accordance with BS EN ISO 5135, and BS EN 13030.

PR_70_65_04_00.1040 ELECTRICAL BONDING TERMINAL:
Ensure an electrical bonding terminal suitable for connection of 6mm^2 maximum conductor is provided on metal grilles, diffusers and louvres where indicated.

PR_70_65_04_00.2010A GRILLES - FIXED BLADE TYPE:
Secure blades within flanged mounting frame or core collar. Provide support mullions to ensure blade stability.

Style, blade rows and air pattern control as indicated on schedule.

PR_70_65_04_00.2020A GRILLES - ADJUSTABLE BLADE TYPE:
Pivot blades within flanged mounting frame and retain blades in set position by tensioners external to the airstream.

Provide blade rows and blade angle adjustment as indicated on schedule.

PR_70_65_04_00.2030A GRILLES - MESH TYPE:
Core material - Cellular, expanded or perforated as indicated on schedule.

Frame - Flange mounting frame or plate flange as indicated on schedule.

Fixing - Permanently fixed or designed for easy removal, as indicated.

PR_70_65_04_00.2040A GRILLES - EGG-CRATE TYPE:
Core material - Aluminium or plastic as indicated.

Style - Flanged or channel frame; or core only as indicated.

PR_70_65_04_00.2050A GRILLES - LINEAR TYPE:
Supply linear type grilles with one row of parallel blades. Secure blades within mounting frame or opening. Permanently set at angle indicated.

PR_70_65_04_00.2080A CONE TYPE CIRCULAR DIFFUSERS:
Supply circular diffusers manufactured to ensure rigid and smooth outer cone or frame, and inner assembly.

Space all cones to ensure even distribution of air flow with minimum resistance and noise, and to allow easy cleaning.

Cone type - Fixed or adjustable deflection cone type as indicated.

PR_70_65_04_00.2080B PAN TYPE CIRCULAR DIFFUSERS:
Supply circular diffusers manufactured to ensure rigid and smooth outer cone or frame, and inner assembly.

Pan type - Fixed or adjustable pan type as indicated.

PR_70_65_04_00.2080C CIRCULAR DIFFUSERS - CORE ADJUSTMENT:
Provide core adjustment to obtain required air distribution pattern. Allow inner assembly to move vertically by vertical sliding action or rotation as indicated.

PR_70_65_04_00.2090A DIFFUSERS - LINEAR TYPE:
Supply single unit or continuous length linear diffusers manufactured with one or more rigid and smooth line slot units with parallel bars and partitions.

Fit closing caps at ends of single or multiple continuous length units.

Provide continuous lengths complete with locating pins or strips with keys to ensure correct alignment of abutted ends.

Air Controller - Fit each slot with device indicated.

PR_70_65_04_00.2100 DIFFUSERS - PERFORATED FACE TYPE:
Supply perforated face diffusers with rigid and smooth inlet spigot expanded to butt and seal against easily removable framed perforated front panel. Incorporate back deflectors above front panel, set to give required performance.

Supply type and profile of framed perforated front panel to mount flush with surrounding false ceiling panels.

PR_70_65_04_00.2110A ADJUSTABLE CURVED BLADE DIFFUSER:
Supply diffusers manufactured from curved cross sectional profile parallel blades pivoted at each end within flanged mounting frame. Ensure that each blade is individually adjustable to give directional control of airstream. Retain blades in set position by tensioners external to airstream.

PR_70_65_04_00.2120A ADJUSTABLE CURVED BLADE DIFFUSER WITH REMOVABLE INNER CORE:
Supply diffusers manufactured from curved cross sectional profile parallel blades within removable core frame and include integral multi-blade volume control at each blade set. Ensure assembly is removable from flanged mounting frame. Make provision for volume control adjustment by loose key.

Ensure that each blade within core is individually adjustable, and that each core is designed to give directional control of airstream through each 90^{o} angle.

PR_70_65_04_00.2130A STRAIGHT LINE, FIXED LOUVRE DIFFUSER WITH FIXED CORE:
Supply diffusers manufactured from louvre type parallel blades permanently set and securely fixed within

frame.

Pre-set each blade to give directional control of airstream.

Control ways as indicated on drawings/schedule.

PR_70_65_04_00.2130B STRAIGHT LINE, FIXED LOUVRE DIFFUSER WITH REMOVABLE CORE:
Supply diffusers manufactured from louvre type parallel blades permanently set and securely fixed within frame.

Supply core frames which are easily removable from flanged mounting frame.

Pre-set each blade to give directional control of airstream.

PR_70_65_04_00.2140A SPHERICAL PUNKAH LOUVRE DIFFUSERS:
Supply diffusers manufactured with adjustable core. Supply core in the form of a rotatable sphere with circular outlet nozzle, the whole retained by a flanged cup allowing manual change of discharge air pattern to give an adjustable high velocity jet, full diffusion, or complete shut-off.

Incorporate tapped ring for duct mounting, complete with felt, foam rubber or plastic sealing ring and fixing bolts or screws. When connecting to ends of flexible ducting, fit rigid flanged extension collar.

PR_70_65_04_00.2140B DRUM PUNKAH LOUVRE DIFFUSERS:
Supply diffusers manufactured with adjustable core. Supply core in the form of a rotatable cylinder with a rectangular outlet nozzle, the whole retained by a flanged frame allowing manual change of discharge air pattern to give an adjustable high velocity jet or full diffusion, by adjustable integral vertical blades.

Incorporate tapped ring for duct mounting, complete with felt, foam rubber or plastic sealing ring and fixing bolts or screws. When connecting to ends of flexible ducting, fit rigid flanged extension collar.

PR_70_65_04_00.2150 DIFFUSERS - LINEAR LIGHTING/AIR MODULAR TYPE:
Supply diffusers complete with connecting unit for installation behind module flanges, ensuring neat and unobtrusive appearance.

Fit plenum box with integral independent air volume regulating vanes to direct an equal air velocity along complete length of connecting air diffuser slot. Ensure easy access from below to regulating vanes. Retain vanes in set position by tensioners external to air stream.

Fit spigot, suitable for flexible ducting joint connection to plenum box.

Ensure that supports are independent, and do not depend upon module casing or flanges.

PR_70_65_04_00.2180 DIFFUSERS - EXTRACT/EXHAUST VALVE TYPE:
Supply diffusers incorporating intake ring and adjustable valve disc assembly. Provide bayonet type fixing for purpose made mounting ring with plastic foam sealing gasket. Provide setting template.

Adjust valve to required setting and lock valve in required position.

PR_70_65_04_00.2190A LOUVRES - EXTERNAL AIR SUPPLY/EXTRACT TYPE:
Performance - Ensure louvre withstands specified wind loads and prevent ingress of rain.

Construction - Construct louvre frame and aerodynamically profiled louvre blades from galvanized mild steel or aluminium as indicated.

Provide integral drainage channels.

Retain infill on louvre blades by perforated sheet of galvanized mild steel or aluminium as indicated.

Screen - Fit a bird-screen using mesh no coarser than 12mm, across inside face of louvres.

Fit an insect-screen using mesh no coarser than 3mm, across inside face of louvres.

Quality assurance - Ensure manufacturers are a firm of Assessed Capability to BS EN ISO 9001 and produce louvre to relevant Quality Assessment schedule.

PR_70_65_04_00.2210A GALVANISED STEEL:

- Finish
    - Primed to prevent rust.
    - Stove enamelled to colour
    - With epoxy resin powder/hardener coating colour

Galvanised steel in accordance with BS EN 10327 or BS EN 10143.

PR_70_65_04_00.2210B ALUMINIUM:

- Finish
    - Etched or buffed to give self-colour satin finish.
    - With clear lacquer finish.
    - Primed to prevent oxidization.
    - Stove enamelled to colour
    - With epoxy resin powder/hardener coating colour
    - Anodized after manufacture colour

Use aluminium sheet/extruded aluminium produced to BS EN 485, BS EN 515 and BS EN 573, or BS EN 755.

PR_70_65_04_00.2210C STAINLESS STEEL:
Use stainless steel.

PR_70_65_04_00.2220A GRILLE AND DIFFUSER CONSTRUCTION:
Ensure grilles and diffusers are robust and mounting frame flanges on square and rectangular terminals have mitred corners. Fit a rubber or plastic foam sealing strip or gasket to rear face of flange.

Diffusers - Ensure face of diffuser outer cone or frame is completely smooth.

PR_70_65_04_00.2230A LOUVRE CONSTRUCTION:
Ensure louvres are robust. Incorporate in purpose made sub-frame. Provide drip cills as required.

PR_70_65_04_00.3010A OPPOSED BLADE VOLUME CONTROL DAMPERS - LOCAL CONTROL:
Balance and tension operating mechanisms to give positive setting for blade positions from fully open to fully closed.

Local blade operation - Supply device for operating damper blades through face or side of grille/diffuser as indicated.

PR_70_65_04_00.3010B OPPOSED BLADE VOLUME CONTROL DAMPERS - REMOTE CONTROL:
Balance and tension operating mechanisms to give positive setting for blade positions from fully open to fully closed.

Remote blade operation - Supply remote control with necessary brackets and linkage at control unit.

PR_70_65_04_00.3030A ANNULAR RING VOLUME CONTROL DAMPERS:
Provide manual operation by loose key.

PR_70_65_04_00.3040A BUTTERFLY VOLUME CONTROL DAMPERS:
Operate via a simple hooked wire key connecting with a lug on the underside of each plate; or by a loose key locating into a control mechanism.

PR_70_65_04_00.3050A "IRIS" VOLUME CONTROL DAMPERS:
When in fully open setting ensure that unit inside diameter is equal to full internal diameter of air diffuser spigot, or ducting branch connection. Method of operation as indicated on the schedule.

PR_70_65_04_00.3060A FIXED AIR FLOW DEFLECTORS:
Direct airstream evenly from main ducting into branches or spigots serving air grilles and diffusers by using a number of equally spaced curved blades linked together.

PR_70_65_04_00.3060B ADJUSTABLE AIR FLOW DEFLECTORS:
Direct airstream evenly from main ducting into branches or spigots serving air grilles and diffusers by using a number of equally spaced curved blades linked together.

PR_70_65_04_00.3070 BLANKING PLATES:
Supply blanking plates to restrict projection of air flow from a particular section of grille or diffuser. Ensure that indicated dimensions or angles in degrees are maintained.

PR_70_65_04_00.3090 PERFORATED SCREENS:
Fit perforated screens behind grille volume control devices to equalize air flow and pressure. Contain perforated sheet within rigid surrounding frame, incorporating fixing brackets or lugs.

PR_70_65_04_00.3100 CEILING OR WALL MOUNTED PLENUM BOXES:
Supply single plenum box or series of plenum boxes butted together to form continuous length, where indicated. Ensure sturdy and rigid construction with circular inlet spigots 65mm minimum length.

Incorporate at least four drilled angle brackets, or flat bar lugs, for securing to, or suspension by rods or wires from building or other construction.

PR_70_65_04_00.3110 FLOOR MOUNTED PLENUM BOXES:
Supply single plenum box or series of plenum boxes butted together to form continuous length, where indicated. Ensure sturdy and rigid construction with circular inlet spigots 65 mm minimum length. Ensure box base material and reinforcement is able to with stand pressures of concrete handling and pouring when casting into floor slab.

Incorporate at least four drilled angle brackets, for fixing to slab soffit, or building ragged ties when casting into a floor slab.

PR_70_65_04_00.3120A HINGED LOUVRE ACCESS PANELS AND DOORS:
Incorporate purpose made access panels or doors within body of louvres, manufactured from compatible materials.

Use hinged access panels or doors of single or double style and with front or rear locking facilities.

PR_70_65_04_00.3120B LIFT OUT LOUVRE ACCESS PANELS AND DOORS:
Incorporate purpose made access panels or doors within body of louvres, manufactured from compatible materials.

Use permanent housed or lockable lift out access panels.

PR_70_65_04_00.3130 SPARES:
Supply 3 number of loose keys, suitable for adjusting each size and type of grille, or operating accessories.

PR_70_65_04_00.3140A OPPOSED BLADE VOLUME CONTROL DAMPERS - LOCAL BLADE OPERATION:
Balance and tension operating mechanisms to give positive setting for blade positions from fully open to fully closed.

Local blade operation - Supply device for operating damper blades through face or side of grille/diffuser as indicated.

PR_70_65_04_00.3140B OPPOSED BLADE VOLUME CONTROL DAMPERS - REMOTE BLADE OPERATION:
Balance and tension operating mechanisms to give positive setting for blade positions from fully open to fully closed.

Remote blade operation - Supply remote control with necessary brackets and linkage at control unit.

PR_70_65_04_00.3150A BUTTERFLY VOLUME CONTROL DAMPERS:
Operate via a simple hooked wire key connecting with a lug on the underside of each plate, or by a loose key locating into a control mechanism.

PR_70_65_04_00.3160A "IRIS" VOLUME CONTROL DAMPERS:
When in fully open setting ensure that unit inside diameter is equal to full internal diameter of air diffuser spigot, or ducting branch connection. Method of operation as indicated on the schedule.

PR_70_65_04_00.4010 GRILLE/DIFFUSER LOCATION:
Fit at terminal air supply, extract and transfer points indicated, in accordance with the HEVAC Air Diffusion Guide.

PR_70_65_04_00.4020 LOUVRE LOCATION:
Fit at system main air intake and discharge points, as indicated.

PR_70_65_04_00.4030 ACCESSORIES:
Fit accessories to each grille and diffuser in accordance with manufacturer's instructions and as indicated.

PR_25_31_48_00.1034 PROTECTION APPLIED IN SITU:
Where fire and surface spread of flame certificates relate to factory made products, ensure that the certificate remains valid when the finish is site applied.

PR_70_65_04_00.4040 CONNECTION TO DUCTWORK:
When connecting directly to duct spigot, secure grille mounting frame or flange with screws, or bolts and nuts, to returned flange, with filled in corners, at end of duct spigot.

PR_70_65_04_00.4050A INSTALLATION IN BUILDERS WORK:
Ensure outer edge of grille mounting frame or flange extends on all sides beyond the joint between any builders work frame and surrounding building construction.

Ensure grilles are sealed to building fabric - including ceilings, to prevent air leakage from pressurised rooms to voids above.

Fix louvres to building fabric using method as required by the manufacturer’s instructions.

PR_70_65_04_00.4060A TRANSFER GRILLES:
Where transfer points are located in partitions or walls, prevent through vision by fitting a fixed blade grille on

both faces of partition or wall. Connect cavity wall or partition transfer grille assemblies with ducting sleeve or collar extending between grilles.

PR_70_65_04_00.4060B TRANSFER GRILLES WITH FIRE DAMPER:
Where transfer points are located in partitions or walls, prevent through vision by fitting a fixed blade grille on both faces of partition or wall. Connect cavity wall or partition transfer grille assemblies with ducting sleeve or collar extending between grilles.

Incorporate fire damper in fire compartment wall transfer grille assembly.

16.0 PR_25_31_48_00 THERMAL INSULATION

PR_25_31_48_00.1000 GENERAL
PR_25_31_48_00.1010 TEMPERATURE RANGE:
Surface temperature within range -40°C to 230°C.

PR_25_31_48_00.1020 STANDARDS:
Comply in general with BS EN ISO 12241. Use the description of terms as BS 3533.

PR_25_31_48_00.1030 MATERIALS:
Employ materials that comply with BS 476-7.

Ensure metals and materials that cause galvanic corrosion are not installed in contact with each other.

Do not use galvanized or zinc coated steel jacketing and accessories on austenitic stainless steel and austenitic nickel steel/alloy equipment and piping.

PR_25_31_48_00.1032 PRE-INSULATED EQUIPMENT:
Where fire and surface spread of flame certificates relate to factory made products, ensure that certificates are still valid where products are incorporated in pre-insulated equipment.

PR_25_31_48_00.1035A CLASS A1 EUROPEAN CLASSIFICATION FOR REACTION TO FIRE PERFORMANCE:
Supply insulating materials that comply with Euroclass A1.

PR_25_31_48_00.1035B CLASS A2 EUROPEAN CLASSIFICATION FOR REACTION TO FIRE PERFORMANCE:
Supply insulating materials that comply with Euroclass A2.

PR_25_31_48_00.1035C CLASS B EUROPEAN CLASSIFICATION FOR REACTION TO FIRE PERFORMANCE:
Supply insulating materials that comply with Euroclass B.

PR_25_31_48_00.1035D CLASS C EUROPEAN CLASSIFICATION FOR REACTION TO FIRE PERFORMANCE:
Supply insulating materials that comply with Euroclass C.

PR_25_31_48_00.1050A SPREAD OF FLAME:
When completed, ensure surface-finish complies with BS 476-7 Class 1 spread of flame.

PR_25_31_48_00.1055A SMOKE EMISSION CHARACTERISTICS:
Supply materials classified as less than 5% smoke obscuration rating when tested in accordance with BS EN ISO 5659-2.

PR_25_31_48_00.1080 ELECTRICAL BONDING TERMINAL:
Ensure an electrical bonding terminal suitable for connection of 6mm^2 maximum conductor is provided where indicated.

PR_25_31_48_00.1090 INSPECTION AND TESTING:
Arrange performance test of thermal conductivity on materials selected, carried out at manufacturer's works or at an approved laboratory and in accordance with appropriate British Standard.

PR_25_31_48_00.2010 THERMAL CONDUCTIVITY:
Ensure values are in accordance with BS EN 12664, BS EN 12667, BS EN 12939 or BS EN ISO 8990.

PR_25_31_48_00.2015A THERMAL PERFORMANCE LIFE EXPECTANCY FOR PLANT DESIGN LIFE:
Ensure the insulation will maintain its thermal performance for a minimum of the plant design life.

PR_25_31_48_00.2015B THERMAL PERFORMANCE LIFE EXPECTANCY DETAILS:
Provide manufacturer's details which define the life expectancy of the insulation material.

PR_25_31_48_00.2020 RESTRICTIONS ON USE OF MATERIALS:
Protect insulated stainless steel surfaces from the risk of stress corrosion in accordance with the recommendations in BS 5970.

PR_25_31_48_00.2030A FOIL FACED MINERAL FIBRE PIPE INSULATION:
Standard - BS 3958-4.

Nominal density - 80 kg/m^3 to 120 kg/m^3.

Thickness - 20mm to 100mm.

Thermal conductivity

Not exceeding 0.038 W/mK at a mean temperature of 50^{o}C.

Finish - Reinforced aluminium foil with at least 25mm overlap.

PR_25_31_48_00.2030B CANVAS COVERED MINERAL FIBRE PIPE INSULATION:
Standard - BS 3958-4.

Nominal density - 80 kg/m^3 to 120 kg/m^3.

Thickness - 20mm to 100mm.

Thermal conductivity - not exceeding 0.038 W/mK at a mean temperature of 50^{o}C.

Finish - Canvas covered with at least 25mm overlaps.

PR_25_31_48_00.2030C FOIL FACED GLASS FIBRE PIPE INSULATION:
- Standard - BS 3958-4.
- Nominal density - 80 kg/m3 to 120 kg/m3.
- Thickness - 20mm to 100mm.
- Thermal conductivity - not exceeding 0.035 W/mK at a mean temperature of 500C.

PR_25_31_48_00.2040A FOIL FACED ROCK MINERAL FIBRE RIGID DUCT INSULATION:
- Standard - BS 3958-5.
- Nominal density - 45 - 48 kg/m3.
- Thickness - 25mm to 100mm.
- Thermal conductivity - Not exceeding 0.04 W/mK at a mean temperature of 50oC.
- Finish - Reinforced aluminium foil.

PR_25_31_48_00.2050A FOIL FACED ROCK MINERAL FIBRE FLEXIBLE DUCT INSULATION:
- Nominal density - 28 kg/m3 to 45 kg/m3.
- Thickness - 25mm to 60mm.
- Thermal conductivity - Not exceeding 0.04 W/mK at a mean temperature of 50oC.
- Finish - Reinforced aluminium foil.

PR_25_31_48_00.2060A FOIL FACED ROCK MINERAL FIBRE LAMELLA DUCT INSULATION:
- Nominal density - 24-45 kg/m3.
- Thickness - 25mm to 80mm.
- Thermal conductivity - Not exceeding 0.051 W/mK at a mean temperature of 50oC.

- Finish - Reinforced aluminium foil.

PR_25_31_48_00.2060B KRAFT PAPER FACED ROCK MINERAL FIBRE LAMELLA DUCT INSULATION:

- Nominal density - 24-45 kg/m3.
- Thickness - 25mm to 80mm.
- Thermal conductivity - Not exceeding 0.051 W/mK at a mean temperature of 50oC.
- Finish - Plain Kraft paper.

PR_25_31_48_00.2065 CRIMPED MAT DUCT INSULATION:

- Nominal density - 25 to 45 kg/m3.
- Compression resistance - Maximum of 13% compression at a static load of 2 kPA.
- Thickness - 25mm to 80mm.
- Thermal conductivity - Not exceeding 0.039 W/mK at a mean temperature of 50oC.
- Finish - Reinforced aluminium foil.

PR_25_31_48_00.2070A GALVANIZED METAL MESH ON MINERAL FIBRE MATTRESSES - ONE FACE:

- Standard - BS 3958-3.
- Nominal density - 66 - 128 kg/m3.
- Thickness - 25mm to 100mm.
- Thermal conductivity - Not exceeding 0.038 W/mK at a mean temperature of 50oC.
- Mesh - Galvanized. Faced, one side.

PR_25_31_48_00.2070B GALVANIZED METAL MESH ON MINERAL FIBRE MATTRESSES - BOTH FACES:

- Standard - BS 3958-3.
- Nominal density - 66 - 128 kg/m3.
- Thickness - 25mm to 100mm.
- Thermal conductivity - Not exceeding 0.038 W/mK at a mean temperature of 50oC.
- Mesh - Galvanized. Faced, both sides.

PR_25_31_48_00.2070C STAINLESS STEEL MESH ON MINERAL FIBRE MATTRESSES - ONE FACE:

- Standard - BS 3958-3.
- Nominal density - 66 - 128 kg/m3.
- Thickness - 25mm to 100mm.
- Thermal conductivity - Not exceeding 0.038 W/mK at a mean temperature of 50oC.
- Mesh - Stainless steel. Faced, one side.

PR_25_31_48_00.2070D STAINLESS STEEL MESH ON MINERAL FIBRE MATTRESSES - BOTH FACES:

- Standard - BS 3958-3.
- Nominal density - 66 - 128 kg/m3.
- Thickness - 25mm to 100mm.
- Thermal conductivity - Not exceeding 0.038 W/mK at a mean temperature of 50oC.
- Mesh - Stainless steel. Faced, both sides.

PR_25_31_48_00.2080A FLAT DUCTWORK FIRE PROTECTION INSULATION - MITRED JOINTS:

- Material - Mineral fibre, slab for flat ducts, with 45o mitred joints.
- Nominal density - 165 kg/m3.
- Thermal conductivity - Not exceeding 0.035 W/mK at a mean temperature of 10oC.
- Facing - Reinforced aluminium foil.

PR_25_31_48_00.2080B FLAT DUCTWORK FIRE PROTECTION INSULATION - BUTTED JOINTS:

- Material - Mineral fibre, slab for flat ducts, with 90o butted joints.
- Nominal density - 66 - 165 kg/m3.
- Thermal conductivity - Not exceeding 0.035 W/mK at a mean temperature of 10oC.

- Facing - Reinforced aluminium foil.

PR_25_31_48_00.2080C CIRCULAR DUCTWORK FIRE PROTECTION INSULATION - SECTION:

- Material - Mineral fibre
- Section for circular duct, 17 to 610 mm diameter.
- Nominal density - 165 kg/m3.
- Thermal conductivity - Not exceeding 0.035 W/mK at a mean temperature of 10oC.
- Facing - Reinforced aluminium foil.

PR_25_31_48_00.2080D CIRCULAR DUCTWORK FIRE PROTECTION INSULATION - PSM:

- Material - Mineral fibre
- PSM for circular duct greater than 406mm diameter.
- Nominal density - 165 kg/m3.
- Thermal conductivity - Not exceeding 0.035 W/mK at a mean temperature of 10oC.
- Facing - Reinforced aluminium foil.

PR_25_31_48_00.2080E CIRCULAR DUCTWORK FIRE PROTECTION INSULATION - FLEXIBLE MAT:

- Material - Mineral fibre wire faced flexible mattress.
- Nominal density - 66 kg/m3.
- Thermal conductivity - Not exceeding 0.035 W/mK at a mean temperature of 10oC.
- Facing - Reinforced aluminium foil.

PR_25_31_48_00.2110A FOIL FACED CLOSED CELL RIGID PHENOLIC FOAM (PF) PREFORMED SECTIONS - CFC AND HCFC FREE:

- Standard - BS EN 14314:2015
- Nominal density - 35 - 40 kg/m3.
- Temperature range: -180 to +120oC.
- Thickness - 15mm to 50mm.
- Thermal conductivity - Not exceeding 0.021 W/mK at a mean temperature of 10oC.
- Finish - Reinforced aluminium foil.

PR_25_31_48_00.2110B CLOSED CELL RIGID PHENOLIC FOAM (PF) PREFORMED SECTIONS - CFC AND HCFC FREE:

- Standard - BS EN 14314:2015
- Nominal density - 35 - 40 kg/m3.
- Temperature range: -180 to +120oC.
- Thickness - 15mm to 50mm.
- Thermal conductivity - Not exceeding 0.021 W/mK at a mean temperature of 10oC.

PR_25_31_48_00.2120A FOIL FACED CLOSED CELL RIGID LAMINATED PHENOLIC FOAM (PF), DUCT INSULATION SLAB - CFC AND HCFC FREE:

- Standard - BS EN 13166.
- Nominal density - 40 kg/m3.
- Thickness - 20mm to 50mm.
- Thermal conductivity - Not exceeding 0.021 W/mK at a mean temperature of 10oC.
- Finish - Reinforced aluminium foil.

PR_25_31_48_00.2120B CLOSED CELL RIGID LAMINATED PHENOLIC FOAM (PF), DUCT INSULATION SLAB - CFC AND HCFC FREE:

- Standard - BS EN 13166.
- Nominal density - 40 kg/m3.
- Thickness - 20mm to 50mm.
- Thermal conductivity - Not exceeding 0.021 W/mK at a mean temperature of 10oC.

PR_25_31_48_00.2130A HIGH DENSITY PHENOLIC PIPE AND DUCT SUPPORT FOAM:

- Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Standard - BS EN 13166.
- Nominal density - 60 kg/m3 to 120 kg/m3.
- Temperature range: -180 to +120oC.
- Thermal conductivity - Not exceeding 0.040 W/mK at a mean temperature of 50oC.
- CFC and HCFC free.

PR_25_31_48_00.2140A CLOSED CELL NITRILE RUBBER ELASTOMERIC SHEET AND PREFORMED FLEXIBLE SECTIONS:

- Nominal density - 90 - 100 kg/m3.
- Temperature range: -40 to +105oC.
- Thickness
- Sections - 13mm to 25mm for pipe sizes 15mm to 100mm.
- Sheets - 6mm to 25mm.
- Thermal conductivity - Not exceeding 0.04 W/mK at a mean temperature of 20oC.

PR_25_31_48_00.2170A VAPOUR BARRIER PERMEANCE:

- Do not exceed the following permeance values for vapour barriers.
- Permeance values
- Cold water pipework - 0.05g/sMN.
- Chilled water pipework - 0.015g/sMN.
- Refrigeration pipework - 0.010g/sMN.

PR_25_31_48_00.2180A BITUMEN VAPOUR BARRIER COATINGS:
Cut-back bitumens with cotton canvas or open mesh glass cloth to reinforce coatings.

PR_25_31_48_00.2180B VINYL VAPOUR BARRIER COATINGS:
Vinyl emulsions with cotton canvas or open mesh glass cloth to reinforce coatings.

PR_25_31_48_00.2180C SOLVENT POLYMER VAPOUR BARRIER COATINGS:
Solvent-based polymers with cotton canvas or open mesh glass cloth to reinforce coatings.

PR_25_31_48_00.2180D BITUMEN EMULSION VAPOUR BARRIER COATINGS:
Bitumen emulsions (with or without elastomer latex) with cotton canvas or open mesh glass cloth to reinforce coatings.

PR_25_31_48_00.2190 ADHESIVES:
Comply with the recommendations of clause 8.2 of BS 5970, section 2 for insulation bonding adhesives, lagging adhesives; and facing and film attachment adhesives.

PR_25_31_48_00.2200A POLYISOBUTYLENE PROTECTION:
Minimum thickness 0.8mm.

PR_25_31_48_00.2200B ROOFING FELT PROTECTION:
Secure in position with galvanized wire netting, of 1mm x 25mm mesh. Finish with two coats of black bituminous paint.

PR_25_31_48_00.2200C FLAT ALUMINIUM-ZINC COATED STEEL PROTECTION:
Mild steel sheet continuously hot dipped with 185gm aluminium-zinc coating to BS EN 10327, applied directly to insulating material.

0.4mm thick flat sheet.

PR_25_31_48_00.2200D RIBBED ALUMINIUM-ZINC COATED STEEL PROTECTION:
Mild steel sheet continuously hot dipped with 185gm aluminium-zinc coating to BS EN 10327, applied directly to insulating material.

0.4mm thick ribbed sheet.

PR_25_31_48_00.2200E ALUMINIUM SHEETING PROTECTION:
Apply flat (embossed) or profiled aluminium cladding directly to insulating material. 0.56mm thick on pipework; 0.71mm thick on ductwork.

PR_25_31_48_00.2200I RIGID PVC PROTECTION:
0.35mm thick.

PR_25_31_48_00.2200J LAMINATED FOIL/FILM PROTECTION:
Enclose insulation with laminated foil/film around insulation and finish.

PR_25_31_48_00.2210A ALUMINIUM BANDS REINFORCEMENT:
Aluminium bands at 300mm centres.

PR_25_31_48_00.2230A ALUMINIUM PROTECTION FOR HEAT EXCHANGERS AND OTHER VESSELS:
Finish with 0.9mm thick aluminium ribbed or embossed sheeting, with lapped, riveted and sealed joints, laps to shed water. Seal all joints at manholes and stools. Fit cut-outs with purpose made over-plates or collars.

PR_25_31_48_00.2230B ALUMINIUM PROTECTION FOR HEAT EXCHANGERS AND OTHER VESSELS - WITH CHEST AND ACCESS COVERS:
Finish with 0.9mm thick aluminium ribbed or embossed sheeting, with lapped, riveted and sealed joints, laps to shed water. Seal all joints at manholes and stools. Fit cut outs with purpose made over-plates or collars.

Enclose chests and access covers in removable covers lined with high density flexible material. Remove manufacturer's name plate and re-fix on cladding.

PR_25_31_48_00.2230E MULTI-LAYER LAMINATE PROTECTION FOR HEAT EXCHANGERS AND OTHER VESSELS - WITH CHEST AND ACCESS COVERS:
Finish with self-adhesive weather resistant zero perm multi-layer laminate to encapsulate insulation, using the taped system as a quick and easy access point.

PR_25_31_48_00.2240A MINERAL FIBRE INSULATION FOR BOILER FLUES WITH ALUMINIUM CASING:
Use bonded mineral fibre preformed sections secured with aluminium bands direct to flue. Use multi-layers and stagger joints for thicknesses in excess of 65mm. Finish with 0.9mm thick aluminium ribbed or embossed sheeting.

PR_25_31_48_00.2260 PRE-INSULATED STORAGE VESSELS:
Ensure insulation standards on pre-insulated storage vessels meet the general specification requirements of the works.

PR_25_31_48_00.2280 PUMPS AND OTHER IRREGULAR SHAPES:
Where access is required to pumps and other irregular shapes submit proposals for materials and methods of applying a demountable finish, for approval.

PR_25_31_48_00.2285 CALCULATION OF INSULATION THICKNESS:
Provide insulation of thickness conforming to the values given in the tables on the pipe work schedule. These figures are derived from the tables given in BS EN ISO 12241.

PR_25_31_48_00.2287 CALCULATION OF INSULATION THICKNESS - ECA ENHANCED:
Provide insulation thickness conforming with ECA enhanced recommendations which are derived from the

maximum heat loss criteria provided for a 10 year payback within this specification using calculation methods given in BS EN ISO 12241.

PR_25_31_48_00.3010 GENERAL:
Carry out thermal insulation work using one of the scheduled firms employing skilled craftsmen conversant with class of work.

Do not apply thermal insulation until installation has been fully tested and all joints proved sound.

Ensure all materials are kept dry.

Ensure all pipework surfaces are dry before the installation of thermal insulation.

Insulate each unit separately. Do not enclose adjacent units together.

Ensure there is clearance between insulated pipes.

Application - Apply insulants, facings, coatings and protection strictly in accordance with manufacturer's instructions.

Finish - Neatly finish joints, corners, edges and overlaps and, where possible, arrange overlaps to fall on blind side. Ensure overlaps are neat and even and parallel to circumferential and longitudinal joints.

PR_25_31_48_00.3020 INSTALLATION OF FOIL FACED MINERAL WOOL INSULATION ON PIPEWORK:
Ensure joints are close butted together. Secure overlaps with adhesive or matching class 'O' tape, a minimum of 50mm wide, on both longitudinal and circumferential butt joints. Insulate fittings to same standard as adjacent pipework and use mitred segments where necessary, taped as above.

Where a vapour seal or fibre containment is required tape exposed insulation membrane and return to pipe surface.

Where insulation abuts pipe support inserts that have integral vapour barriers seal using class 'O' foil tape to continue vapour barrier or containment.

PR_25_31_48_00.3030 INSTALLATION OF FOIL FACED PHENOLIC FOAM INSULATION ON PIPEWORK:
Ensure joints are close butted together. Secure overlaps with adhesive or matching class 'O' tape, a minimum of 50mm wide, on both longitudinal and circumferential butt joints. Insulate fittings to same standard as adjacent pipework and use mitred segments where necessary, taped as above.

PR_25_31_48_00.3040 INSTALLATION OF INSULATION WITH CANVAS FINISH ON PIPEWORK:
Ensure joints are close butted together and secure overlaps with adhesive and smooth out. Insulate fittings to same standard as adjacent pipework and use mitred segments where necessary, secure with adhesive using a minimum of 50mm wide canvas to cut mitred joints.

Apply two coats of class 'O' polymer solution.

PR_25_31_48_00.3050 INSTALLATION OF CLOSED CELL NITRILE RUBBER INSULATION ON PIPEWORK:
Install closed cell nitrile rubber in accordance with manufacturer's recommendations.

Check installation procedure when closed cell nitrile rubber is to be installed on stainless steel pipework.

PR_25_31_48_00.3060 INSTALLATION OF FOIL FACED SEMI-RIGID SLAB INSULATION ON DUCTWORK:
Secure the insulation with adhesive in accordance with manufacturer's recommendations. Use insulation hangers spaced at maximum 300mm centres on the underside of ducts.

Cut slabs so that the top and bottom pieces overlap the sides. Seal joints and pin penetrations using 100mm wide class 'O' aluminium foil tape.

Where cut outs for test holes, etc. occur tape over insulation membrane and return to the duct surface.

Where insulation abuts duct support inserts that have integral vapour barriers seal using class 'O' foil tape to continue vapour barrier.

PR_25_31_48_00.3070 INSTALLATION OF FOIL FACED FLEXIBLE DUCTWORK INSULATION:
Secure the insulation with adhesive in accordance with manufacturer's recommendations. Use insulation hangers spaced at maximum 300mm centres on the underside of rectangular and flat oval ducts.

Seal joints and pin penetrations using 100mm wide class 'O' aluminium foil tape. Where cut outs for test holes, etc occur tape over insulation membrane and return to the duct surface.

Where insulation abuts duct support inserts that have integral vapour barriers seal using class 'O' foil tape to continue vapour barrier.

PR_25_31_48_00.3080 INSTALLATION OF FOIL FACED LAMELLA ON DUCTWORK:
Secure the insulation with adhesive in accordance with manufacturer's recommendations. Use insulation hangers spaced at maximum 300mm centres on the underside of rectangular and flat oval ducts.

Seal joints and pin penetrations using 100mm wide class 'O' aluminium foil tape. Where cut outs for test holes, etc occur tape over insulation membrane and return to the duct surface.

Where insulation abuts duct support inserts that have integral vapour barriers seal using class 'O' foil tape to continue vapour barrier.

PR_25_31_48_00.3090 INSTALLATION OF INSULATION ON TANKS:
Fit insulation so that two opposite pieces overlap the sides. Bond insulation to the tank with adhesive, applied in accordance with the manufacturer's recommendations. Closely butt together all slabs and seal joints with a matching self-adhesive tape 100mm wide.

PR_25_31_48_00.3100 INSTALLATION OF MINERAL WOOL INSULATION ON VESSELS:
Cut Lamella to length to wrap around duct with an additional 75mm to form an overlap. Remove insulation from facing of overlap together with dust, and seal overlap with adhesive in accordance with manufacturer's instructions. Butt joints closely together and seal with matching self-adhesive tape at least 100mm wide.

PR_25_31_48_00.3110 INSTALLATION OF PHENOLIC FOAM INSULATION ON VESSELS:
Use pre-formed segments or pre-slotted foil faced insulation to fit the diameter of the vessel, laid with staggered joints. Vapour seal the joint faces. Use jointing compound to fill and seal joints around protrusions.

Do not use wire to secure insulation.

Secure insulation segments up to 3500mm outside insulation diameter with filament tape 38mm wide at 300mm centres.

Secure insulation segments over 3500mm outside insulation diameter with aluminium banding.

PR_25_31_48_00.3120 INSTALLATION OF POLYISOBUTYLENE (PIB) PROTECTION:
Wrap pipework and fittings, ductwork or tanks and vessels with PIB sheeting lapped at every joint by at least 50mm. Solvent weld joints and support with banding in accordance with manufacturer's

Arrange joints to shed water and prevent the ingress of water.

PR_25_31_48_00.3130A INSTALLATION OF SHEET METAL FINISH ON PIPEWORK:
Secure insulation with metal bands at each end of section and at maximum centres of 450mm. Form sheet metal to fit tightly over the outer circumference of insulation with a longitudinal overlap of at least 40mm. Secure the outer part of overlap with self-tapping screws or rivets at centres of not more than 150mm. Not on pipes with vapour barrier; or metal bands of same material.

Ensure circumferential overlaps are at least 50mm, secured with self-tapping screws or rivets. Make provision to accommodate expansion and contraction at intervals. Ensure all joints are lapped to shed liquids and seal all joints exposed to weather or spillage. Cover all bends and fittings with matching sheet metal, tailored to fit and sealed as appropriate. Fit pre-insulated, purpose-designed boxes to valves, flanges, etc.

PR_25_31_48_00.3140A INSTALLATION OF SHEET METAL FINISH ON DUCTWORK, TANKS AND VESSELS:
Form sheet metal to fit tightly over the insulation with a longitudinal overlap of at least 40mm. Secure the outer part of overlap with self-tapping screws or rivets at centres of not more than 150mm. Not on vapour sealed ducts; or metal bands of same material.

Ensure circumferential overlaps are at least 50mm, secured with self-tapping screws or rivets. Make provision to accommodate expansion and contraction at intervals. Ensure all joints are lapped to shed liquids and seal all joints exposed to weather or spillage. Cover all bends and fittings with matching sheet metal, tailored to fit and sealed as appropriate.

PR_25_31_48_00.3150 INSTALLATION OF CANVAS PROTECTION:
Cover the whole with 4.5oz (minimum) canvas with at least 50mm overlaps. Seal joints.

Give two coats of class 'O' polymer solution. Fit aluminium bands where indicated.

PR_25_31_48_00.3160 INSTALLATION OF ROOFING FELT PROTECTION:
Apply directly to insulating material with an overlap of at least 50mm on all joints, made to shed water. Secure in position with galvanized wire netting, of 1mm x 25mm mesh. Finish with two coats of black bituminous paint.

PR_25_31_48_00.3170 INSTALLATION OF ALUMINIUM SHEETING PROTECTION:
Secure lapped joints (at least 40mm) by means of pop rivets at a maximum spacing of 150mm. For cold piping use matching aluminium straps at maximum spacing of 225mm. On piping operating below ambient temperature seal all joints against moisture. For external use make joints shed water and use sheets with treated surface.

Where `lockform' seams are used submit proposals for dealing with surfaces curved in three dimensions.

PR_25_31_48_00.3180 INSTALLATION OF ALUMINIUM-ZINC COATED STEEL PROTECTION:
Install aluminium-zinc coated steel protection, in accordance with manufacturer's instructions.

PR_25_31_48_00.3190 INSTALLATION OF RIGID PVC PROTECTION:
Apply rigid PVC sheet and pre-formed fittings directly to insulation with an overlap of at least 40mm on longitudinal and circumferential joints. Secure longitudinal laps with plastic rivets at 150mm centres.

Ensure rigid PVC is not installed in contact with heat sources.

PR_25_31_48_00.3195 INSTALLATION OF LAMINATED FOIL/FILM PROTECTION:
Install laminated foil/film protection, in accordance with manufacturer's instructions.

Ensure all surfaces are dry and clean, free from dust, oil and grease/silicone.

Arrange joints to give a water shed with the lap facing down.

PR_25_31_48_00.3200 INSTALLATION OF DUCTWORK FIRE PROTECTION INSULATION:
Install fire protection insulation on ductwork, in accordance with manufacturer's instructions.

PR_25_31_48_00.3210 FLANGES AND VALVES:
Cut back to allow removal of bolts and nuts; finish with neat bevel or use end caps.

Where boxes are used fit over insulation on adjacent piping. Ensure operation of valve remains unimpaired with box in place.

PR_25_31_48_00.3220 LINERS:
Where load bearing insulation is required use segmental liners suitable for temperature. Fit insulant up to liner and carry facing across the pipe ring.

PR_25_31_48_00.3230A INSTALLATION WHERE INSULATION IS CARRIED THROUGH PIPELINE SUPPORT:
For load bearing insulation, carry through insulation and finish.

For non-load bearing insulation on hot pipework close butt to a section of load bearing finished material 100mm long.

For non-load bearing insulation on cold pipework, close butt to high density phenolic foam pipe supports. Ensure the vapour barrier is maintained.

PR_25_31_48_00.3230B INSTALLATION WHERE CLOSED CELL INSULATION IS CARRIED THROUGH PIPELINE SUPPORT:
For load bearing insulation, carry through insulation and finish.

For non-load bearing insulation on hot pipework up to 120oC, close butt to a high density phenolic or polyisocyanurate pipe support.

For non-load bearing insulation on cold pipework, close butt to high density phenolic foam pipe supports.

Ensure the vapour barrier is maintained.

PR_25_31_48_00.3240 INSTALLATION WHERE INSULATION IS NOT CARRIED THROUGH PIPELINE OR DUCTLINE SUPPORT:
Provide end caps to match applied finish.

PR_25_31_48_00.3250 INSTALLATION WHERE INSULATION IS CARRIED THROUGH DUCTWORK SUPPORT:
Provide insulation between duct and support using high density phenolic foam strips. Butt insulation to spacer and carry over finish by 40mm and tape joint. Provide a sheet metal protecting sleeve.

PR_25_31_48_00.3260 LIQUID VAPOUR BARRIERS:
Apply vapour seal solution evenly by brush in accordance with manufacturer's instructions; use solution which dries to a colour distinctive from insulating material.

PR_25_31_48_00.3270 INTEGRITY OF VAPOUR BARRIERS:
Where a vapour barrier is indicated ensure its integrity throughout. Repair immediately any damage to vapour barriers and where such barriers have been applied off site, repair to manufacturer's instructions. Where aluminium sheeting is used for protection, submit proposals for securing sheeting without impairing the integrity of the vapour seal for approval.

PR_25_31_48_00.3280 WATER TANKS:
Arrange insulation and finish to allow removal of access covers and/or tank top.

17.0 AC_60_00_00_00 TESTING AND COMMISSIONING

AC_60_00_00_00.1000 GENERAL
AC_60_00_00_00.2010 PRESSURE TESTING - GENERAL:
Comply with procedures given in HVCA TR/6 Guide to Good Practice for Site Pressure Testing of Pipework. Ensure safety precautions detailed in HSE Guidance Note GS4 Safety in Pressure Testing are adopted.

Provide a blanked connection to accommodate a check gauge in addition to the accurate gauge fitted to section under test.

Test concealed or buried pipework before any permanent covering is applied.

Advise appropriate personnel, in advance, of the time pressure tests may be witnessed.

AC_60_00_00_00.2020 PRESSURE TESTING - WATER CIRCULATING AND SUPPLY SYSTEMS AND STEAM AND CONDENSE LINES:
Carry out Hydraulic Pressure Testing as described in HVCA TR/6 Guide to good Practice for Site Pressure Testing of Pipework. Test section by section for one hour, as the work proceeds and prior to application of thermal insulation as follows:

- Operating gauge pressure less than 3.5 bar, test gauge one and a half times operating pressure.
- Operating gauge pressure 3.5 - 7.0 bar, test gauge pressure twice operating pressure.
- Operating gauge pressure greater than 7.0 bar, test gauge pressure 14.0 bar or one and a half times operating pressure, whichever is the greater.

AC_60_00_00_00.2030# PRESSURE TESTING - UNDERGROUND PIPEWORK:
- Test to a gauge pressure not less than twice the operating pressure for 1 hour.
- Test to a gauge pressure twice the operating pressure or 7 bar, whichever is the greater, for 4 hours.

AC_60_00_00_00.2030A PRESSURE TESTING - UNDERGROUND PIPEWORK, 1 HOUR:
Test to a gauge pressure not less than twice the operating pressure for 1 hour.

AC_60_00_00_00.2030B PRESSURE TESTING - UNDERGROUND PIPEWORK, 4 HOURS:
Test to a gauge pressure twice the operating pressure or 7 bar, whichever the greater, for 4 hours.

AC_60_00_00_00.2040 PRESSURE TESTING - WATER MAINS:
Test to Local Authority requirements. Ensure the provisions laid down in HVCA TR/6 Guide to Good Practice for Site Pressure Testing of Pipework for testing underground CWS mains are carried out.

AC_60_00_00_00.2050 PRESSURE TESTING - FIRE RISERS:
Test hydraulically to a pressure of 10 bar (gauge) measured at the top outlet to maintain pressure for not less than 15 minutes. Demonstrate to Fire Brigade when tests are satisfactory. Carry out flow tests after satisfactory pressure testing.

AC_60_00_00_00.2055# PRESSURE TESTING - REFRIGERANT PIPEWORK:
- Test refrigerant pipework using the strength test procedure as detailed in Clause R6.4 of the CIBSE Commissioning Code R: 2002.
- Test refrigerant pipework using the leak test procedure as detailed in Clause R6.5 of the CIBSE Commissioning Code R: 2002.
- Test refrigerant pipework using the deep vacuum test method as detailed in Clause R6.6 of the CIBSE Commissioning Code R: 2002.

AC_60_00_00_00.2055A PRESSURE TESTING - REFRIGERANT PIPEWORK, STRENGTH PRESSURE TEST:
Test refrigerant pipework using the strength test procedure as detailed in Clause R6.4 of the CIBSE Commissioning Code R: 2002.

AC_60_00_00_00.2055B PRESSURE TESTING - REFRIGERANT PIPEWORK, LEAK TEST:
Test refrigerant pipework using the leak test procedure as detailed in Clause R6.5 of the CIBSE Commissioning Code R: 2002.

AC_60_00_00_00.2055C PRESSURE TESTING - REFRIGERANT PIPEWORK, DEEP VACUUM TEST:
Test refrigerant pipework using the deep vacuum test method as detailed in Clause R6.6 of the CIBSE Commissioning Code R: 2002.

AC_60_00_00_00.2060B PRESSURE TESTING - GAS PIPEWORK TO BS EN 12327:
Pressure test gas supply pipework in accordance with BS EN 12327.

AC_60_00_00_00.2060C PRESSURE TESTING - GAS PIPEWORK TO IGE/UP/1:
Comply with IGE/UP/1 Strength and tightness testing and direct purging of industrial and commercial gas installations.

AC_60_00_00_00.2060D PRESSURE TESTING - GAS PIPEWORK TO IGE/UP/1A:
Comply with IGE/UP/1A Strength and tightness testing and direct purging of small low pressure industrial and commercial Natural Gas installations.

AC_60_00_00_00.2065 PRESSURE TESTING - OIL PIPEWORK TO BS 5410:
Test oil pipework in accordance with BS 5410-2, Section 39.

AC_60_00_00_00.2070 PRESSURE TESTING - PIPED MEDICAL SERVICES:
Test in accordance with requirements of Health Technical Memorandum 2022.

AC_60_00_00_00.2080 PRESSURE TESTING - SOIL, WASTE, VENTILATION, ANTI-SYPHON AND RAINWATER PIPEWORK:
Test section by section as the work proceeds and subsequently on completion with all sanitary fittings fixed and working. Submit systems to two separate tests, Air test and Hydraulic Performance test in accordance with BS EN 12056-2.

AC_60_00_00_00.2090 PRESSURE TESTING - UNDERSLAB DRAINAGE:
Test section by section as the work proceeds and subsequently after completion of backfilling and compaction to the satisfaction of the Engineers and the local Authority.

Individually test sections which will be permanently embedded in the structure or concealed in ducts or voids.

Submit sections to two separate tests Water test and Test for Straightness and Obstruction in accordance with BS EN 752.

AC_60_00_00_00.2100 VACUUM TESTING:
Test vacuum mains in accordance with HVCA TR/6 Guide to Good Practice for Site Pressure Testing of Pipework, Table 1.

AC_60_00_00_00.2110 TESTING RECORDS:
Keep a systematic record of tests. Distribute records to CA/EA, the Client and any other interested parties.

AC_60_00_00_00.3010 CLEANING DUCTWORK SYSTEMS:
Clean ductwork before plant is first run, using access openings in ductwork.

AC_60_00_00_00.3020 COMMISSIONING CODES:
Carry out commissioning of installations in accordance with the procedures, checks and tolerances given in the BSRIA Application Guides for water systems and air systems to achieve the standards set in the CIBSE Commissioning Codes.

AC_60_00_00_00.3030A COMMISSIONING WATER DISTRIBUTION SYSTEMS INCLUDING BSRIA PRE-COMMISSIONING CHECKLIST:
Preliminary checks:

- Carry out checks and procedures as detailed in CIBSE Commissioning Code W, Section W1. Ensure system is statically complete as defined in BSRIA Guide BG 29/2021 Pre-Commissioning Cleaning of Pipework Systems.
- Use pre-commissioning checklist from BSRIA Guide 29/2021.

Setting to work and regulation - Set to work and regulate water distribution systems in accordance with CIBSE Commissioning Code W, Sections W2 and W3, and BSRIA Guide BG 2/2010.

Measurement - Use instruments for measurement detailed in BSRIA Guide 2/2010.

AC_60_00_00_00.3040A COMMISSIONING AIR DISTRIBUTION SYSTEMS INCLUDING BSRIA PRE-COMMISSIONING CHECKLIST:
Preliminary checks

- Carry out checks and procedures as detailed in BSRIA Guide BG 49/2015 Commissioning of air systems in buildings.
- Use pre-commissioning checklist in BSRIA Guide BG 49/2015.

Setting to work and regulation - Set to work and regulate air distribution systems in accordance with CIBSE Commissioning Code A, Section A2, and sections 7.2 and 9.1 in BSRIA Guide BG 49/2015.

Measurement of air flow - Use instruments for measurement and methods of measurement detailed in BSRIA Guide BG 49/2015 and CIBSE commissioning guide, section A3.

AC_60_00_00_00.3040B COMMISSIONING VAV AIR DISTRIBUTION SYSTEMS INCLUDING BSRIA PRE-COMMISSIONING CHECKLIST:
Preliminary checks:

- Carry out checks and procedures as detailed in CIBSE Commissioning Code A, Section A1. Ensure system is statically complete as defined in section 4 of BSRIA Guide BG 49/2015 Commissioning of air systems in buildings.
- Use pre-commissioning checklist in BSRIA Guide BG 49/2015.

Setting to work and regulation:

- Set to work and regulate air distribution systems in accordance with CIBSE Commissioning Code A, Section A2, and sections 7.2 and 9.1 in BSRIA Guide BG 49/2015.
- For regulation of Variable Air Volume Systems follow routine in BSRIA Application Guide 1/91 The Commissioning of VAV Systems.

Measurement of air flow - Use instruments for measurement and methods of measurement detailed in BSRIA Guide BG 49/2015 and CIBSE commissioning guide, section A3.

AC_60_00_00_00.3050 COMMISSIONING BOILER PLANT:
Follow the procedures laid down for carrying out Preliminary Checks and Start Operation in accordance with

CIBSE Commissioning Code B and manufacturers' instructions.

Apparatus and Instruments - Use Apparatus and Instruments detailed in CIBSE Commissioning Code B, Appendix B3.1. Apply tolerances defined in Appendix B3.2.

AC_60_00_00_00.3055 COMMISSIONING OF GAS PLANT AND SYSTEMS:
Commission gas fired plant on industrial and commercial premises in accordance with IGE/UP/4.

Commission gas supply systems in accordance with BS EN 12327.

AC_60_00_00_00.3060 COMMISSIONING REFRIGERATING SYSTEMS:
Follow the procedures given for use and handling of refrigerants, pressure and leak testing, evacuation and dehydration, charging and lubrication of refrigerating systems in CIBSE Commissioning Code R and manufacturer's instructions.

Pre-commissioning - Carry out the procedures for pre-commissioning detailed in CIBSE Commissioning Code R, Section R5.

Combined pressure and leak testing - Carry out the procedures for combined pressure and leak testing, including refrigerant charging, detailed in CIBSE Commissioning Code R, Section R6.

Setting to work and adjusting - Carry out the procedures for setting to work and adjusting detailed in CIBSE Commissioning Code R7.

Absorption Systems - Carry out the procedures for Preliminary Checks, Testing and Charging, and Setting to Work and adjusting detailed in CIBSE Commissioning Code R, Section R10.

Apparatus and Instruments - Use Apparatus and Instruments detailed in CIBSE Commissioning Code R, Section R8. Apply tolerances defined in Section R8.6.

AC_60_00_00_00.3070 COMMISSIONING AUTOMATIC CONTROL SYSTEMS:
Carry out commissioning of Automatic Control Systems in accordance with Manual prepared by the controls equipment manufacturer. Carry out the Checking and Setting-Up procedure detailed in the CIBSE Commissioning Code C, Section C1.

Measurement - Carry out measurements in accordance with CIBSE Commissioning Code C, Appendix C2.1.

AC_60_00_00_00.3080 COMMISSIONING PLANT ITEMS:
Comply with the manufacturer's recommendations for setting to work.

AC_60_00_00_00.3090A INSTRUMENTS AND GAUGES:
Ensure instruments are correctly calibrated. Record details of instruments on record sheets.

Submit evidence of correct calibration of instruments to be used in connection with commissioning and testing.

AC_60_00_00_00.3100A AIR SYSTEMS COMMISSIONING RECORDS TO BSRIA Guide BG 49/2015:
Keep a systematic record of commissioning results and distribute as indicated.

For air systems, use record sheets as described in BSRIA Guide BG 49/2015 Commissioning air systems in buildings.

AC_60_00_00_00.3100B WATER SYSTEMS COMMISSIONING RECORDS TO BSRIA BG 29/2021:
Keep a systematic record of commissioning results and distribute as indicated.

For water systems, use record sheets as detailed in BSRIA Guide BG29/2020 Commissioning water systems in buildings.

AC_60_00_00_00.3110 BMS COMMISSIONING - CONTROL SYSTEM SPECIFICATION DETAILS REQUIRED FOR COMMISSIONING:
Ensure that the following information is supplied to the commissioning engineer:

- A network schematic providing a record of the overall control system architecture.
- Schematics of the systems to be controlled indicating the location of sensors and actuators.
- A written description of the configured control strategies.
- Control strategy logic diagrams in the form of logic flow charts.
- Set-points and other control settings such as initial default parameters for control loops relating to the control strategies.
- Criteria relating to control accuracy and stability.
- A points list including digital inputs/outputs and analogue inputs/outputs.
- Control panel drawings.
- BMS operator workstation graphics and associated point data displaying monitored conditions.
- Trend logging archiving requirements and alarm routing.
- The scope of operational and specified functionality of management software, e.g. utility monitoring and targeting software.
- Functional requirements of any occupant interfaces.
- Details of any hard-wired interfaces from, or to, other control devices.
- Functionality and scope of data to be transferred over any gateway for use as part of an integrated system.
- Functional profiles for any direct interoperability integration.

Ensure that the following is included in the BMS commissioning specification:

- A clear description of the division of responsibility between the various parties.
- Off-site and on-site pre-commissioning procedures.
- On-site commissioning procedures.
- Requirements for assistance to air and water balancing testing (e.g. opening and closing control valves) and other plant tests where the controls need to be overridden.
- A requirement for any point-by-point verification of correct operation.
- Requirements for evaluation of control loop performance/loop tuning.
- Requirements for the BMS operator workstation for assistance in the commissioning of plant.
- Arrangement for the management of delays.
- Phased completion requirements.
- Requirements for demonstration/witness testing on the basis of a percentage of points or on a point-by-point basis. Ensure that the witnessing requirement includes the identification of those responsible.
- Requirement for software/configuration data back-up.
- Requirement for, and involvement in, any complete system and sub-system performance testing.
- Requirement for system documentation.
- Requirement for operator training requirements.
- Requirement for post occupancy checks.

AC_60_00_00_00.3120 BMS COMMISSIONING - PRE-COMMISSIONING:
Ensure that as much pre-commissioning work as possible is performed off-site:

Ensure that the following is followed:

Table 15 Pre-commissioning requirements

Pre-commissioning action	Pre-commissioning off-site

Control application software	Yes (final commissioning on-site)

User interface software	Yes (final commissioning on-site)

Control panels	Yes (final commissioning on-site)

Terminal units (fan coil units, etc.)	Yes (final commissioning on-site)

Wiring	No

Communications network	No

Sensors	No

Actuators	No

Integration gateways	Partial

Ensure that a record of all settings, set-points and offsets are maintained throughout the pre-commissioning period.

Ensure that all final physical adjustments to the field devices are indelibly marked.

Ensure that all packaged plant interfaced with the BMS is fully tested and commissioned by the manufacturer or installer.

Ensure that the BMS is pre-commissioned in accordance with the following requirements of CIBSE Code C (Commissioning of automatic control systems).

Table 16 CIBSE Code C automatic control systems pre-commissioning requirements

Pre-commissioning action	CIBSE Code C section reference
Control applications software	C5.2
Control panels	C5.3
Wiring	C5.4
Communications networks	C5.5
Sensors	C5.6
Actuators and valves	C5.7
Digital inputs/outputs	C5.8
Pneumatic actuation with microprocessor control	C5.9
Field control devices	C5.10

AC_60_00_00_00.3130A BMS COMMISSIONING - PLANT READY FOR CONTROL SYSTEM COMMISSIONING:
Confirm that the following plant commissioning has been performed before commencing the final BMS commissioning:

Water systems:

- The system is cleaned and flushed to remove any debris.
- All regulating, isolating and control valves in place and operating correctly.
- That all flow measuring devices are in place and in the correct location for accurate measurement (including pressure tappings).
- The system is vented.
- That the proportional balancing is completed to obtain the branch flow rates in the correct ratio to each other (or through the use of and setting of self-balancing valves).
- That the pump flow rate has been adjusted to provide the specified flow rate.

Air systems:

- Debris has been removed from the air distribution system.
- That dampers are in the correct location and fully functional.
- That fire/smoke dampers open.
- Test holes have been drilled and sealed with removable plugs.
- That in-situ flow measuring devices have been installed.
- Ductwork air leakage testing has been performed (if specified).
- Completion of proportional balancing of regulating dampers so that terminals share the air flow in the correct proportions.
- Regulation of the fan(s) to provide the specified flow rate.

Packaged equipment:

- Ensure that plant and controls have been fully commissioned and are functional, ready for integration with other plant/systems.
- That control equipment inputs/outputs are in the specified format for connection to the main control system.

Confirm that the plant is commissioned in accordance with:

- Air distribution systems, CIBSE Code A
- Boiler plant, CIBSE Code B
- Refrigeration systems, CIBSE Code R
- Water distribution systems, CIBSE Code W
- Commissioning water systems. Application principles, AG 89.3/2, BSRIA
- Commissioning air systems. Application systems for buildings, AG 89.3/3, BSRIA.

AC_60_00_00_00.3140 BMS COMMISSIONING - CONTROL SYSTEM REQUIREMENTS FOR PLANT COMMISSIONING:
Ensure that the BMS is pre-commissioned to allow the building services plant to operate under "manual" running conditions.

Ensure that the control valves can be manually set in their fully open position to allow the balancing of pipework flows.

Ensure that dampers can be manually opened to allow the commissioning of air systems.

AC_60_00_00_00.3150 BMS COMMISSIONING:
Ensure that the BMS is commissioned in accordance with the following requirements of CIBSE Code C (Commissioning of automatic control systems).

- Control strategy checking - C6.2
- Checking procedures for basic control functions - C6.3
- Lighting controls - C6.4
- Operator workstations - C6.5
- Occupant interfaces - C6.6
- Communication networks - C6.7
- Integrated systems - gateways - C6.8
- Integrated systems - direct interoperability - C6.9
- Integration with fire detection systems - C6.10
- Security systems - C6.11
- Interruption of electrical power supplies - C6.12
- Valves - C7.1
- Dampers - C7.2
- Fans - single speed - C7.3
- Fans - variable speed - C7.4
- Pumps - C7.5

AC_60_00_00_00.4010 SYSTEM PERFORMANCE TESTING:
Demonstrate the performance of installations including single, standby, multi-duty plants and systems, and of plants specified for future use.

AC_60_00_00_00.4015 TESTING OF RESIDENTIAL VENTILATION SYSTEMS:
Demonstrate the performance of residential ventilation systems through performance testing and installation checks in accordance with BS EN 14134.

AC_60_00_00_00.4020# ENVIRONMENTAL TESTS:
- Carry out environmental testing to prove the performance of the systems.
- Apply artificial loads or provide test arrangements to simulate the full range of operating conditions and duties.
- Carry out ambient air quality tests in accordance with BS EN 13528-1, BS EN 13528-2 and BS EN 13528-3.

AC_60_00_00_00.4020A ENVIRONMENTAL TESTS, ARTIFICIAL LOADS:
Carry out environmental testing to prove the performance of the systems.

Apply artificial loads or provide test arrangements to simulate the full range of operating conditions and duties.

AC_60_00_00_00.4020B ENVIRONMENTAL TESTS, AMBIENT AIR QUALITY
Carry out environmental testing to prove the performance of the systems.

Carry out ambient air quality tests in accordance with BS EN 13528-1, BS EN 13528-2 and BS EN 13528-3.

AC_60_00_00_00.4030 RECORDERS:
- Seven day space temperature recorders
- Number
- For (weeks)
- Relative humidity recorders
- Number
- For (weeks)

Provide and maintain on free loan portable seven day space temperature and relative humidity recorders, as indicated, together with adequate charts.

AC_60_00_00_00.4040 TESTING TO SPECIFIED CONDITIONS:
AC_60_00_00_00.4040A RAINWATER SYSTEMS:
Demonstrate by flow tests that the systems give satisfactory performance.

AC_60_00_00_00.4040B SANITARY SYSTEMS:
Comply with performance tests given in BS EN 12056.

AC_60_00_00_00.4040C COLD WATER SYSTEMS:
Demonstrate that outlets supply adequate rates of flow.

AC_60_00_00_00.4040D FIRE FIGHTING SYSTEMS:
Comply with requirements of the local Fire Authority and with the appropriate section of BS 5306.

AC_60_00_00_00.4040E HYDRAULIC SYSTEMS:
Comply with requirements as indicated within the main specification.

AC_60_00_00_00.4040F MEDICAL GAS AND AIR SYSTEMS:
Comply with Health Technical Memorandum 2022.

AC_60_00_00_00.4040G LABORATORY AND INDUSTRIAL SYSTEMS:
Comply with requirements as indicated within the main specification.

AC_60_00_00_00.4040H GAS SYSTEMS:
Comply with the requirements of the local Authority.

AC_60_00_00_00.4040I SILENCERS AND ACOUSTIC TREATMENT:
Demonstrate by measured tests that noise criteria indicated have been achieved.

AC_60_00_00_00.4040J ACOUSTIC ENCLOSURES:
Demonstrate that measured air leakage complies with scheduled values.

AC_60_00_00_00.4050 PERFORMANCE TEST RECORDS:
Keep a systematic record of tests. Distribute records to the CA/EA, the Client and any other interested party.

18.0 PR_80_77_94_00 VIBRATION ISOLATION MOUNTINGS

PR_80_77_94_00.1000 GENERAL
PR_80_77_94_00.1010 DESIGN INTENT
Supply equipment indicated to ensure that vibration from equipment is not transmitted to building, other supporting structure, pipework or ductwork.

PR_80_77_94_00.1020 SPRING ANTI VIBRATION MOUNTINGS
Select spring mounts with an overload capacity of 50%, for metal springs the outside diameter should be at least 75% of operating height. Permanently identify individual mounts with their load capacity.

PR_80_77_94_00.1030 SPRING HANGERS
Provide spring hangers that allow the lower hanger rod to move laterally at least 15°.

PR_80_77_94_00.1040 LOCKING FACILITY
Where indicated, provide lockable levelling device.

PR_80_77_94_00.2010A SYNTHETIC MATERIAL CONFIGURED MAT MOUNTINGS
Provide configured mat mountings manufactured from neoprene or composite fibre/synthetic rubber.

Where mats are stacked, bond 1mm steel sheet thickness between each pad without filling voids.

PR_80_77_94_00.2010B NATURAL RUBBER CONFIGURED MAT MOUNTINGS
Provide configured mat mountings manufactured from natural rubber.

Where mats are stacked, bond 1mm steel sheet thickness between each pad without filling voids.

PR_80_77_94_00.2010C HIGH TEMPERATURE CONFIGURED MAT MOUNTINGS
Provide configured mat mountings manufactured from high temperature synthetic rubber.

Where mats are stacked, bond 1mm steel sheet thickness between each pad without filling voids.

PR_80_77_94_00.2010D RESILIENT MAT MOUNTINGS
Provide a minimum of 20mm resilient mat and sheet of 1.6 mm steel for incorporation in cast in situ base.

PR_80_77_94_00.2010E PAD MOUNTINGS
Provide pad mountings manufactured from composite synthetic rubber.

PR_80_77_94_00.2020A SYNTHETIC RUBBER TURRET COMPRESSION MOUNTINGS
Provide turret compression mountings fabricated from synthetic rubber between two steel plates.

Protect the metal from corrosion by painting and fix friction pads to top and bottom. Provide bolt holes to allow fixing.

PR_80_77_94_00.2020B NEOPRENE TURRET COMPRESSION MOUNTINGS
Provide turret compression mountings fabricated from neoprene between two steel plates.

Protect the metal from corrosion by painting and fix friction pads to top and bottom. Provide bolt holes to allow fixing.

PR_80_77_94_00.2030 SPRING COMPRESSION MOUNTINGS
Provide spring compression mountings comprising high strength low stress helical spring capped with steel pressure plate, on resilient base pad, mounted on pre-drilled base for bolting down, and enclosed with cap. Protect metal from corrosion.

PR_80_77_94_00.2040 CAPTIVE SPRING MOUNTINGS
Provide captive spring mountings comprising high strength low stress helical spring designed to achieve horizontal and vertical snubbing.

Mount spring on pre-drilled base plate for bolting down and protect against corrosion. Supply complete with levelling screw.

PR_80_77_94_00.2050A SYNTHETIC RUBBER HANGERS, TURRET COMPRESSION:
Provide turret compression hangers fabricated from synthetic rubber incorporated with hanger box.

Construct hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

PR_80_77_94_00.2050B NEOPRENE HANGERS, TURRET COMPRESSION:
Provide turret compression hangers fabricated from neoprene incorporated within hanger box.

Construct hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

PR_80_77_94_00.2060 SPRING COMPRESSION HANGERS:
Provide spring compression hangers comprising high strength low stress helical spring capped with steel pressure plate, on resilient base pad, mounted within hanger box.

Construct hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

PR_80_77_94_00.2070A SYNTHETIC RUBBER HANGERS, COMBINED TURRET/SPRING COMPRESSION:
Provide turret/spring compression hangers with turret fabricated from synthetic rubber and high strength low stress helical spring capped with steel pressure plate, on resilient base pad, incorporated within hanger box.

Construct hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

PR_80_77_94_00.2070B NEOPRENE HANGERS, COMBINED TURRET/SPRING COMPRESSION:
Provide turret/spring compression hangers with turret fabricated from neoprene and high strength low stress helical spring capped with steel pressure plate, on resilient base pad, incorporated within hanger box.

Construct hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

PR_80_77_94_00.2080 HORIZONTALLY RESTRAINED SPRING MOUNTINGS:
Provide horizontally restrained spring mountings comprising high strength low stress helical spring capped with steel pressure plate, on resilient base pad, mounted within hanger box.

Construct hanger box from steel (minimum thickness 1.6mm) complete with holes for installing across connection. In addition supply synthetic rubber or neoprene snubber as a horizontal buffer.

PR_80_77_94_00.2090A CONCRETE/STEEL FORMWORK INERTIA BASES:
Provide purpose built inertia bases constructed using welded steel frame formwork containing concrete reinforced with 12mm minimum diameter bars at 100mm maximum centres, 35mm above the bottom of the base; and mounted on spring compression mountings.

PR_80_77_94_00.2090B WELDED STEEL FRAME INERTIA BASES:
Provide purpose built inertia bases constructed using welded steel frame mounted on spring compression mountings.

PR_80_77_94_00.2110A NATURAL CORKWOOD PIPEWORK NOISE VIBRATION ISOLATION:
Incorporate within pipework support ring purpose made isolators manufactured from natural corkwood of density 160 kg/cubic metre, impregnated with fungicide, individually bound with steel strip not more than half depth of isolator.

PR_80_77_94_00.2110B RECONSTITUTED CORKWOOD PIPEWORK NOISE VIBRATION ISOLATION:
Incorporate within pipework support ring purpose made isolators manufactured from resin bonded reconstituted soft corkwood granules, of density 100 kg/cubic metres.

PR_80_77_94_00.2110C RUBBER MATTING PIPEWORK NOISE VIBRATION ISOLATION:
Incorporate within pipework support ring purpose made isolators manufactured from rubber matting.

PR_80_77_94_00.2120A SPONGE FOAM PIPE WALL AND RISER SEALS:
Provide pipe sleeves, minimum length 300mm, with minimum 25mm dense sponge foam lining bonded internally.

PR_80_77_94_00.2120B MINERAL FIBRE PACKING PIPE WALL AND RISER SEALS:
Provide pipe sleeves, minimum length 300mm, with minimum 52mm mineral fibre packing lining bonded internally.

PR_80_77_94_00.3010 GENERAL:
Install vibration isolation equipment and carry out levelling of equipment in accordance with manufacturer's instructions.

PR_80_77_94_00.3020 CAST IN SITU BASES:
Ensure bases are cast to achieve design static deflection.

PR_80_77_94_00.3030 FIXING:
Fix down vibration isolation mountings only where indicated.

PR_80_77_94_00.3040 HORIZONTALLY RESTRAINED SPRING MOUNTINGS:
Ensure snubbers for limiting excessive movement are installed out of contact during normal operation.

19.0 PR_40_10_57_26 IDENTIFICATION - MECHANICAL

PR_40_10_57_26.1000 GENERAL
PR_40_10_57_26.1010 REQUIREMENTS:
Identify all pipework, ductwork, equipment, appliances and ancillaries comprising the various systems.

54.1020 NEW SYSTEMS:
Comprehensively label and colour code throughout works.

PR_40_10_57_26.1030 EXISTING SYSTEMS:
Where identification details are incompatible with those required for new systems, obtain approval to mode of cross referencing.

PR_40_10_57_26.1040 COLOURS:
To colour ranges given in BS 381C and BS 4800.

PR_40_10_57_26.1045 PERFORMANCE AND DURABILITY:
Ensure durability of identification for safety purposes is to BS ISO 17398.

PR_40_10_57_26.2010 PIPEWORK IDENTIFICATION:
Standards - Colour code and label to BS 1710.

Primary Identification

- Apply colour bands, 300mm wide, to each pipe at least
    - Once in every room or enclosed area.
    - At intervals not exceeding fifteen metres.
    - At every junction.
    - At every valve.
    - At every inspection and access position into service shafts, false ceilings, bulkheads etc.

Secondary Identification

- Apply colour bands, 50mm wide, and superimpose a legend identifying circuit, direction of fluid or gas flow, nominal pipe bore and, where appropriate, fluid or gas pressure.

Legends

- Apply to colour bands by transfers of an approved type.

PR_40_10_57_26.2020 DUCTWORK IDENTIFICATION:
Standards - Generally colour code and label to HVCA Specification DW 144 (Appendix B).

Primary Identification

- Apply colour bands, 300mm wide, to each duct at least
    - Once in every room or enclosed area.
    - At intervals not exceeding fifteen metres.
    - At every junction.
    - At every damper.
    - At every inspection and access position into service shafts, false ceilings, bulkheads etc.

Secondary Identification

- For ducts with longest side or diameter up to and including 225mm. Paint colour bands 50mm wide and superimpose legends.

- For ducts with longest side or diameter over 225mm. Paint or apply transfers to identification triangles, or triangular plates. Superimpose or incorporate legends.

Triangular Plates

- Attach to buckle bands or stool pieces and fix to ducting, with apex indicating direction of airflow. Submit details of plates and fixings for approval before painting and marking. Use equilateral triangle of side 150mm minimum.

Legends

- Apply transfers of an approved type to colour bands or triangles or triangular plates. Identify floor and space served, associated equipment reference and direction of airflow.

PR_40_10_57_26.2030B PLANT AND EQUIPMENT IDENTIFICATION, LAMINATED PLATES:
Standards

- Identify each item of equipment by name and, where appropriate, by agreed reference characters. Provide colour identification as called for in work sections and, in all cases, colour firefighting equipment red.

Identification Colours

- Use primary and secondary identification colours of associated system.

Plates

- Use rectangular metal or laminated plastic, securely fixed to each item of equipment.

Lettering

- Laminated plates, multi-coloured with outer layer removed for lettering.

Legends

- Engrave plates with an approved text. Incorporate operating duty of equipment where this is not incorporated in other labelling.

PR_40_10_57_26.2035 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416:
Graphical symbols for use on equipment to be created and applied in accordance with BS EN 80416-1, BS EN 80416-2, BS EN 80416-3.

PR_40_10_57_26.2040 VALVE AND COCK IDENTIFICATION:
Standards

- Identify each valve, cock, stop valve, air vent, drain cock etc. with disc engraved with numerical reference. Except where exposed in occupied areas.

Identification Colours

- Use primary and secondary identification colours of associated system for painted or self colour discs.

Discs

- Securely attach metal or laminated plastic discs, minimum diameter 35mm, to each item.

Legends

- Engrave discs with permanent characters, minimum height 6mm.

Incorporate in operating instructions relating to regulating valves and flow measuring equipment, details of flow rate, pressure differential and setting, as appropriate.

PR_40_10_57_26.2070 AIR VOLUME REGULATING AND CONTROL DAMPER IDENTIFICATION:
Standards

- Identify each regulating and control damper. Except where exposed in occupied areas. On ductwork dampers, clearly indicate commissioning set point.

Identification colours

- Use primary and secondary identification colours of associated system for painted or self colour discs.

Discs

- Securely attach metal or laminated plastic discs, minimum diameter 35mm, to each item.

Legends

- Engrave discs with permanent characters, minimum height 6mm.

PR_40_10_57_26.2080 INSTRUMENT IDENTIFICATION:
Standards

- Identify each instrument by name and, where appropriate, by agreed reference characters.

Plates

- Use rectangular metal or laminated plastic, securely fixed to each instrument.

Legends

- Engrave plates with an approved text.

PR_40_10_57_26.2090 DANGER AND WARNING NOTICES:
Hazardous Systems

- Colour code and label hazardous systems and equipment to requirements of Health and Safety Executive Guidance Notes.

PR_40_10_57_26.2100A SYSTEM IDENTIFICATION INSTALLATION CHARTS, PERSPEX GLAZED FRAME:
System Schematics

- Supply and fix a referenced schematic diagram (or diagrams) of all systems as installed, including equipment and ancillary schedules. Show scheduled information on diagram.
- Identify all items by appropriate reference characters.

Control Schematics

- Supply and fix a referenced schematic diagram (or diagrams) of all control systems as installed, including equipment and ancillary schedules. Show scheduled information on diagram.
- Identify all items by appropriate reference characters.

Location

- Fix in each boiler house, calorifier room, plant room or equipment room.

Finish

- Perspex sheet glazing with surrounding frame and mounting attachments.

20.0 PR_65_70_11_00 CONDUIT AND CABLE TRUNKING

PR_65_70_11_00.1000 GENERAL
PR_65_70_11_00.1010 STANDARDS:

- Provide conduit and cable trunking in accordance with the manufacturers installation requirements, the relevant British Standards and in particular the requirements of BS 7671 (18th Edition) Requirements for Electrical Installations (The IET Wiring Regulations).

PR_65_70_11_00.2010A CONDUIT SYSTEMS METAL RIGID All CLASSES

- Provide conduit systems to BS EN 61386. Use conduit of each type from one manufacturer.
- Material - Metal, steel.
- Method of connection - Threadable.
- Suitability for bending - Rigid, BS EN 61386-21.
- Electrical characteristics - with electrical continuity.
- Resistance against corrosive or polluting substances

PR_65_70_11_00.2010A CONDUIT SYSTEMS METAL RIGID CLASS 2:

- Conduits with same protection outside and inside BS EN 61386-1 Table 10 Class 2
- Medium protection
- e.g. stove enamel or air drying paint.

PR_65_70_11_00.2010B CONDUIT SYSTEMS METAL RIGID CLASS 4:

- High protection - Hot dip zinc coating. BS EN 61386-1 Table 10 Class 4.

PR_65_70_11_00.2010E CONDUIT SYSTEMS - NON-METALLIC RIGID:

- Electrical characteristics - Without electrical insulating characteristics.

PR_65_70_11_00.2010F CONDUIT SYSTEMS - NON METALLIC FLEXIBLE:

- Provide conduit systems to BS EN 61386. Use conduit of each type from one manufacturer.
- Material - Insulating, PVC.
- Method of connection - threadable or non-threadable.
- Suitability for bending - Flexible, BS EN 61386-23.
- Electrical characteristics - Without electrical insulating characteristics.

PR_65_70_11_00.2020A RIGID CONDUIT SYSTEM - METALLIC CONDUIT

- Use couplers to match conduit grade and finish.
- Use solid couplers to join lengths of conduit unless inspection couplers are shown on the drawings or schedules.
- Conduit fittings and adaptable boxes
- Material - Malleable iron adaptable boxes – not spot welded strip formed boxes.
- Do not use factory made bends, inspection bends or inspection couplers unless shown on drawings or schedules.
- Ensure fittings are same class and finish as associated conduit system.
- Supply covers for circular or adaptable boxes in the same material and finish as boxes.
- Use steel dome or cheese headed screws to secure covers for Class 2 finish.
- Use brass dome or cheese headed screws to secure covers for Class 4 finish.
- Limit number of entry holes within loop-in boxes to four.
- Adaptable box, minimum size - 100mm x 100mm x 50mm.
- Connections
- Use couplers and externally screwed brass bushes to connect conduit to loop-in circular conduit boxes, switchgear, distribution boards, and adaptable boxes. Use solid couplers.
- Conduit fixing saddles - Spacer bar.
- Plugs - Hexagonal malleable iron.
- Locknuts - Hexagonal steel.

PR_65_70_11_00.2030A RIGID CONDUIT SYSTEM - INSULATING CONDUIT:

- Do not use slip joints. Use expansion couplings as required. Use solvent solution connections.
- Use boxes and connections to suit size of conduit and method of jointing.
- Use heavy gauge, high impact rigid PVC conduit fittings.
- Provide all boxes for supporting luminaires or other heavy devices with metal brackets or insert clips to provide a support independent of the box.
- Provide boxes for flexible conduit, accessories and luminaire connection with a brass earthing terminal and/or steel circular earthing ring.
- Conduit fixing saddles - Spacer bar or hospital.
- Plugs - Spout entry plug.

PR_65_70_11_00.2050A PLIABLE OR FLEXIBLE CONDUIT SYSTEMS - NON-METALLIC:

- Method of connection - Threadable conduit.
- Use plastic adaptors and bushes.
- Use male adaptors to connect flexible conduit to motors and other equipment having a threaded entry.
- Use female adaptors and externally screwed bushes to connect flexible conduit to trunking and equipment not having a threaded entry.

PR_65_70_11_00.2090B METAL SURFACE TRUNKING - ZINC FINISH:

- Material
    - Steel trunking to BS EN 50085. Supply partitions and covers in the same material as trunking.
    - Gauge of metal - BS EN 50085.
- Style
    - Use trunking manufactured with inward return edge flanges and fitted with flange couplers which ensure that when the cover is removed a minimum of 80% of the nominal trunking or compartment width is available for access.
    - Protection to BS EN 50085
    - Electroplated zinc having a minimum thickness of zinc coating of 0.0012mm inside and outside.
    - Hot dip zinc coated steel to BS EN 10327 or BS EN 10143.
    - Colour - Self Colour or Manufacturer's standard.
- Fixings
    - Use purpose made brackets to fix to structural steel or suspension rods.
    - Provide external fixing lugs where specified protection for the installation is IP44 or greater.
- Fittings
    - Use bends, tees and angles of similar gauge, type and finish as trunking body and supplied by same manufacturer.
- Partitions and Covers
    - Ensure partitions are electrically continuous with the body of the trunking or provide a connector for a circuit protective conductor.
    - Ensure gap between partitions and lids maintains segregation of circuits.
    - Provide individual mounting plates for each accessory mounted on trunking covers.
- Joints
    - Use purpose made jointing pieces fixed with screws into captive nuts. Ensure screws do not protrude through the nuts.
    - Ensure rigidity of trunking is maintained across joint.
    - Ensure external dimensions of trunking are maintained and not reduced by more than 4% across joints between trunking lengths and/or fittings.
    - Use purpose made fittings of the same manufacture where trunking connects to switchgear and distribution boards.
    - Provide flanges for connection of flush floor trunking to vertical trunking to maintain the cross sectional area of compartments with 50 mm minimum radius.
    - Maintain electrical continuity at each joint by a copper link, (tinned copper for galvanized trunking), fixed on outside of trunking, secured by screws, nuts and shakeproof washers. Screws must not project through the nut. Make provision for continuity to be achieved

without need to remove paint from ferrous metal where trunking has a painted finish.

- Screws, Nuts, Washers
  - Do not use self-tapping screws. Use cheese or round head screws except where provision is made for the use of counter-sunk heads.
- Material
  - Use steel zinc coated
- Cable supports
  - Provide horizontal trunking with removable cable retainers or bridges to retain cables in situ.
  - Provide vertical trunking with pin racks to support cables at 3000 mm maximum spacing.
  - Use insulated pins or insulation sleeved pins on pin racks.

PR_65_70_11_00.2090D FLUSH FLOOR TRUNKING:

- Trunking bodies
  - Supply trunking bodies complete with flanged connections for service outlet boxes.
  - Provide robust screwed levelling device to ensure that the trunking does not more during flooring activities.
  - Secure covers to trunking body using countersunk brass screws with slots, crosshead or hexagon key heads or steel cam locking devices for use with a removable tool.
  - Provide cork gasket or equivalent between cover and flange for sound deadening.
  - Where embedded in screed or a slab seal the trunking and associated floor boxes to prevent the egress of slurry.
- Trunking lids
  - Provide for trunking body recessed lids to suit applied floor finish.
  - Ensure securing devices on recessed covers are accessible without removing applied floor finish.

PR_65_70_11_00.2090E STEEL DADO TRUNKING:

- Material steel - BS EN 50085.
- Wall/dado trunking - three compartment.
- Installation - surface.
- Use trunking manufactured within ward return edge flanges and filled with flange couplers, which ensure that when the cover is removed a minimum of 80% of the nominal trunking or compartment width is available for access.

PR_65_70_11_00.2100A UNDERFLOOR STEEL TRUNKING:

- Trunking material
  - Sheet steel trunking to BS 4678-2.
- Gauge of Metal - BS EN 50085.
- Degree of Protection - Class 3.
- Connection to vertical trunking
  - Provide flanges for connection of vertical trunking and temporary blanking plates.
  - Maintain cross sectional area of compartments with 50 mm minimum radius for connections to vertical trunking.
  - Provide flyovers to ensure compartment segregation at all tees and cosses.
- Trunking bodies
  - Supply trunking bodies complete with flanged connections for service outlet boxes.
  - Provide robust screwed levelling device to ensure that the trunking does not more during flooring activities.
  - Where embedded in screed or a slab seal the trunking and associated floor boxes to prevent the egress of slurry.

PR_65_70_11_00.2110A TRUNKING SERVICE OUTLET BOXES:

- Provide service outlet boxes and junction boxes constructed from sheet steel with same finish as trunking.
- Maintain continuity and segregation of compartments through boxes and fit flyovers where necessary.
- Provide service outlet boxes with separate and segregated access to outlets associated with each

wiring compartment. Fit cable guard or grommet to each section and any penetrations through the trunking, service box body.
- Incorporate spigots on boxes for connection to trunking.
- Make frames adjustable on each corner.
- Recess all lids into the service box frame to ensure that the lid is flush with the final finished floor level.
- Manufacture frame and lids for service outlet boxes and junction boxes of cast metal, and suitable to accept the type of flooring used in the area where the service box is installed.
- Outlet plates
    - Provide outlet plates for each low voltage compartment equipped with socket outlets.
    - Provide outlet plates for each extra low voltage compartment equipped with items.
    - Provide outlet plates for each information technology compartment that ensures the IT compartment and its outlet plate conform to the requirements of BS EN 50174 and of the IT system installer, equipped with suitable outlets.
    - Provide blank outlet plates for any unused compartments.

PR_65_70_11_00.2120A POWER POLES:
- Provide service poles complete with associated conduit or trunking fittings. Maintain continuity and segregation of circuits throughout. Provide outlet boxes with separate access to wiring compartments.
- Standard - BS EN 50085-2-4.
- Material - Extruded Aluminium.
- Finish - Manufacturer's standard.
- Fixings - Free standing or complete with fixing brackets at top.

PR_65_70_11_00.2130C PVC DADO TRUNKING - GENERAL PURPOSE:
- Trunking to BS 4678-4
    - Mechanical properties, trunking for medium mechanical stress.
    - Temperature tolerances - BS 4678-4, Table 1.
- Electrical characteristics
    - Without electrical insulating characteristics.
- Resistance against ingress of solid objects
    - Protected against solid objects greater than 1.0mm (IP4X).
- Resistance to ingress of water
    - Protected against dripping water (IPX2).
- Resistance against corrosive or polluting substances
    - Medium protection.
- Fittings
    - Use fittings from same manufacturer as trunking. Use 'snap-on' covers. Use trunking fittings and accessories suitable for jointing by solvent welding.
    - Use proprietary cable retaining clips at 500mm maximum intervals on trunking that exceeds 1.8m in length. Where junctions occur ensure first clip is not more than 300mm from junctions.

PR_65_70_11_00.2150A SEPARATE OR MULTI-COMPARTMENT TRUNKING:
- Use separate trunking or multi-compartment trunking for segregation of services. Ensure steel partitions have a provision for connecting a circuit protective conductor.
- Any penetrations through trunking elements are to be fitted with a grommet to prevent cable damage.
- Provide separation of wiring for circuits as required by BS 7671.

PR_65_70_11_00.2170 SUPPORTS AND FIXINGS:
- Provide proprietary suspension systems comprising channel sections with return lips and compatible fixing accessories made of material to BS EN 10162, BS EN 10210 and/or slotted angles to BS 4345.
- Ensure support components for Class 4 conduit have the same finishing method as the conduit carried out after manufacture. Ensure components in direct contact with conduit match profile of conduit.
- Ensure all steel components such as studding, bolts and steel screws, bolts, nuts and washers are

either cadmium plated and passivated or zinc electroplated to BS 7371 after manufacture. Do not use metal fixing components likely to deteriorate and/or cause damage through electrolytic action.

PR_65_70_11_00.3010A GENERAL:

- Ensure entire system is electrically and/or mechanically continuous, to BS 7671.
- Fire barriers
    - Comply with the requirements of BS 7671 wherever the conduit or trunking passes through the perimeter of a fire compartment (wall, floor or ceiling).
- Appearance
    - Arrange conduit, trunking and ducting to present neat appearance, parallel with other service runs and lines of building construction, except where in screed or in-situ concrete. Ensure plumb vertical runs.
- Cable installation
    - Install cable in conduit, trunking or equipment enclosures only when completely erected throughout its length.
    - Do not use framework of partitions or similar unless indicated.
- Building expansion and settlement
    - Make provision in conduit and trunking at expansion and settlement joints to allow for movement of building structure. Provide circular through or adaptable boxes no more than 300 mm either side of expansion or settlement joints for conduit crossing.
    - Join boxes with flexible steel conduit type C or conduits arranged to form a telescopic joint and cover overall with PVC sleeve to provide minimum degree of protection of IP44 or purpose made telescopic joint protected by a PVC sleeve to at least IP44.
- Quality
    - Cut conduit clean and square with axis. Remove any burrs prior to erection.
    - Site form 90^{O} in conduit wherever practical or use circular or adaptable boxes.
    - Construct bends and sets cold with a bending machine. Do not apply heat when forming sets or bends.
    - Use bending tools complying with British Standards appropriate to conduit material.
    - Ensure no indentation or reduction in cross sectional area occurs during installation.
    - Use correct tools to assemble conduit. Ensure no toolmarks or damage to components occurs.

PR_65_70_11_00.3020 LAYOUT:

- Ensure the maximum circuit lengths and groupings of cables indicated are not exceeded.
- Conduit sizing
    - Where dimensions are not indicated select trunking and conduit sizes in accordance with Appendix A of Guidance Note I Selection and Erection published by the IEE (now IET).

PR_65_70_11_00.3030 SPACING:

- Install conduit, trunking and equipment clear of other services. Measure distance from external surface of any thermal insulation. Notify instances where minimum clearance cannot be achieved and bond items concerned. Minimum general spacings between conduits, trunking, equipment and
    - Insulated steam services - 300 mm.
    - Other services excluding steam - 150 mm.
    - Above central heating radiators - 1000 mm.
    - Ensure separation is in accordance with Appendix K of Guidance Note I Selection and Erection published by the IET and BS EN 50174.
    - Space conduits at a minimum of 150mm centres within cast concrete slabs to prevent cracking – confirm with structural engineer.

PR_65_70_11_00.3040 CONDENSATION PREVENTION:

- Install conduit and trunking systems to ensure internal condensation does not affect operation of associated circuits. Provide drainage points in accordance with BS 7671.
- Where conduit passes through external wall between two areas of different ambient temperatures or in other locations likely to cause condensation, install a conduit or adaptable box. After wiring fill box with inert, permanently plastic compound with high insulation value.

PR_65_70_11_00.3050A PROTECTION AND REPAIR OF STEEL COMPONENTS:

- Paint joints of conduit and minor damages to finish of conduit and trunking immediately after erection or after damage occurs.
- Conduits with a powder coated or enamel finish are to have the finish repaired following any bending or installation activity that has caused light damage. Flaking larger that 15mm in diameter requires a full replacement of the affected length of conduit.
- Use paint compatible with finish as follows
    - Galvanized finish, use two coats zinc rich paint.
    - Black enamelled finish, use two coats of good quality, air drying, black enamel paint.
- Remove grease, oil, dirt and rust before applying protective paint.
- Notify serious damage and repair or replace as instructed.

PR_65_70_11_00.3060 EQUIPMENT CONNECTIONS:

- Where surface mounted equipment is installed in conjunction with concealed conduit work, terminate concealed conduit at flush mounted conduit or adaptable box. Drill back of equipment, bush for back entry and mount equipment to conceal back box.
- Connect to fixed equipment via conduit box located adjacent to termination point, using either solid or flexible conduit as indicated for final connection to equipment terminations.
- Use conduit box as cable change point to facilitate changed wiring locally to adjacent equipment.
- Connect trunking to equipment by specially fabricated connectors or by couplers and externally screwed brass bushes.

PR_65_70_11_00.3070 CLEANING BEFORE WIRING:

- Clean inside of conduits and trunking with swabs immediately before wiring.
- Inspect all components and remove any foreign matter, fit temporary plugs to open ends of conduit and trunking to prevent ingress of water and solid material.

PR_65_70_11_00.3080A WIRING:

- Comply with BS 7671 when wiring installations.
- Segregate circuits in accordance with BS 7671 to avoid EMC interference.
- Ensure draw wires are left within empty conduits for use of specialist installers. Use draw wires comprising nylon tapes with fitted eyelets.
- For concealed conduit ensure system is installed to enable re-wiring to be carried out from boxes for fittings or accessories only. Draw-in boxes will only be permitted with prior permission in writing.
- Do not use tallow or any other substances to facilitate drawing-in of cables.

PR_65_70_11_00.3090 BUILDERSWORK:

- Ensure conduit is not concealed until work has been inspected and approved.
- Obtain permission before horizontally chasing walls.
- Ensure that conduit and fittings buried in concrete or behind plaster are protected against corrosion or electrolytic action prior to rendering.
- Ensure conduit concealed in wall chases is covered by plaster and/or rendering to minimum depth of 12 mm.

PR_65_70_11_00.4010 DRAW-IN BOXES:

- Provide draw-in boxes in conduit at maximum intervals of 10 metres or after bends and/or sets totalling 180 degrees.

PR_65_70_11_00.4020 INSTALLATION OF CAST IN OR BURIED CONDUIT:

- Ensure cast-in conduits are firmly secured to reinforcing steelwork and that accessory and/or conduit boxes are secured so they do not move during subsequent building operations.
- Ensure there is no blockage immediately shuttering is removed.
- Check there is no mechanical damage to conduit in floor screed prior to screeding. Fix securely before screed is poured. Provide temporary protection to conduits until screeds are laid.
- Ensure minimum amount of cross-overs occur dependent upon screed depth. Do not install draw boxes in floors.

- Do not install conduits
    - In screeds in areas indicated.
    - Within site blinding.
    - In main structural slabs unless prior permission in writing is obtained.

PR_65_70_11_00.4030 CONDUIT BOXES:

- Ensure that wherever conduit boxes are cast in the face of the box is flush with the face of the concrete or plaster. Fit circular conduit boxes with extension rings to ensure a flush face with plaster or concrete or where terminal blocks are to be accommodated.
- Ensure fixing holes are countersunk where material thickness allows or use round head screws to prevent damage to cables and remove burrs before cables are drawn in.
- Use a minimum of two screw fixings for standard circular conduit boxes and four screws for large conduit boxes and adaptable boxes up to 150 mm x 100 mm.
- Use back outlet boxes where surface conduits pass through walls, to outside accessories or lighting points.
- Secure switch boxes and socket boxes using countersunk steel screws where provision is made for them or if not use round head screws. Use plug inserts and finally grout in position prior to plastering or screeding.

PR_65_70_11_00.4040 FIXING CONDUIT:

- Support conduit in accordance with Appendix I of Guidance Note I Selection and Erection published by the IEE.
- Ensure conduit is not under mechanical stress. Fix conduit boxes independently of conduit. Make allowance for any additional mechanical loading supported by conduit boxes.
- Where protection is specified as IP44 or greater ensure fixings of conduit boxes are suitable to maintain degree of protection.

PR_65_70_11_00.4050 FLEXIBLE AND PLIABLE CONDUIT:

- Use flexible conduit for final connections to motors, other equipment subject to vibration or adjustment and to thermostats, motorised valves and similar items mounted in pipelines or ducts.
- Use sufficient length between equipment and circular through box at end of conduit run (minimum 450 mm) to allow necessary full range of withdrawal, adjustment or movement.
- Use solid type adapters to terminate flexible conduit.
- Only use PVC covered flexible conduit where installed externally, exposed to weather or in any position where ingress of moisture or condensation may occur. PVC is not to be used within buildings.

PR_65_70_11_00.4060 SCREWED STEEL CONDUIT:

- Use materials clean and free from defects, rust, scale and oil. Obtain prior permission in writing for use of materials subject to remedial work before erection. Repair any damage caused by threading, bending or erection by painting with zinc rich paint before any rust occurs.
- Ensure length of thread on conduit matches that in conduit couplers, fittings or equipment with no thread exposed after erection except at running couplers.
- Ensure conduits butt inside couplers.
- Use lubricant when cutting threads.
- Use minimum number of running couplings
    - For running couplings in Class 2 conduit, use coupler and locknut. Paint exposed thread with zinc rich paint.
    - For running couplings in Class 4 conduit, use three piece conduit unions.

PR_65_70_11_00.4070A NON-METALLIC CONDUIT:

- Comply with manufacturer's instructions for bending, setting and jointing of conduit. Use plastic conduit only where indicated.
    - Do not install conduit when ambient working temperature is or will be below -5^{O}C or above 60^{O}C.
- Use solvents recommended by manufacturer of conduit when using solvent welded joints and ensure spigots enter full depth of sockets. Hold joints rigid and in position until weld sets. Remove excess

solvent before surface damage occurs.

- Use slip joints as necessary, but not exceeding 6 metres on straight lengths to allow for expansion and contraction over temperature variation.
- Use semi-mastic adhesive where expansion joints are formed.
- Where fitments do not have shaped or smooth conduit entries connect with male bushes and external couplings.
- Ensure special care is taken to prevent mechanical damage or warping to conduit where mechanical loads are imposed on conduit system, e.g. lighting fittings.

PR_65_70_11_00.4080 UNDERGROUND INSTALLATION:

- Where buried below ground, use Class 4 conduit. Do not use any buried conduit boxes unless prior permission in writing has been obtained. Wrap conduit with PVC self-adhesive tape, half lapped. Extend taping 150 mm beyond point where conduit leaves ground. Install circular through conduit boxes at the end of the tape. Fill conduit boxes after cable installation with inert, permanently plastic compound with high insulation value, and wrap in PVC self-adhesive tape.

PR_65_70_11_00.5020 ACCESS:

- Arrange trunking to allow access to wiring. Locate covers on top or sides of trunking if practicable. Arrange access so covers are on a continuous face and cables can be laid in throughout the length of the trunking.
- Where trunking is specified as inverted provided internal cable straps to restrain cables when the trunking lid is removed.

PR_65_70_11_00.5030A FIXING TRUNKING:

- Ensure trunking is independently fixed and supported from building fabric. Obtain approval for proposed fixings/supports.
- Support trunking in accordance with the manufacturers' requirements and/or Guidance Note 1 Selection and Erection published by the IEE.
    - Use two fixings minimum per standard length.

PR_65_70_11_00.5040A STEEL TRUNKING:

- Install steel trunking in accordance with the manufacturer's requirements and those of BS 7671.
- Use trunking to avoid multiple parallel conduit runs, subject to approval.
- Cut trunking clean and square with axis, prepare ends and remove burrs and sharp edges. Ensure inside of trunking is free from anything liable to damage cables either during installation or after covers are fitted.
- When trunking is held in a vice, ensure surfaces remain undamaged and components are not warped.
- Avoid tool marking or damage to trunking system components.
    - Do not site fabricate trunking tees, bends, flanges and other accessories. Use only factory made accessories.
- Form circular holes over 6 mm diameter in trunking body using correctly sized punch sets. Use twist drill for holes up to 6 mm maximum diameter. Line all holes with a grommet to prevent cable damage.
- Use only factory formed openings for accessories.
- Line unprotected apertures in trunking with PVC or nylon edging strip.
- Fit ends of runs with removable blanking plates.
- Ensure connections are not made to covers unless indicated or approval obtained.
- Provide fixed section of cover projecting 25 mm either side of fabric where trunking passes through wall, floors or ceiling.
- Fit cable retaining straps at 500 mm intervals except where cover is on top.

PR_65_70_11_00.5050 UNDERFLOOR AND FLUSH FLOOR TRUNKING INSTALLATION:

- Lay underfloor and flush floor trunking straight and level. Adjust height of services outlets, junction boxes and flush floor trunking to suit top of screed level. Ensure that spaces below trunking are free from voids and correctly packed. Prevent ingress of screed by masking where necessary.
- Ensure trunking levelling and alignment is carried out in co-operation with person(s) responsible for confirming location and finish of floor levels.

- Immediately following installation of trunking fit temporary covers to service outlets, junction boxes and flush floor trunking. Fit temporary blanking plates over open connections to vertical trunking.
- Retain temporary covers until permanent covers are installed.
- Ensure underfloor trunking systems are fully re-wireable to final circuit outlets.
- Connect conduits only at inspection or other easy access points.

PR_65_70_11_00.5060 TRUNKING OF INSULATING MATERIAL:

- Comply with manufacturer's instructions. Do not install trunking where ambient temperature is below - 5^{O}C or working temperature is above 60^{O}C.
- Use solvents recommended by trunking manufacturer when making solvent welded joints. Remove excess solvent before surface damage occurs. Hold joints rigid and in position until welds set.
- Use manufacturer's standard radiused bends, connector tees, off-sets, end plates and component parts of trunking system assembly.
- Ensure no type of trunking other than that specified is installed without approval.
- Trunking may be substituted for conduit at certain positions subject to approval.

21.0 PR_65_70_36/48_00 HV/LV CABLES AND WIRING

PR_65_70_36/48_00.1000 GENERAL

PR_65_70_36/48_00.1010 CABLE MANUFACTURER:

- Use new cables, delivered to site with seals intact, manufactured not more than one year prior to delivery, labelled with manufacturer's name, size, description, BS number, classification, length, grade and date of manufacture. If any of this information is missing the cable should not be installed without seeking approval.

PR_65_70_36/48_00.1020 CABLE CERTIFICATION MARKING:

- Mark all types of cables with CENELEC cable certification marking or if included in British Approvals Service for Cables (BASEC) in accordance with BASEC regulations.

PR_65_70_36/48_00.2005 LSOH SHEATHING:

- Supply cables with Low Smoke Zero Halogen (LSOH) sheathing, tested in accordance with BS EN 50267 and BS EN 60332.

PR_65_70_36/48_00.2010D STANDARD ORDINARY FLEXIBLE CORDS - MULTI COPPER CORES:

- Standard - BS EN 50525-2-21, Clauses 4.1, 4.2, 4.3 and 6.3.

PR_65_70_36/48_00.2020A STANDARD POWER SUPPLY CABLES, COPPER CONDUCTORS, THERMOSETTING INSULATION, SHEATHED:

- Standard - BS 5467, Tables 4, 6, 8, and 10.
- Mechanical protection - Unarmoured.

PR_65_70_36/48_00.2020B STANDARD POWER SUPPLY CABLES, COPPER CONDUCTORS, THERMOSETTING INSULATION, SHEATHED AND ARMOURED:

- Standard - BS 5467, Tables 4, 6, 8, and 12.
- Mechanical protection - Armour.

PR_65_70_36/48_00.2020C STANDARD POWER SUPPLY CABLES, COPPER CONDUCTORS, PVC INSULATION, SHEATHED:

- Standard - BS 6004, Tables 7 and 8.
- Mechanical protection - Unarmoured.

PR_65_70_36/48_00.2020E STANDARD POWER SUPPLY CABLES, COPPER CONDUCTORS, LSF SHEATHED AND ARMOURED:

- Standard - BS 6724, Tables 4, 6, 8, and 10.
- Mechanical protection - Armour.

PR_65_70_36/48_00.2020G STANDARD CABLES FOR CONDUIT AND TRUNKING, COPPER CONDUCTORS, LSF INSULATED:

- Standard - BS EN 50525-3-41, Clauses 4.1 and 4.3.
- Mechanical protection - Conduit and trunking.

PR_65_70_36/48_00.2020J STANDARD FLAT CABLES, 2-CORE OR 3-CORE, COPPER CONDUCTORS WITH OR WITHOUT CPC, LSF INSULATED SHEATHED:

- Standard - BS 7211, Table 5.

PR_65_70_36/48_00.2020K STANDARD POWER SUPPLY CABLES, COPPER CONDUCTORS LSF INSULATION, SHEATHED:

- Standard - BS 7211, Tables 3 and 4.
- Mechanical protection - Unarmoured.

PR_65_70_36/48_00.2020M STANDARD CABLES WITH DEFINITE FIRE PERFORMANCE:

- Standard - BS 7629-1 type as shown on drgs/schedules.

- Fire performance BS 5839-1 Standard.
- Sheath colour - red.
- Mechanical protection, as shown on drgs/schedules.

PR_65_70_36/48_00.2020N STANDARD CABLES FOR WALLS, PARTITIONS AND BUILDING VOIDS WHERE PENETRATION BY SHARP OBJECTS IS A HIGH RISK:

- Standard - BS 8436.

PR_65_70_36/48_00.2040B LIGHT DUTY MINERAL INSULATED CABLES, LSF OUTER COVERING:

- Standard - 500V light duty to BS EN 60702-1, section 14.
- Outer covering
- Halogen free material to BS EN 60702-1, section 8.3.

PR_65_70_36/48_00.2050B PAIRED, SCREENED CONTROL CABLES WITH OR WITHOUT METALLIC PROTECTION:

- Standard - BS EN 50288-7.
- Paired, screened control cables, with or without metallic protection.

PR_65_70_36/48_00.2050G MULTI-CORE UNARMOURED LSF, SHEATHED AUXILIARY CABLES:

- Standard - BS 7211, Table 4
- Mechanical protection - Unarmoured.

PR_65_70_36/48_00.2070B STANDARD COMMUNICATIONS CABLES FOR INDOOR USE:

- Standard - BT CW 1308; BT CW 1370; BT CW 1700; and BT CW 1750.

PR_65_70_36/48_00.2080A STANDARD COAXIAL CABLES, FOR BROADCAST RECEIVING:

- Standard - BS EN 50117. CAI benchmark status, cable types CT 100, CT 125, CT 165.

PR_65_70_36/48_00.2100A INFORMATION TECHNOLOGY CABLES - STRUCTURED WIRING: CATEGORY 5:

- Provide IT cables in accordance with the IT system suppliers specification.
- Type of system - Structured cabling - BS EN 50173-1.
- Standard - BS EN 50288-3-1.
- Termination reference - EIA/TIA TSB-40.
- Cable construction - Multi pair; unshielded (UTP)

PR_65_70_36/48_00.3010A CABLES GLANDS - UNARMOURED CABLES:

- Cable type
    - Flexible; wiring and power; control and auxiliary; and communications.
- Standard - BS EN 50262 non-metallic, cable retention, IP54; Type A1 as BS 6121-5 Annex A.

PR_65_70_36/48_00.3010C CABLES GLANDS - ARMOURED CABLES

- Cable type
    - Wiring and power; and control and auxiliary.
- Standard - BS EN 50262 metallic, cable retention Class A, protective connection to earth, IP54.
- Type B as BS 6121-5 Annex A for indoors
- Type C as BS 6121-5 Annex A for outdoors

PR_65_70_36/48_00.3020B CABLE SEALS - HEAVY AND LIGHT DUTY MINERAL INSULATED CABLES - PROTECTED 'E' FOR HAZARDOUS AREAS:

- Use seals for mineral insulated cables in accordance with BS EN 60702-2, recommended or supplied by cable manufacturer.
- Seal type
    - Plain; or earth tail and self-threading pot; or polymeric one piece.
- Pot closure - Plastic disc.
- Pot sealant - Epoxy putty.
- Conductor insulation sleeving - Headed PTFE.

- Seal maximum temperature rating - 100^{O}C or 85^{O}C.
- Other seal characteristics
    - Certified to BS EN 60079-14 for hazardous areas, `e'.

PR_65_70_36/48_00.3110A CABLE DUCTS:

- Standard BS 4660

PR_65_70_36/48_00.3120A CABLE SLEEVES:

- Supply and hand to others for installation non-ferrous cable sleeves for incorporation into the structure where cables pass through fire compartment floors and walls.
- Packing material
    - Weak mix mortar; intumescent, plaster or mastic; solid intumescent material; or intumescent granule filled bags.

PR_65_70_36/48_00.3130A CABLE COVERS AND MARKERS:

- Material - Recovered plastic, integral tape.
    - Marking - Electricity or telephone.
- Plastic marker tape
    - Yellow, marked electricity or telephone.

PR_65_70_36/48_00.4010 CABLE INSTALLATION - GENERAL:

- Use and install cables only as directed in the appropriate standard or as directed by the manufacturer in writing. Lay cables in one length unless otherwise indicated. Obtain permission from the consultant for all through joints, and where overall length requirement exceeds practical drum size.
- Handle, install and dispose of cables on wooden drums in accordance with BS 8512.
- Install cables when ambient temperature is 5^{O}C or greater, using cables stored at or above this temperature for not less than 24 hours.
- Use drum stands, drum axles, fair leads, rollers, cable stockings and other equipment as recommended by the cable manufacturer and as appropriate to the method of installation.

PR_65_70_36/48_00.4020 CABLE INSTALLATION IN LOW TEMPERATURES:

- Install cables at lower installation temperatures when authorised by manufacturer in a written statement.

PR_65_70_36/48_00.4030 INSTALLATION OF LSF CABLE:

- Install LSF cables in accordance with manufacturer's instructions. Ensure ambient temperature is above 5^{O}C. Ensure oversheaths are not damaged by abrasion or scuffing.

PR_65_70_36/48_00.4040 INSTALLATION OF UNARMOURED CABLES:

- Install and use unarmoured cable to BS 7540-1, BS 7540-2, BS 7540-3 or the manufacturer's written instructions.

PR_65_70_36/48_00.4060 CABLE INSTALLATION IN TRENCHES:

- Lay cables on newly prepared bedding. Ensure multiple layers of cable are separated vertically by a 50mm layer of hard rammed bedding material.
- When using a power winch ensure tension on the cable is taken by element of the cable designed for that purpose, that is armour or conductor cores as appropriate and not plastic sheath, metal sheath or core insulation.
- When hand pulling cable ensure no kinks are formed and that flaking, when used, is done in the correct direction.
- Do not allow cable to twist during installation. Use swivels to connect pulling bond to cable stocking or equivalent fitting.
- Check drum is suitable for jacking before commencing installation. If drum or reel is unsuitable for jacking, flake cable in correct direction in maximum size turns from drum or reel before commencing

installation. Use skilled labour to supervise all unreeling, flaking or running of cable from a drum.

- Lay cables in the formation shown; ensure spacing is not reduced below that indicated.
- Bind trefoil groups at 1m intervals. Bind any associated earth or protective conductor to its cable or trefoil group at 1m intervals.
- Space multiple cables in trenches in accordance with BS 7671.
- Ensure installation radii and permanent bending radii are not less than those recommended by the manufacturer.
- Do not lay cables to BS 7211 or BS EN 50525 direct in the ground.

PR_65_70_36/48_00.4090A CABLE INSTALLATION IN CONDUIT AND TRUNKING:

- Install cables so that they are orderly and capable of being withdrawn.
- Arrange single core wiring generally using the loop-in method.
- Trunking
    - In vertical trunking provide pin racks at 3m intervals. Use ties at 2m intervals for all wires of the same circuit reference. Mark ties with circuit reference number at 10m intervals.
- Conduit
    - Provide cable clamps in conduit boxes at 10m intervals in vertical conduit.
    - Allow for full range of movement at building construction movement joints. Make all joints to wiring at terminal blocks in conduit boxes.

PR_65_70_36/48_00.4110A CABLE INSTALLATION:

- Dress cables flat, free from twists, kinks and strain, and align parallel to building elements. When glands and clamps are not required, take sheathing of cables into accessory boxes and equipment and protect against abrasion using grommets or similar sharp edge protection.

PR_65_70_36/48_00.4120A CABLE EMBEDDED INSTALLATION:

- Ensure plaster or screed over cable is a minimum of 12mm. Protect embedded cables with metal capping or PVC oval conduit.

PR_65_70_36/48_00.4130A CABLE INSTALLATION - MINERAL INSULATED CABLES:

- Straighten and dress cables using methods and tools recommended by cable manufacturer.
- Use thermoplastic or LSF sheathed cables in location indicated, and where cables may come into direct contact with any material that may be corrosive to copper or where the copper sheath is likely to carry earth leakage current under normal operating conditions.
- Do not allow extra length on installed cables to allow for cutting back of moisture affected ends. Store mineral insulated cables in the form as supplied by manufacturer.

PR_65_70_36/48_00.4140 CABLE INSTALLATION - FLEXIBLE CORDS:

- Grip cords securely at connections. Where they do not form an integral part of the connected accessory or equipment, provide separate proprietary cord grips.

PR_65_70_36/48_00.4150A CABLE JOINTING AND TERMINATING GENERALLY:

- Ensure all joints and terminations are made by appropriately qualified cable jointers, using jointing materials, components and workmanship recommended by the cable manufacturer and the jointing accessory manufacturer. Install cable glands in accordance with BS 6121-5.

Cold pour resin and heat shrink joints.

- Cut all cable ends immediately prior to jointing or terminating. Seal cables left unconnected for more than 24 hours to prevent the ingress of moisture. Seal plastic sheathed cables using proprietary shrink on end caps. Seal lead sheathed cables by a plumbed dressed lead cap with an airspace to allow conductor movement.
- Strip cables to bring out the cores and expose conductors, for the minimum length required for connection, to leave no exposed length of conductor after termination. Ensure that strands are not damaged when stripping cable cores. Twist strands together. Do not reduce number of strands. Secure all strands at terminations.

- Clean armour thoroughly prior to jointing or terminating.
- At connections to equipment and switchgear without integral cable clamping terminals, use compression or solder type lugs for bolted terminal connections, of correct bore.
- Form all compression connections to components using tools that cannot be released unless the correct degree of compression has been achieved.
    - Install and inspect compression and mechanical connectors on conductors in accordance with BS EN 60228 and BS 7609.
- Bolt core terminations with lugs to equipment using washers or proprietary shakeproof devices.
- Do not bunch more than three cores at clamping terminals or bolted connections.
- Mark cable conductor phasing, or other core identification, at each end of all cables, and at all joints, maintaining consistency of marking with any existing system.
- Connect all cores, including multicore cable spare cores, at all joints and terminations. Bond any unused cores or multicore cables to earth at both ends, unless otherwise indicated.

PR_65_70_36/48_00.4180A TERMINATING - MINERAL INSULATED CABLES:

- Use terminations in accordance with BS EN 60702-2 and components and materials recommended or supplied by cable manufacturer.
- Use seals with maximum temperature rating indicated, stub caps to the largest size available, and drilled caps and headed sleeves for larger sizes.
- Use glands of type indicated. At terminations to accessory boxes within a plaster or render finish, cable clamps fixed to accessory box and firmly gripping cable sheath may be used. Use earth tail seals with sheath grip type accessory boxes.
- At equipment not provided with threaded entries secure glands using lock washers and locknuts or brass conduit bush. Use gland shrouds when plastic covered MI cables are used.
- Using PVC, PIB or LSF material tape to BS 3924 or BS EN 60454 to match sheath, tape overall gland any bare copper sheath and form seal to cable sheath under all shrouds.
- Mark core sleeving with appropriate identification.
- Install voltage surge suppressors in accordance with manufacturer's recommendations and surge suppressors to BS 7671, section 534.

PR_65_70_36/48_00.4190A CABLE JOINTS - MINERAL INSULATED CABLES:

- Joint mineral insulated cables using methods and materials recommended by cable manufacturer. Terminate cables in externally threaded glands using seals with temperature rating indicated. Join conductors using crimped connectors.
- Insulate connectors using PVC tape to BS 3924 or BS EN 60454, ensuring good seal to conductor sleeving. Make off glands into either end of internally threaded brass sleeve of correct size. Protect brass sleeve using heat shrink sleeve.

22.0 PR_60_70_48_06 BUSBAR TRUNKING

PR_60_70_48_06.1000 GENERAL

PR_60_70_48_06.1010 BUSBAR TRUNKING SYSTEMS STANDARDS:

- Supply and install busbar trunking systems in accordance with the manufacturer's installation recommendations and BS 7671 Requirements for Electrical Installations (The IET Wiring Regulations).

PR_60_70_48_06.1020 POWER TRACK SYSTEMS:

- Supply and install busbar trunking systems in accordance with the manufacturer's installation recommendations, BS EN 61534-1 and in the requirements of BS 7671 Requirements for Electrical Installations (The IET Wiring Regulations).

PR_60_70_48_06.2010A GENERAL PURPOSE BUSBAR:

- System characteristics
    - Electrical Supply - Voltage between phases 400 volts; frequency 50 Hz.
    - Rate system to withstand a short circuit fault current of 21 kA.
    - Short time rating - 0.2 seconds.
- Busbar
    - Use high conductivity busbars and connections.
    - Material - Copper.
    - Number of Poles - 3 phase and full size neutral.

PR_60_70_48_06.2020A GENERAL PURPOSE BUSBAR TRUNKING:

- Busbar trunking type
    - Surface; flush; bench or underfloor.
- Steel enclosure
    - Comply with relevant sections of BS 4678.
    - Apply high standard of finish to busbar trunking. For a painted finish apply a minimum of one coat rust inhibiting primer, one undercoat and two semi-gloss finish coats.
    - Remove rust and degrease metal prior to application of selected finish. Zinc coated steel is acceptable as anti-rust treatment.
    - Use rust-proofed (e.g. cadmium plated) screws, bolts, nuts and washers.
    - Finish - Paint or Stove enamel.
    - Colour- Manufacturer's standard colour.
- Fittings
    - Use trunking fittings of the same type and manufacture as the busbar trunking. Use screw fixed covers. Use manufacturer's purpose made units at changes of direction.
- Supply termination
    - Provide facilities for the correct termination of supply cable.
- Fixings
    - Provide external fixing brackets at not greater than 2m intervals. In accordance with manufacturer's instructions and recommendations.
- Marking
    - Provide clear marking of busbars and tap-off outlet sockets with phase colours to enable sequence identification throughout system.

PR_60_70_48_06.2040A INTERNAL PROTECTIVE CONDUCTORS:

- Standard BS EN 61534-1.
- Provide protective conductor throughout busbar system length to manufacturer's standard.
    - Busbar pole with tap-off at each socket for wall/dado type with integral socket outlets.
- Install protective conductor internally to busbar enclosure.
- Bond protective conductor to trunking enclosure using a method in accordance with BS 7430 at 1.2m maximum intervals.
- Use high tensile brass bolts and locking nuts.
- Complete trunking system before installing the protective conductor.

- Ensure the continuity of protective circuits.

PR_60_70_48_06.3010 GENERAL:

- Install busbar trunking in accordance with manufacturer's instructions and the relevant standards.
- Check total length of busbar system required on site prior to manufacture commencing.
- Fit covers at end of each run or provide proprietary end boxes.

PR_60_70_48_06.3020 BONDING:

- Bond between adjacent lengths of busbar trunking with approved mechanical means to maintain conductivity, where two or more parallel runs of busbar trunking occur. Tighten bolted connections between adjacent lengths of busbars to correct torque setting. Avoid damage to conductors.

PR_60_70_48_06.3030 EXPANSION:

- Anchor busbars rigidly in a minimum of one position and provide means of absorbing maximum expansion and contraction likely to occur in busbars under normal operating conditions.
- Provide expansion joints in each length of run

PR_60_70_48_06.3050 FIRE BARRIERS:

- Provide barriers of fire-resisting materials within the busbar trunking where vertical runs pass through floors and horizontal runs pass through fire break walls to prevent spread of fire. (BS 7671 Section 527).

23.0 PR_65_70_11_00 SUPPORT COMPONENTS - CABLES

PR_65_70_11_00.1000 GENERAL
Install all cables in accordance with manufacturer's recommendations.

PR_65_70_11_00.1010 APPLICATION:
- Cables referred to in this section are only those types that can be installed without further mechanical protection.

PR_65_70_11_00.2010A CABLE SUPPORTS AND FINISHES:
- Support all cables throughout their length using cable tray, cable racking, special support systems; or cleat, clip fixing direct to building fabric as indicated on the drawings/schedules.
- Ensure tray, racking and special support systems are continuous and firmly fixed to building fabric.
- Allow 25% spare capacity space for additional cables.
- Ensure cable support system allows for spacing in accordance with BS 7671 for the design current of the cable.
- Ensure finish for all support components, fixings, hangers and accessories is as cable support system or as specified.

PR_65_70_11_00.2020A CABLE SUPPORT SYSTEM - PERFORATED TRAY:
- Type - Flanged or return flanged.
- Perforations
    - Admiralty pattern for light or medium duty; GDCD pattern standard 23; or manufacturer's standard pattern.
- Fittings
    - Use factory made fittings throughout of same material, type, pattern, finish and thickness as cable tray.
    - Use reducers, inside angles and outside angles as manufacturer's standard.
    - Use flat bends, equal tees, unequal tees and crosses with corners gusseted.
    - Join lengths of tray and fittings using manufacturer's standard shouldered ends, fish plates, or couplers, with galvanized or zinc plated slotted domed head `roofing' bolts, nuts, washers and shakeproof washers.
    - Ensure electrical continuity by fitting earth straps to all joints
- Material
    - Hot rolled steel galvanized after manufacture to BS EN 10327 or BS EN 10143.

PR_65_70_11_00.2020B CABLE SUPPORT SYSTEM - CABLE RACK:
- Proprietary system of channel sections with return lip and compatible jointing and fixing accessories
- Fittings
    - Use factory made fittings throughout of same material finish and section as rack, for risers, bends, reducers, tees, crosses and drop outs.
- Material
    - Hot rolled steel galvanized after manufacture to BS EN 10327 or BS EN 10143.

PR_65_70_11_00.2025A CABLE SUPPORT SYSTEM - PROPRIETARY CABLE TIES:
- Two piece cable tray pattern, on cable tray only. Wrap round self-locking non releasable pattern on everything except cable trays.

PR_65_70_11_00.2025C CABLE SUPPORT SYSTEM - TWO WAY SADDLES:
- Bright copper for unsheathed mineral insulated cables. PVC covered bright copper for sheathed mineral insulated cables.

PR_65_70_11_00.2025D CABLE SUPPORT SYSTEM - CABLE BASKET:
- Proprietary system of wire basket with compatible jointing and fixing accessories.
- Use factory made fittings throughout of same material finish as basket, for risers, bends, reducers,

tees, crosses and drop outs.
- Ensure electrical continuity by fitting earth straps to all joints

PR_65_70_11_00.3010 CABLE TRAY INSTALLATION:
- Support from building fabric with minimum clearance behind of 20mm. Install fixings at regular intervals to prevent visible sagging when loaded, with maximum spacing 1.2m and 230mm from fittings.
- Keep cutting of cable tray to a minimum. Cut along a line of un-perforated metal. Make good finish with zinc rich paint, primer and top coat, or two pack epoxy paste, as appropriate to tray material and finish.
- Fit holes cut in tray for passage of cables with grommets, bushes or other lining.
- Install all bolts, fixings and hangers with threaded portion away from cables. Cable routes to cross at right angles or spacing to BS EN 50374.

PR_65_70_11_00.3020A CABLE CLEATS, TIES, SADDLES AND CLIPS INSTALLATION:
- For cables on horizontal tray use ties for each circuit. Use tie manufacturer's special tensioning tool where available. Crop off tie ends.
- For cables on vertical tray use cleats bolted to tray for paper, plastic or elastomeric insulated cables and saddles or clips for mineral insulated cables. Use cleats sized to grip cables firmly without undue pressure or strain on cable, but preventing slipping.
- For cables on vertical or horizontal rack use proprietary fixings to rack for paper, plastic or elastomeric insulated cables and saddles or clips for mineral insulated cables. On continuous flat surfaces of wood, plaster, brick etc.
    - Use polypropylene surface fixing clips with prefixed hardened steel pin for PVC insulated and sheathed cables and sheathed or bright mineral insulated cables. Use round or flat or flat twin pattern as appropriate, manufactured specifically for cable being fixed.
    - Use one hole 'P' clips or two way saddles of bright copper for unsheathed mineral insulated cable. Use PVC covered for sheathed mineral insulated cables.
- Space cleats, ties, saddles and clips
    - As Appendix G of Guidance Notes `Selection & Erection' published by the IET.

24.0 PR_60_70_48_00 LV SWITCHGEAR AND DISTRIBUTION BOARDS

PR_60_70_48_00.2010A CUBICLE SWITCHBOARD / CONTROL PANEL

- Standard - BS EN 61439-1.
- External design - Cubicle type assembly.
- Usage - Switchboard.
- Conditions of installation - Indoors.
- Electrical characteristics
    - Rated operational voltage 400V +10% -6%
- Service conditions
    - Ambient air temperature and altitude as BS EN 61439.

PR_60_70_48_00.2020A FLOOR STANDING ASSEMBLY CONSTRUCTION:

- Enclosure standard - BS EN 62208.
- Terminals for external conductors, main power circuits
    - Accommodate cross-sectional area of copper cables in accordance with BS EN 61439-1.
- Terminals for external conductor, control and auxiliary circuits
    - Terminal block. Mounting as manufacturer's standard.
- Size of neutrals on three phase supplies - Full sized.
- Degree of protection to BS EN 60529, IP31 for assembly.
- Protection against direct and indirect contact
    - IP31 (IP54 for any life safety equipment)
- Accessibility for inspection
    - Arrange for following operations to be performed when assembly is in service and under voltage
    - Visual inspection of switching devices and other apparatus; settings and indicators of relays and releases; conductor connections and markings.
    - Adjusting and re-setting of relays, releases and electronic devices.
    - Replacement of fuse links and indicating lamps.
    - Fault location by voltage and current measuring.
    - Ensure that all trip and control voltages are compatible
- Accessibility for maintenance
    - Provide space between functional unit or group and adjacent functional units or groups. Provide retainable fastening means for parts likely to be removed for maintenance.
- Removable parts and withdrawable parts as manufacturer's standard.
- Internal separation - Form 4 Type 2
- Input voltage variations for electronic equipment supply - BS EN 60439.
- Supply frequency deviation - BS EN 60439.
- Mounting - Floor standing.

PR_60_70_48_00.2020B WALL MOUNTED ASSEMBLY CONSTRUCTION:

- Enclosure standard - BS EN 62208.
- Terminals for external conductors, main power circuits
- Accommodate cross-sectional area of copper cables in accordance with BS EN 60439-1.
- Terminals for external conductor, control and auxiliary circuits
- Terminal block. Mounting as manufacturer's standard.
- Size of neutrals on three phase supplies - Full sized.
- Degree of protection to BS EN 60529, IP31 for assembly.
- Accessibility for inspection
    - Arrange for following operations to be performed when assembly is in service and under voltage
    - Visual inspection of switching devices and other apparatus; settings and indicators of relays and releases; conductor connections and markings.
    - Adjusting and re-setting of relays, releases and electronic devices.
        - Replacement of fuse links and indicating lamps.

    - Fault location by voltage and current measuring.
- Accessibility for maintenance
    - Provide space between functional unit or group and adjacent functional units or groups. Provide retainable fastening means for parts likely to be removed for maintenance.
    - Removable parts and withdrawable parts as manufacturers' standard.
- Input voltage variations for electronic equipment supply - BS EN 60439.
- Supply frequency deviation - BS EN 60439.
- Mounting - Wall mounted.

PR_60_70_48_00.2030A ENCLOSURE FINISH:

- Apply high standard finish to enclosure and supporting metalwork. Degrease metal and remove rust prior to applying finish.
- Comply with paint manufacturer's recommendations regarding preparation, stoving times, temperatures, mixing of finishes, application and coat thickness.
- Finish - Manufacturer's standard.
- Colour – To Consultant's specification

PR_60_70_48_00.2060 SITE BUILT ASSEMBLIES:

- Ensure that components of site assemblies are part of a proprietary system and type tested as appropriate. Carry out full Site Acceptance Test SAT
- Install assemblies in accordance with manufacturer's drawings and instructions.

PR_60_70_48_00.2070 SITE MODIFICATION:

- Do not make site alterations unless authorised. Where site modifications to assemblies are authorised make in accordance with manufacturer's certified drawings and instructions. Ensure that modifications made comply with type test certificate obtained for arrangement of components.

PR_60_70_48_00.2080A WALL MOUNTED, BATTERY CHARGER AND BATTERY UNIT:

- Supply a unit for tripping.
- Input Supply - 230 V single phase 50 Hz.
- DC Output - 50 Volt -20% +10%
- Operating temperature range -10oC - 45oC.
- Charger type
    - Thyristor or transistor.
- Battery type
    - Lead acid (sealed) or Nickel Cadmium (maintenance free).
- Cubicle (sheet steel) - Wall mounted.
- Finish - Manufacturer's standard.
- Colour – To Consultant's specification
- Ventilation - Natural.
- Facilities - MCB input protection; float charge.
- Battery over-discharge protection
- Fuses for battery protection; MCB's for outgoing circuits; automatic selection of boost charge.
- Meters
    - Battery voltage; charging current (dual scale for float and boost); output current.
- Lamp indications
    - Supply on; supply fail (monitor input terminals); float charge; boost charge; no charge (when supply is on); battery voltage low; battery voltage high.
    - Alarms (connected to operate a relay with shrouded 230V3A a.c. or 0.5A d.c. N/C volt free contacts, closed on any alarm, for remote indication circuit)
    - Supply failed; no charge (when supply is on); battery voltage low; battery voltage high.

PR_60_70_48_00.2090A UTILISATION A, WITHDRAWABLE AIR BREAK CIRCUIT BREAKERS:

- Provide circuit breakers in accordance with BS EN 60947. Ensure that uninterrupted current rating indicated applies when unit is enclosed and in operating environment at rated operational voltage.

- Standard - BS EN 60947-2
- Details of equipment - Circuit breaker.
    - Characteristics of circuit breakers
        - a.c. Interrupting medium - Air.
- Rated and limiting values for the main circuit.
    - Rated voltage (Volts) - operational, 400.
    - Rated frequency 50 Hertz.
    - Circuit breaker Utilisation category - A.
    - Enclosure degree of protection IP 31.
- Circuit breakers and switches
    - Provide metal clad withdrawable isolating removable type circuit breakers with provision for safe maintenance.
    - Closing mechanism
        - Independent manual spring operated.
    - Provide automatic shutters to cover all live contacts when circuit breaker is isolated, withdrawn or removed from housing.
    - Provide a padlock to lock circuit breaker in isolated/withdrawn position, and to lock automatic shutters covering live contacts when removed from housing.
    - Provide moulded case circuit breakers with provision for safe maintenance.

PR_60_70_48_00.2090D UTILISATION B, MCCB AIR BREAK CIRCUIT BREAKERS:

- Provide circuit breakers in accordance with BS EN 60947. Ensure that uninterrupted current rating indicated applies when unit is enclosed and in operating environment at rated operational voltage.
- Standard - BS EN 60947-2
- Characteristics of circuit breakers
    - a.c. Interrupting medium - Air.
    - Rated and limiting values for the main circuit.
    - Rated voltage (Volts) - operational, 400.
    - Rated frequency 50 Hertz.
    - Circuit breaker Utilisation category - B.
    - Enclosure degree of protection IP 31.
    - Circuit breakers and switches
    - Provide manual closing air-break circuit breakers, (MCCB).
- Closing mechanism
    - Independent manual spring operated.
- Provide automatic shutters to cover all live contacts when circuit breaker is isolated, withdrawn or removed from housing.
- Provide a padlock to lock circuit breaker in isolated/withdrawn position, and to lock automatic shutters covering live contacts when removed from housing.
- Provide moulded case circuit breakers with provision for safe maintenance

PR_60_70_48_00.2100A SWITCH DISCONNECTORS:

- Supply switch disconnectors in accordance with BS EN 60947.
- Standard - BS EN 60947-3
- Details of equipment - Switch-disconnector.
    - a.c. Interrupting medium - Air.
- Rated and limiting values for the main circuit.
    - Rated voltage (Volts) 230/400.
    - Rated frequency 50 Hertz.
    - Utilisation category - AC 23A.
    - Enclosure degree of protection IP 65.
    - Fit each switch with facility to padlock in OFF position.
    - Provide switches with auxiliary contacts as indicated. Where switches isolate final connections between a starter and its motor, fit one set of contacts to open starter coil circuit when switch is opened.

PR_60_70_48_00.2100B FUSE COMBINATION UNITS:

- Supply fuse combination units in accordance with BS EN 60269 (BS 88).
- Standard - BS EN 60947-3.
- Details of equipment - Fuse combination unit.
    - a.c. Interrupting medium - Air.
- Rated and limiting values for the main circuit
    - Rated voltage (Volts) 230/400.
    - Rated frequency 50 Hertz.
    - Utilisation category - AC23A
    - Enclosure degree of protection IP 31.
    - Fit removable neutral link in switches controlling circuits with neutral conductor.
    - Fit solid links in isolating switches.
    - Fit each switch with facility to padlock in OFF position.
    - Ensure that withdrawable chassis isolating type switches are provided with fully shrouded fixed contacts or insulated cover plates, to prevent accidental contact with live parts.
    - Ensure that switches in individual enclosures have an earth terminal, meet the degree of protection for the switchboard and have operating mechanisms interlinked with access door.
    - Provide switches with auxiliary contacts as indicated. Where switches isolate final connections between a starter and its motor, fit one set of contacts to open starter coil circuit when switch is opened.

PR_60_70_48_00.2110A RESET PROTECTION DEVICES INTERPOSING RELAYS AND INTER-TRIPPING RELAYS:

- Standard - BS EN 61810.
- Housing
    - Flush panel mounting type. House all protection relays, excluding motor protection relays, in draw out cases.
- Reset type – Automatic or manual reset type as required.
- Overcurrent tripping device
    - Provide overcurrent tripping device with overcurrent characteristic similar to a BS 2692 high voltage cartridge fuse, sized to protect the equipment/load.

PR_60_70_48_00.2120 VOLTAGE SENSING RELAYS:

- Provide single phase inverse time under voltage type voltage sensing relays to monitor the voltage between respective phases of supply.
- Mounting
    - Supply suitable for flush panel mounting with relay trip indication.
- Voltage settings
    - 50-90% in five equal steps with automatic resetting at 105% of voltage setting.
- Relay Inverse time characteristics
    - When voltage increases from zero to rated voltage with time multiplier set at 1.0, set relay resetting times as follows:-
    - Relay setting % 50 60 70 80 90
    - Resetting time (secs) 2 4 5 10 12

PR_60_70_48_00.2130 TRIP/CLOSE SWITCHES AND CONTROL SELECTOR SWITCHES:

Provide a panel mounted heavy duty; spring return trip/close switch on each circuit breaker fitted with solenoid or motorized spring closing mechanisms.

Ensure contacts have a continuous rating of 10A minimum at between 30V to 250V ac and dc, and make and break duty rating of 30A at 250V ac or dc for a minimum period of 3 secs.

Where remote trip/close control is indicated, supply a panel mounted selector switch to select circuit breaker for local or remote closing. Ensure that selection of remote or local closing does not prevent circuit breaker tripping under operation of local or remote trip switch.

PR_60_70_48_00.2140 CURRENT TRANSFORMERS:

- Comply with BS EN 60044-1. Provide separate current transformers for each protection device and instrumentation. Ensure current transformers provide appropriate accuracy and are compatible with over current factors, characteristics, performance and VA rating required for satisfactory operation of protection devices, instruments and meters indicated. CT's used for metering must accurately measure current across the full device operating range.
- Ensure that current transformers are capable of withstanding maximum short time withstand current of value and duration indicated for assembly.
- Provide test links in secondary connections of all current transformers to facilitate testing of instruments, meters and protection devices.

PR_60_70_48_00.2150A INSTRUMENTS AND METERS:

- Standards
    - Comply with BS 89 and BS EN 60051-1 for voltmeters, ammeters, watt meters, frequency indicators and power factor indicators.
    - Comply with BS 7856, BS EN 62053-11, BS EN 62053-22 or BS EN 62053-21 for kWh meters, kVA and kW maximum demand meters and polyphase reactive kVA meters, and BS EN 62053-23 for KVAhr meters.
- Protect wiring to voltmeters by separate fuses.
- Protect potential coils of watt meters, frequency indicators, power factor indicators and kWh meters, kVA and kW maximum demand meters and polyphase reactive kVA meters by separate fuses.
- Supply instruments and meters suitable for flush mounting and type, size and accuracy as indicated.
- Ensure that indicating scales for all instruments comply with BS 3693.
- Supply so that normal indication is 50% to 75% of full scale deflection.
- Completely segregate all instruments in instrument compartments. Panel mount meters on front of instrument compartment.

PR_60_70_48_00.2160A ELECTRICAL RECORDING INSTRUMENTS:

- Provide electrical recording instruments in accordance with BS EN 61143

PR_60_70_48_00.2170A INDICATOR LIGHTS:

- Supply lamps of same type throughout. Provide indicator lamps with lamp test facility.
- Lamps
    - Supply interchangeable indicators for respective units.
- Protect wiring to indicator lamp units by separate cartridge fuses.
- Lens Colour in accordance with BS EN 60073.

PR_60_70_48_00.2180 LOW VOLTAGE COILS RATING:

- Ensure coils for switching relays, contactors and other applications are capable of withstanding inherent voltage drop within system without armature or switching apparatus dropping out of position.

PR_60_70_48_00.2190A FRAMEWORK:

- Construct framework for supporting electrical equipment from mild steel plate and strip, cold and hot rolled steel sections or slotted angles, in accordance with BS EN 10210 and BS 4345 respectively. Comply with BS EN 1011-2 for metal arc welding.
- Finish
    - Frameworks mounted inside building manufacturer's standard finish.
    - Frameworks mounted outside building hot dip galvanized to BS EN ISO 1461.
- Supply cadmium or zinc electroplated bolts, nuts, washers and screws.
- Provide all required end caps.

PR_60_70_48_00.2210A DISTRIBUTION BOARDS:

- Comply with BS EN 60439-3 as appropriate. Make internal separation Form 1 unless otherwise indicated. Make fuse boards fully shrouded. Fit each distribution board with a 2 or 4 pole isolating switch.

- Install busbars in same position relative to their fuse carriers or miniature circuit-breakers (MCBs) for each pole. In TPN distribution boards supply neutral busbars with one outgoing terminal for each outgoing circuit.
- Provide a multi-terminal earthing bar for circuit protective conductors for both insulated and metal-cased boards, with one terminal for each outgoing circuit. Connect directly to earthing terminal without dependence on exposed conductive parts of enclosure.
- Identify each fuse way and MCB way by numbering. Identify each terminal on neutral busbar and earthing bar with its respective fuse way or MCB way.
- Where specific ratings are indicated incorporate fuses or MCBs, otherwise leave ways blank for future additions.
- Enclosures finish
- Finish - Manufacturer's standard.
- Colour – To Consultant's specification

PR_60_70_48_00.2200A FUSES:

- Supply cartridge fuse links including fuse carrier, bases and associated components that comply with BS EN 60269 (BS 88), fusing factor category gG, unless otherwise indicated.

PR_60_70_48_00.2230A MINIATURE CIRCUIT BREAKERS:

- Standard - BS EN 60898-1.
- Supply miniature circuit-breakers with voltage and current ratings, type according to instantaneous tripping current, energy limiting class, category of duty and frequency in accordance with BS EN 60898-1.

PR_60_70_48_00.2240A RESIDUAL CURRENT DEVICE:

- Comply with BS EN 61008. Supply residual current devices (RCCDs) with rated voltage, rated current, rated tripping current, rated tripping time and rated breaking capacity as indicated.
- DC component
    - Ensure dc component does not affect operation.
- Overcurrent protection
    - Fit RCDs with integral overcurrent protection.

PR_60_70_48_00.2245 COMBINED RESIDUAL CURRENT/OVER CURRENT OPERATED CIRCUIT BREAKERS:

- Supply combined residual current/over current operated circuit breakers (RCBOs) in accordance with BS EN 61009.

PR_60_70_48_00.2250 CABLE TERMINATIONS:

- Ensure that switchgear and distribution boards are provided with facilities to terminate size, number and type of cable indicated. Where necessary use fabricated steel extension boxes (header trunking) for glanding large and multiple cables.
- Provide non-ferrous metal glanding plates for single core cable terminations.

PR_60_70_48_00.2270A FREE STANDING/ WALL MOUNTED/ WITHIN SWITCHGEAR AUTOMATICALLY CONTROLLED CAPACITOR BANKS:

- Standard - BS EN 61921.
- Voltage rating of capacitor - 400V, 3 phase, 50 Hz.
- Bank unit
    - Include in each module contactors, line fuses and control circuitry.
- Switching - Block contactor switching.
- Control
    - Provide automatic control via an automatic multi-stage kVAr sensitive, solid state relay with stage switches to operate the capacitor contactors.
- Control relay
    - Incorporate relay into cubicle.
    - Fit relay with a loss of voltage no volt release re-setting feature to reset switching sequence

to all contacts open position following failure of supply.
    - Provide visual indication by means of LED's for capacitor stages and capacitor/inductive load.
    - Provide Hand/Off/Auto selection switch.
- Isolator - Incorporate on load break isolator.
- Capacitor unit
    - Provide assembly housed in sheet steel enclosure complete with main terminals, comprising individual low loss, power capacitor elements and fuses to BS EN 60143-3 or BS EN 60871-4.
- Capacitor unit assembly
    - Incorporate thermal equalizers within assembly of elements.
    - Fill enclosure with inorganic, inert and non-flammable granules.
    - Fit discharge resistors.
    - Ensure all internal and external connections are adequately rated and fully insulated.
- Automatic bank enclosure
    - Material - Manufacturer's standard.
    - Finish and colour - Manufacturer's standard.
    - Access - Front access.
- Capacitor discharge devices - Manufacturer's standard.

PR_60_70_48_00.2280A HARMONIC FILTER:

- Unit - Filter conditioning to meet G5/4.
- Mounting - Floor mounting
- Cubicle
    - Incorporating IGBTs, capacitors, reactors, block contactors and control gear.
- Cable termination chamber
    - Mount cable termination chamber on side of cubicle with access through removable plates.

PR_60_70_48_00.2290A MEDIUM VOLTAGE IRON CORE FILTER REACTOR:

- Provide three phase filter reactor in accordance with BS EN 60076.
- Reactor
    - Copper foil windings insulated between layers, impregnated under vacuum and in over pressure conditions with polyester resin and dried in furnace temperature of 150oC.
    - Ensure iron core flux density is designed for indicated harmonic loading. Ensure that saturation does not occur at switch-in of filter network.
    - Provide insulation for continuous operation at ambient temperature up to 40oC, temperature class T40/E.
- Electrical connections
    - To copper bars in accordance with DIN 46206.

PR_60_70_48_00.3010 FIXING:

- Fix all equipment independently of wiring system. Use cadmium or zinc electroplated bolts, nuts, washers and screws.

PR_60_70_48_00.3020 MOUNTING HEIGHT:

- Mount single items of equipment 1450mm above finished floor level to centre of equipment, unless otherwise indicated.
- Arrange groups of equipment, other than floor mounted assemblies, so that all parts of equipment requiring access for operation or maintenance are at least 500mm and no more than 2000mm above finished floor level, unless otherwise indicated.

PR_60_70_48_00.3030 ACCESS:

- Ensure that clearance in front of switchgear and control-gear is not less than 1m to provide sufficient throwback space.

PR_60_70_48_00.3040A MARKING AND DRAWING:

- Number terminals, cables and component parts to correspond with manufacturer's certified drawings.

PR_60_70_48_00.3050 CABLE TERMINATIONS:

- Terminate paper-insulated cable by means of switchboard manufacturer's standard compound filled cable boxes.
- Terminate PVC SWA PVC and MICS cables inside enclosure by securing cables to switchboard with glanding plates or glanding brackets; and outside enclosure with glanding plates or fabricated steel extension boxes (header trunking).

PR_60_70_48_00.3060A INSTALLATION AND COMMISSIONING:

- Install and commission switchgear and control gear in accordance with the appropriate standard and the manufacturer's recommendations. Include CT Polarity check in commission tests.

25.0 PR_75_51_52_00 CONTACTORS AND STARTERS

PR_75_51_52_00.1000 GENERAL

PR_75_51_52_00.1010A 3 PHASE SUPPLY:

- Ensure all electrical equipment supplied and installed is suitable for 3 phase or for single phase power supplies as required by BS 7697.

PR_75_51_52_00.1010B SINGLE PHASE ELECTRICAL SUPPLY:

Ensure all electrical equipment supplied and installed is suitable for single phase power supply to BS 7697.

PR_75_51_52_00.1020B INSTALLER FITTED SURGE SUPPRESSORS:

- Supply surge suppressors to star connected motors and to all motors subject to star-delta starting to limit peak voltage to 1200 volts. Fitted by installer.

PR_75_51_52_00.1030A MANUFACTURER FITTED TRANSIENT SUPPRESSORS:

- Supply transient suppressors in the form of resistor and capacitor networks across the starter contactor coils. Fitted by Manufacturer.

PR_75_51_52_00.2010A CONTROLGEAR ASSEMBLY:

- Standard - BS EN 60439-1.
- External design - Cubicle type assembly.
- Usage - Control panel, motor control centre or single starter enclosure.
- Conditions of installation - Indoors.
- Electrical characteristics
    - Rated operational voltage, 400 V. Rated short-time withstand current, 20 times rated current.
- Service conditions - Ambient air temperature and altitude as BS EN 60439.

PR_75_51_52_00.2020A ASSEMBLY CONSTRUCTION:

- Enclosure standard - BS EN 62208.
- Material of enclosure - Manufacturer's standard.
- Terminals for external conductors, main power circuits
    - Accommodate cross-sectional area of copper cables in accordance with BS EN 60439-1, Appendix A.
- Terminals for external conductor, control and auxiliary circuits
    - Terminal block. Mounting - top hat rails (35mm) to BS 5584 (EN 50022).
- Size of neutrals on three phase supplies
    - Full current-carrying capacity of phase conductor.
- Degree of protection to BS EN 60529
    - IP 31 for units installed inside buildings excluding boiler rooms and pump rooms.
    - IP 55 for units installed in boiler rooms, pump rooms and outside buildings or supplying life safety equipment in accordance with BS8519: 2010
- Protection against direct and indirect contact as Manufacturer's standard.
- Accessibility for inspection
    - Arrange for following operations to be performed when assembly is in service and under voltage.
    - Visual inspection of switching devices and other apparatus; settings and indicators of relays and releases; conductor connections and markings.
    - Adjusting and re-setting of relays, releases and electronic devices.
    - Replacement of fuse links and indicating lamps.
    - Fault location by voltage and current measuring.
    - Ensure that all trip and control voltages are compatible.
- Accessibility for maintenance
    - Provide space between functional unit or group and adjacent functional units or groups. Provide retainable fastening means for parts likely to be removed for maintenance.
    - Use barrier protected sub-sections for each functional unit or group.

    - Use compartments for each functional unit or group.
- Removable parts and withdrawable parts
    - Degree of protection of assembly after removal or withdrawal of part as manufacturer's standard.
- Input voltage variations for electronic equipment supply - BS EN 60439, Section 7.9.1.
- Supply frequency deviation - BS EN 60439, Section 7.9.4.
- Mounting - Floor standing or wall mounted.

PR_75_51_52_00.2030A ENCLOSURE FINISH:

- Apply high standard finish to enclosure and supporting metalwork. Degrease metal and remove rust prior to applying finish.
- Comply with paint manufacturer's recommendations regarding preparation, stoving times, temperatures, mixing of finishes, application and coat thickness.
- Finish - Manufacturer's standard.
- Colour – As specified

PR_75_51_52_00.2040 SITE MODIFICATION:

- Do not make site alterations unless authorised. Where site modifications to assemblies are authorised make in accordance with manufacturer's certified drawings and instructions. Ensure that modifications made comply with type test certificate obtained for arrangement of components.

PR_75_51_52_00.2050C CONTINUOUS LV CONTACTORS AND MOTOR STARTERS:

- Standard - BS EN 60947-4-1 or BS EN 60947-4-2.
- Type of equipment - A.C. mechanical contactor. Interrupting medium, air.
- Operating condition.
    - Method of operation - Electromagnetic.
    - Method of control - Automatic.
- Rated and limiting values for the main circuit.
    - Rated voltage (Volts) - Operational, 400.
    - Rated duty - Continuous.
    - Operational performance.
        - One rotation direction, with motor stopping between operations.
    - Control circuits
        - Electrical - ac; rated frequency (Hertz), 50; rated voltage (Volts), 230.
    - Co-ordination with short-circuit protective devices - Type1
    - Enclosure degree of protection to BS EN 60529, IP 31.
    - Minimum mechanical and electrical endurance
        - Mechanical 0.3 million; electrical 15,000.
    - Provide mechanical and electrical interlocks to prevent simultaneous closure of paired contactors.

PR_75_51_52_00.2060A CONTROL CIRCUIT DEVICES:

- Standard - BS EN 60947-5-1
- Type of equipment.
    - a.c. control circuit device
    - Manual control switches; emergency stop; control relays; pilot switches; position switches; associated equipment; auxiliary contacts and indicating lamps.
    - Interrupting medium, Air.
    - Operating condition.
        - Method of operation - electromagnetic.
        - Method of control - automatic.
- Rated and limiting values for the main circuit.
    - Rated voltage (Volts) - operational, 230.
    - Rated frequency (Hertz), 50.
    - Contact element classification.

- Enclosure degree of protection IP 31.

PR_75_51_52_00.2070A ISOLATING SWITCHES:

- Standard - BS EN 60947-3.
- Provide independent manual operation type isolating switches with rated duty, rated operational current and utilization category compatible with contactor.

PR_75_51_52_00.2080A CONTROL SELECTOR SWITCHES:

- Standard - BS EN 60947-5-1
- Provide panel mounting independent manual operation rotary type switch to select local/off/remote control.
- Ensure switch rated thermal current, rated operational current, and utilization category are compatible with contactor control circuit characteristics and circuit protection device.

PR_75_51_52_00.2090A IN-BUILT PUSH BUTTONS:

- Provide panel mounting type push buttons with actuator colours to BS EN 60073.
- Standard- BS EN 60947-5-1.
- Pattern
  - Supply flush button type start/on and reset push buttons. Supply mushroom actuator type stop/off push buttons released by turning the actuator.
- Ensure rated thermal current, rated operational current and utilization category of push button contacts are compatible with contactor control circuit characteristics and circuit protection device.

PR_75_51_52_00.2110A CONTACTOR CONTROL RELAYS:

- Standard BS EN 60947-5-1, install relays in contactor enclosure.
- Relay enclosure protection to BS EN 60529
  - Compatible with contactor enclosure.

PR_75_51_52_00.2120A CONTROL AND INDICATOR LIGHT CIRCUIT FUSES:

- Provide in contactor enclosure separate low voltage fuse bases, fuse carriers and cartridge fuses for protection of control circuits and indicator light circuits.
- Fuses
  - Fully shrouded impact resistant moulded plastic fuse bases and carriers in accordance with BS EN 60269 (BS 88).

PR_75_51_52_00.2130A MOTOR STARTERS - MOTORS BELOW 0.37 KW:

- Provide circuit breakers for motors below 0.37 kW.

PR_75_51_52_00.2130B MOTOR STARTERS - MOTORS OF 0.37KW AND ABOVE:

- Provide starters incorporating overcurrent protection for motors of 0.37kW and above.
  - Provide starter with manual reset, adjustable, inverse time delay, and ambient temperature compensated thermal overcurrent release to BS EN 60947-4-1. Ensure overcurrent release is compatible with starting, accelerating and running characteristics of motor, starter and driven machine combination. Use phase unbalance protection on three phase equipment.

PR_75_51_52_00.2140 CURRENT LIMITING MOTOR STARTERS:

- Use static type thyristor voltage control starter to provide reduced current starting.
- Provide adjustable ramp times.
- Provide contactor for switching and disconnector for isolation.
  - Provide details of harmonic distortion content prior to ordering.

PR_75_51_52_00.2150 DIRECT-ON-LINE MOTOR STARTERS:

- Use direct-on-line starter to BS EN 60947-4-1, with single phase motors and three phase motors.

PR_75_51_52_00.2160 STAR DELTA MOTOR STARTERS:

- Use star delta starter to BS EN 60947-4-1 with three phase motors.
- Incorporate adjustable time delay contactor relays, to control star delta changeover, ensuring

electrical endurance compatible with starter contactors. Ensure starting sequence activated on voltage restoration.

PR_75_51_52_00.2170A AUTO-TRANSFORMER MOTOR STARTERS:

- Use auto-transformer starter to BS EN 60947-4-1 with three phase motors.
    - Provide 2 step closed transition auto transformers suitable for 3 operating cycles per hour.
- Provide auto transformers with three tappings for selection of motor starting voltage. Arrange tappings to limit motor starting current to 80 per cent, 65 per cent and 50 per cent of full voltage starting current.
- Incorporate adjustable time delay contactor relays, to control automatic changeover from selected reduced voltage to full voltage, having an electrical endurance compatible with starter contactors. Ensure starting sequence activated on voltage restoration.

PR_75_51_52_00.2180A STATOR ROTOR MOTOR STARTERS:

- Use stator rotor starter to BS EN 60947-4-1 with three phase motors.
    - Provide starter resistors suitable for indicated operating cycles per hour.
- Incorporate adjustable time delay contactor relays, to control starter resistor short circuiting contactors, having electrical endurance compatible with starter contactors. Ensure starting sequence activated on voltage restoration.

PR_75_51_52_00.2190A CONTROL PANEL INVERTOR MOTOR STARTERS:

- Supply inverters to control speed of standard AC Squirrel cage motors.
- Inverter type - Digital PWM.
- Control range - 0.5 to 120 Hz
- Power factor - 0.95 or better.
- Characteristics
    - Ensure acceleration and deceleration ramps are independently adjustable.
    - Allow connection to a turning motor without braking to a standstill.
    - Allow connection to a reverse windmilling fan without causing tripping and return fan to correct speed. Ensure inverters require no additional means for starting. Supply inverters that do not require electrical matching to motor. Ensure inverters are capable of running motors in parallel.
    - EMC characteristics to BS EN 61800.
- Mains interruption
    - Ensure inverter does not cause tripping through a mains interruption of 200 msec.
- Protection
    - Ensure inverter incorporates the following protection to cause electronic shut down without operating circuit protective devices.
    - Motor phase to phase fault; motor phase to earth fault; overvoltage; under voltage; inverter overheat; motor overheat; loss of control signal; loss of auxiliary control voltage; current limit.
- Inverter controls - Local/remote facility.
- Display
    - Make provision for inverter to display externally, external and internal faults following a failure.
    - Show 1st, 2nd and 3rd up sequential faults.
    - Provide digital readout to show output frequency Hz; reference 1 (Hand); reference 2 (Auto); motor current (% or Amps); fault memory.
    - Provide volt free remote signalling contacts to indicate common fault; running/stopped conditions; healthy/tripped conditions.
    - Ensure parameters can be set and fault memory interrogated with door closed, and without additional instrumentation.

PR_75_51_52_00.2190B MOTOR CONTROL CENTRE INVERTER MOTOR STARTERS:

- Supply inverters to control speed of standard AC Squirrel cage motors.

- Inverter type - Digital PWM.
- Location - Motor control centre.
- Control range - 0.5 to 120 Hz Power factor - 0.95 or better.
- Starting current - Not to exceed 2 x FLC.
- Characteristics
    - Ensure acceleration and deceleration ramps are independently adjustable.
    - Allow connection to a turning motor without braking to a standstill.
    - Allow connection to a reverse windmilling fan without causing tripping and return fan to correct speed. Ensure inverters require no additional means for starting. Supply inverters that do not require electrical matching to motor. Ensure inverters are capable of running motors in parallel.
    - EMC characteristics to BS EN 61800.
- Mains interruption
    - Ensure inverter does not cause tripping through a mains interruption of 200 msec.
- Protection
    - Ensure inverter incorporates the following protection to cause electronic shut down without operating circuit protective devices.
    - Motor phase to phase fault; motor phase to earth fault; overvoltage; under voltage; inverter overheat; motor overheat; loss of control signal; loss of auxiliary control voltage; current limit.
- Inverter controls - Local/remote facility.
- Display
    - Make provision for inverter to display externally, external and internal faults following a failure.
    - Show 1st, 2nd and 3rd up sequential faults.
    - Provide digital readout to show output frequency Hz; reference 1 (Hand); reference 2 (Auto); motor current (% or Amps); fault memory.
    - Provide volt free remote signalling contacts to indicate common fault; running/stopped conditions; healthy/tripped conditions.
    - Ensure parameters can be set and fault memory interrogated with door closed, and without additional instrumentation.

PR_75_51_52_00.2200 AUTOMATIC CHANGEOVER FOR RUN/STANDBY DUTY - SINGLE POWER SUPPLY:

- Fit a control switch to starter enclosure arranged to select either motor for "run" or "standby" duty. Indicate selection of respective motor by illumination of indicator lights on starter enclosure.
- Provide facilities for connection of remote indicator lights to indicate selection/operation of system and for connection of a system malfunction audible alarm where indicated.
- Arrange for selected "run" duty motor to operate in response to system controls, and in event of operation of duty motor starter overcurrent trip, for automatic changeover to "standby" motor.
- Control power supply to starter by an air break isolating switch interlocked with starter enclosure access door.

PR_75_51_52_00.2210 AUTOMATIC CHANGEOVER FOR RUN/STANDBY DUTY - DUAL POWER SUPPLY:

- Fit a control switch to starter enclosure arranged to select either motor for "run" or "standby" duty.
- Indicate selection of respective motor and availability of the two power supplies by illumination of indicator lights on starter enclosure.
- Provide facilities for connection of remote indicator lights to indicate selection/operation of system and for connection of a system malfunction audible alarm where indicated.
- Arrange for selected "run" duty motor to operate in response to system controls, and on loss of power supply to "run" duty motor or operation of motor starter overcurrent trip, for automatic changeover to "standby" motor.
- Control the two power supplies by a single air break multiple isolating switch interlocked with starter enclosure access door.

PR_75_51_52_00.2220 CONTROL CIRCUIT TRANSFORMERS:

- Provide control circuit transformers to supply power at voltages to suit control components.

- Standard
    - Use transformers in accordance with BS EN 61558-2-9 or BS EN 61558-1 and provide an external label of approved type and size.
- Protection - Primary and secondary fuses.

PR_75_51_52_00.2230A SWITCHING AND INDICATION:

- Provide switches, indicating lamps, instruments and controls of uniform appearance and physically protected.
- Switches and indicators
    - Fit on panel or access doors Stop/Start/Reset push buttons; Auto/Off/Manual control selector switch; run and trip indicator lights.

PR_75_51_52_00.2240 AUDIBLE ALARMS:

- Ensure that operation of any starter trip lamp, safety circuit lamp or alarm lamp operates a common audible alarm with mute and test facilities and terminals for remote alarm signal.
- When an alarm condition has had the audible alarm muted, ensure that terminals for a remote "alarm accepted" light are energised. The audible alarm circuit and terminals for remote alarm signal must still be capable of indicating another fault occurring even though original fault has not been cleared. The test facilities are to test momentarily both the audible alarm and all alarm indicator lamps, whilst the push button is depressed.
- Use alarms that interface with a sensor or controller to sense set-point and measured value. Provide adjustable upper and lower limits on face of unit. Provide unit with indicating lamps to show which limit has been exceeded. Provide each unit with connections for remote alarm.

PR_75_51_52_00.2250A PROGRAMMABLE LOGIC CONTROLLERS:

- Provide programmable logic controllers in accordance with the manufacturer's recommendations and the specified control requirements.
- Standard - BS EN 61131.
    - Provide fuse and isolator for the Programmable Logic Controller. Install PLC with control components.
    - Programming language standard - BS EN 61131-3

PR_75_51_52_00.2260A STARTER AND CONTROL PANEL INTERNAL WIRING:

- Standard - BS 6231.
- Wiring coding - Random colours and CPC green/yellow.
- Control wiring
    - Segregate control wiring from power circuits. Contain control wiring in ventilated plastic trunking. Identify each end of each wire with a unique number.
    - All control trunking to be of LSF construction.
- Power wiring
    - Take account of thermal effects of grouping when routing power wiring. Identify each end of each wire with a unique number.

PR_75_51_52_00.2270A COMPONENT MOUNTING:

- Mount all components of the switchgear and control gear in accordance with the manufacturer's instructions.
- Mount control components on top hat rails (35mm) to BS 5584 (EN 50022).

PR_75_51_52_00.2280A CONTROL SYSTEM FUNCTION CHARTS:

- Prepare function charts for the control system in accordance with BS EN 60848. Obtain approval of function chart before design of system hardware or writing control software.
    - Function chart format - Combined function chart/circuit diagram.

PR_75_51_52_00.3010 INSTALLATION:

- Install control panels, motor control centres, contactors and starters in accordance with BS EN 60947

and manufacturer's recommendations.

26.0 PR_70_70_48_00 LUMINAIRES AND LAMPS

PR_70_70_48_00.2005 LAMP EFFICACY:

- The system is designed to achieve an average initial circuit of at least 65 lumens/watt for fixed lighting equipment within the building.

PR_70_70_48_00.2010A LUMINAIRES - GENERAL PURPOSE:

- Standards
  - Supply luminaires with photometric data in accordance with BS EN 13032-1.
  - Supply luminaires in accordance with BS EN 60598).
- Classification - To BS EN 60598-1.
- Safety Support for Components
  - Provide secondary support for translucent covers, diffusers and gear trays so they are prevented from falling when their primary fixing is released.
- Photometric performance
  - Ensure luminaires of similar type have same photometric performance as published data within the tolerances defined by BS EN 13032-1.
- Electromagnetic compatibility
  - Ensure luminaires comply with BS EN 61547 for EMC immunity.

PR_70_70_48_00.2010B LUMINAIRES - GENERAL PURPOSE WITH SAFETY GLASS:

- Standards
  - Supply luminaires with photometric data in accordance with BS EN 13032-1.
  - Supply luminaires in accordance with BS EN 60598).
- Classification - To BS EN 60598-1.
- Safety
  - Fit luminaire with cover glass to protect against ultra-violet emission and risk from explosion of lamps.
- Safety Support for Components
  - Provide secondary support for translucent covers, diffusers and gear trays so they are prevented from falling when their primary fixing is released.
- Photometric performance
  - Ensure luminaires of similar type have same photometric performance as published data within the tolerances defined by BS EN 13032-1.
- Electromagnetic compatibility
  - Ensure luminaires comply with BS EN 61547 for EMC immunity.

PR_70_70_48_00.2010C LUMINAIRES - SPECIAL APPLICATIONS:

- Standards
  - Supply luminaires with photometric data in accordance with BS EN 13032-1.
  - Supply luminaires in accordance with BS EN 60598).
- Classification - To BS EN 60598-1.
- Electromagnetic compatibility
  - Ensure luminaires comply with BS EN 61547 for EMC immunity.

PR_70_70_48_00.2020A EMERGENCY LIGHTING LUMINAIRES:

- Comply with BS EN 60598-2-22.
- Comply with ICEL:1001. Ensure emergency lighting luminaires are marked with ICEL certification label.

PR_70_70_48_00.2040A HAZARDOUS AREA LUMINAIRES:

- BS EN 60079-15 or BS EN 60079-25 as appropriate.

PR_70_70_48_00.2060A LAMPHOLDERS - GENERALLY:

- Lamp caps - BS EN 60061-1.

- Lamp holders - BS EN 60061-2.
- Lampholders with enhanced safety features - BS 7895.
- Bayonet lampholders - BS EN 61184.
- Lampholders for tubular fluorescent lamps and starter holders - BS EN 60400.
- Edison screw lampholders - BS EN 60238.
- Interchangeability
    - Ensure lampholders in luminaires of similar type and rating are identical.
- Earthing
    - Ensure metal lampholders incorporate an earthing terminal.

PR_70_70_48_00.2080A LAMPHOLDERS - MOUNTING:

- Securely mount lampholder in luminaire when it is sole support for lamp.
- Cord grip
    - Provide integral cord grip type when lampholders are suspended by cord.
- Conduit Mounted
    - When mounted directly to conduit system use back plate lampholder for conduit box.

PR_70_70_48_00.2090A CONTROL GEAR AND COMPONENTS:

- Compatibility
    - Ensure control gear and components are suitable for lamp type, wattage and starting characteristics. Obtain from manufacturers written confirmation of compatibility.

PR_70_70_48_00.2095 CIRCUIT LOSSES:

- Use high frequency ballasts to ensure the installed circuit load does not exceed 3 W/m2/ 100 lux.

PR_70_70_48_00.2100A FLUORESCENT LAMP BALLASTS AND STARTERS:

- Ballasts
    - BS EN 61347-2-8 and BS EN 60921.
    - BS EN 61347-2-3, BS EN 61347-2-7 and BS EN 60925 for d.c. supplied electronic ballasts.
    - BS EN 60081 and BS EN 60901.
    - Supply thermal protectors for ballasts for tubular fluorescent lamps to BS EN 60730-2-3.
- Starters - BS EN 61347-2-1 and BS EN 60927.
- Use low distortion type.

PR_70_70_48_00.2110A DISCHARGE LAMP BALLASTS AND STARTERS:

- Ballasts - BS EN 61347-2-9 and BS EN 60923.
- Starters - BS EN 61347-2-1 and BS EN 60927.

PR_70_70_48_00.2120A CAPACITORS:

- Use capacitors in accordance with BS EN 61048 and BS EN 61049 in tubular fluorescent, high pressure mercury and low pressure sodium vapour discharge lamp circuits.

PR_70_70_48_00.2130 SUPPLY TERMINALS:

- Use screw terminals for supply cables and circuit protective conductors, sized to terminate up to three 2.5mm2 conductors. Provide separate terminal blocks for each incoming circuit, with marking to identify each circuit.

PR_70_70_48_00.2160 REMOTE GEAR:

- Locate control gear in separate lockable cabinet of sheet steel with same degree of protection and finish specified for luminaire. Comply with manufacturer's recommendations for maximum cable length between gear and lamp.

PR_70_70_48_00.2180A FLUORESCENT LAMPS:

- Internationally specified tubular fluorescent lamps to BS EN 60081.
- UK tubular fluorescent lamps to BS 1853-2.
- Single capped fluorescent lamps to BS EN 60901 and BS EN 61199.

- Double capped fluorescent lamps to BS EN 60081 and BS EN 61195.
- Self-ballasted lamps to BS EN 60968.

PR_70_70_48_00.2190 HIGH PRESSURE MERCURY VAPOUR LAMPS:
- Comply with BS EN 60188 and BS EN 62035.

PR_70_70_48_00.2215A LED LAMPS:
- Comply with BS EN 62031, DD IEC/PAS 62612, BS EN 62386-207 and BS EN 61347-2-13.

PR_70_70_48_00.2220A TRANSFORMERS FOR LV LUMINAIRES:
- Type
  - Electronic.
  - Single luminaire.
- Duty
  - Input voltage 230 volts.
  - Output voltage to suit lamp.
  - Single phase.
  - Frequency 50Hz.
  - Rating (kVA) to suit lamp.
- Standards
  - BS EN 55014.
  - BS EN 61000.
  - BS EN 61047.
  - BS EN 61347-2-2.
  - or BS EN 61558 as appropriate.
- Construction
  - Manufacturer's standard.
- Protection
  - Thermal cut out with automatic reset.
- Location
  - Be accessible.
- Cabling
  - Secondary maximum cable length as manufacturer's recommendations.
  - Separate transformer from secondary low voltage cables (m)
- Connections to luminaires
  - Hard wired
  - Plug and socket

PR_70_70_48_00.2240A SUPPORT SYSTEM - CONDUIT:
- Use not less than 20mm conduit of same type as main conduit system.
- Material - steel.

PR_70_70_48_00.2250A SUPPORT SYSTEM - ROD:
- Use continuously threaded rods with matching washers and nuts.
- Diameter - 6mm.
- Material - Cadmium plated steel.

PR_70_70_48_00.2260A SUPPORT SYSTEM - CHAIN:
- Use cadmium plated steel chain with load carrying capacity of not less than twice weight of complete luminaire.

PR_70_70_48_00.2270A SUPPORT SYSTEM - FLEXIBLE CORD:
- Use size and type as indicated.
- Confirm temperature rating is suitable for operating temperature of luminaire or lampholder. Confirm that cord is adequate for mass to be supported.

PR_70_70_48_00.2280A SUPPORT SYSTEM - WALL BRACKETS:

- Provide wall brackets. Confirm wall brackets are suitable for supporting luminaire.

PR_70_70_48_00.2290 SUPPORT SYSTEM - BALL AND SOCKET:

- Provide ball and socket as top support, complete with cover fixed to circular conduit box.

PR_70_70_48_00.2295 SUPPORT SYSTEM - WIRE ROPE:

- Provide wire rope support system. Confirm wire rope is suitable for supporting luminaires.

PR_70_70_48_00.2300A STEEL COLUMNS AND BOLLARDS:

- Standards - BS EN 40-2 and BS EN 40-5.
- Material - Steel.
- Bracket - Match column.
- Earthing
    - Include earthing terminal fixed within service compartment.
- Column base plate - Standard.

PR_70_70_48_00.2300C ALUMINIUM COLUMNS AND BOLLARDS:

- Standards - BS EN 40-2 and BS EN 40-6.
- Material - Aluminium.
- Bracket - Match column.
- Earthing
    - Include earthing terminal fixed within service compartment.
    - Column base plate - Standard.

PR_70_70_48_00.3010A TRACK LIGHTING:

- Where indicated provide track for fixing fittings in accordance with BS EN 60570.

PR_70_70_48_00.3030A AIR HANDLING LUMINAIRES:

- Provide assembly of luminaire and exhaust air device or luminaire and supply air device to meet design requirements for illumination and air flow. Ensure assembly can be integrated into a false ceiling, flush mounted.
- Diffuser
    - Allow for the path of exhaust air in the diffuser.
    - Exhaust air outlet
    - Provide an outlet for the air via a series of circular openings in top of assembly casing.
- Supply air diffuser
    - Supply the air diffuser as a component of the assembly.
- Fixing
    - Ensure the fixing is capable of carrying the weight of the whole assembly.

PR_70_70_48_00.4060 MATERIAL OF SUPPORTING SURFACE:

- Ensure classification of luminaires is appropriate. Do not mount luminaires on readily flammable surfaces.

PR_70_70_48_00.4110 SUPPORT

- Ensure support is adequate for weight of luminaires.
- Number
    - Provide the following minimum number of supports for each luminaire longer than 600mm.

Luminaire width (mm)	Minimum number of supports

Up to and including 300	2
Over 300	4

PR_70_70_48_00.4120 SUPPORT FROM CONDUIT:

- Where luminaire is supported from conduit provide a conduit box forming an integral part of conduit system at each point of suspension. Ensure suspensions are vertical.
- Where conduit enters luminaire use back-nuts and washers to secure luminaire body to conduit support. Provide tube with corrosion resistance equal to conduit system.
- Do not support luminaires directly from conduit boxes made from non-metal or heat sensitive materials, where the temperature of the material may exceed 60^{O}C or the mass suspended exceeds 3kg.

PR_70_70_48_00.4130 SUPPORT FROM TRUNKING:

- Where luminaire is supported from trunking use proprietary clamps or brackets appropriate to the luminaire and trunking.
- Do not support luminaires directly from trunking made from non-metal or heat sensitive materials, where the temperature of the material may exceed 60^{O}C or the mass suspended exceeds 3kg.

PR_70_70_48_00.4140A SUPPORT BY DIRECT FIXING:

- Refer to fixing methods, use luminaire supporting coupler to follow manufacturer's recommendations.

PR_70_70_48_00.4160 SUSPENSION:

- Suspend luminaires at height indicated. Ensure suspensions hang vertically unless otherwise indicated.

PR_70_70_48_00.4170 SUSPENSION BY ROD:

- Use washers, nut and lock-nut at top and bottom of rod. Paint cut ends with calcium plumbate primer or zinc rich paint.

PR_70_70_48_00.4180 SUSPENSION BY CHAIN:

- Use hook cover for suspension from circular conduit box. For connection to luminaires use luminaire manufacturer's own chain hook, but if not available use hook with standard screw threaded body to be secured to luminaire body with nuts and washers. Where indicated use captive hooks.

PR_70_70_48_00.4210A COLUMNS AND BOLLARDS:

- Location - Confirm location before excavation.
- Bases - Install bases in accordance with bollard or column manufacturer's instructions.
- Mounting
    - Mount column or bollard on base as recommended by manufacturer.
    - Ensure columns and bollards are vertical unless otherwise indicated.
- Earthing
    - Install circuit protective conductor to connect luminaire to earthing terminal in service compartment; size circuit protective conductor same as live conductors. Bond accessible metal parts of column or bollard to earthing terminal.

PR_70_70_48_00.4220 CONNECTIONS TO LUMINAIRES

- Cable Protection
    - Use appropriate size of grommet where cables enter through hole in luminaire body.
- Earthing
- Ensure that the earthing terminal of Class 1 luminaires is connected to the conduit protective conductor of the supply circuit.
- Loose Wiring

- Clip or tie back with suitable proprietary devices loose wiring within luminaire, at 300mm intervals.

PR_70_70_48_00.4230A CONNECTIONS TO LUMINAIRES - DIRECT TO CONDUIT - TERMINAL BOX:

- Terminate circuit wiring in terminal block within supporting conduit box. Use flexible cord from terminal block to luminaire.

PR_70_70_48_00.4230B CONNECTIONS TO LUMINAIRES - DIRECT TO CONDUIT - AT LUMINAIRE:

- Terminate circuit wiring at supply terminals of luminaire. Take all conductors through same cable entry into luminaire.

PR_70_70_48_00.4240B CONNECTIONS TO LUMINAIRES - DIRECT TO TRUNKING - AT LUMINAIRE:

- Terminate circuit wiring at supply terminals of luminaire. Take all conductors through same cable entry into luminaire.

PR_70_70_48_00.4260A CONNECTIONS TO LUMINAIRES - RECESSED FITTINGS - PLUG AND SOCKET:

- Where luminaires are recessed in a suspended ceiling, terminate circuit wiring at plug and socket to BS 546, located not more than 500mm from the access through the ceiling. Use flexible cord from plug of ceiling rose to supply terminals of luminaire.

PR_70_70_48_00.4270 CONNECTIONS TO LUMINAIRES - CONDUIT SUSPENSION:

- Terminate circuit wiring in terminal block within supporting conduit box. Use flexible cable from terminal block to luminaire, installed within tube.

PR_70_70_48_00.4280 CONNECTIONS TO LUMINAIRES - ROD OR CHAIN SUSPENSION:

- Terminate circuit wiring in terminal block within supporting conduit box. Use flexible cord from terminal block to luminaire and clip cable to one of the rods or chains, do not weave cable through links of the chain.

PR_70_70_48_00.4290 CONNECTIONS TO LUMINAIRES - MICS CABLE:

- Fix cable gland to luminaire and continue conductors to supply terminals of luminaire.

PR_70_70_48_00.4300A SEPARATE LIGHTING SWITCHES ON DIFFERENT PHASES:

- Install lighting switches on different phases at least 2m apart.

PR_70_70_48_00.4300B PHASE BARRIER LIGHTING SWITCHES ON DIFFERENT PHASES:

- When lighting switches on different phases are in a common box, use phase barrier switches in accordance with BS 7671.

27.0 PR_65_72_00_00 ACCESSORIES FOR ELECTRICAL SERVICES

PR_65_72_00_00.1000 GENERAL:
Install all accessories for electrical services in accordance with the manufacturer's recommendations.

PR_65_72_00_00.1010 APPLICATION:
- Supply fixed electrical wiring accessories for use with fixed and portable peripheral equipment using either power or signalling cables.

PR_65_72_00_00.1020 SAMPLES:
- Submit samples of proposed materials and equipment for approval before work is started. Label each sample with name, catalogue number and reference to the use or services. See contract preliminaries.

PR_65_72_00_00.2010A ACCESSORIES COMMON REQUIREMENTS
- Area of installation - Interior.
- Accessory mounting
    - Adjustable steel grid for grid switches or direct to enclosure for all other accessories.
- Enclosure material- Pressed steel.
- Enclosure finish - Galvanized.
- Coverplate finish, all accessories to match
- Ancillaries
    - Earthing terminal integral within switch box.
    - Neon indicator with red lens, illuminated in "ON" position, for connection units.
    - Switch rocker bar colour - white.
    - Operating keys for key operated switches, minimum number 2.
    - Fuses to BS 1362.
    - Blank inserts for spare ways on grid switches.
- Marking
    - Method - engraving. Mark front plate to indicate equipment served on connection units.
- Conduit and cable entries
    - Knockouts side, top and rear.

  Cable termination - Manufacturer's standard.

PR_65_72_00_00.2010A WHITE PLASTIC PLATES GRID, FLUSH INSTALLATION:
- Enclosure pattern - Flush.
- Coverplate finish, all accessories to match
    - Moulded plastic, colour - white.
- Coverplate pattern - Overlapping; with architrave where indicated.

PR_65_72_00_00.2010B MATT CHROME FINISH METAL PLATES, FLUSH INSTALLATION:
- Enclosure pattern - Flush.
- Enclosure material - Pressed steel.
- Enclosure finish - Galvanized.
- Coverplate finish, all accessories to match
    - Brass with matt chrome surface.

PR_65_72_00_00.2010D METAL CLAD PLATES, SURFACE STEEL CONDUIT INSTALLATION:
- Enclosure pattern - Surface.
- Accessory mounting - Direct to enclosure.
- Enclosure material
    - Pressed steel or cast iron.
- Enclosure finish
    - As conduit system or galvanized.
- Coverplate finish, all accessories to match

    - Metal clad.
- Coverplate pattern - Surface type.
- Conduit and cable entries
    - Threaded entries, top, bottom or side to suit conduit system.
- Cable termination - Manufacturer's standard.

PR_65_72_00_00.2010E SURFACE, STEEL CONDUIT, WEATHERPROOF INSTALLATION:

- Area of installation - Exterior.
- Enclosure pattern - Surface and weatherproof.
- Accessory mounting - Direct to enclosure.
- Enclosure material - Cast iron.
- Enclosure finish - As conduit system or galvanized.
- Coverplate finish, all accessories to match
    - As enclosure.
- Coverplate pattern - Surface type.
- Ancillaries
    - Earthing terminal integral within switch box.
    - Neon indicator with red lens, illuminated in "ON" position, for connection units.
    - Screwed weathering cap and chain for socket outlets.
    - Operating keys for key operated switches, minimum number 2.
    - Fuses to BS 1362.
- Conduit and cable entries
    - Threaded entries, top, bottom or side to suit conduit system.
- Cable termination - Manufacturer's standard.

PR_65_72_00_00.2010F SURFACE, PLASTIC, WEATHERPROOF INSTALLATION:

- Area of installation - Exterior.
- Enclosure degree of protection to BS EN 60529, IP 54.
- Enclosure pattern - Surface and weatherproof.
- Accessory mounting - Direct to enclosure.
- Enclosure material - Impact resistant plastic.
- Enclosure finish - Natural or self-coloured.
- Coverplate finish, all accessories to match
    - Moulded plastic, colour as indicated.
- Coverplate pattern - Surface type.
- Ancillaries
    - Earthing terminal integral within switch box.
    - Neon indicator with red lens, illuminated in "ON" position, for connection units.
    - Protective shrouds to rocker bars.
    - Screwed weathering cap and chain for socket outlets.
    - Switch rocker bar colour as indicated.
    - Operating keys for key operated switches, minimum number 2.
    - Fuses to BS 1362.
- Conduit and cable entries
    - Threaded entries to suit cable/conduit system.
- Cable termination - Manufacturer's standard.

PR_65_72_00_00.2020A INTERIOR LIGHTING SWITCHES – COMMON REQUIREMENTS

- Standard - BS EN 60669-1, enclosure box to BS 4662.
- Switch type - Rocker bar - moulded plastic.
- Rating – to match circuit breaker feeding the circuit
- Gangs as indicated.
- Switch mechanism - Snap action microgap.

PR_65_72_00_00.2020A INTERIOR LIGHTING SWITCHES - GENERAL PURPOSE MOULDED PLASTIC:

- Pole configurations

- Single pole, double pole, 2 way or intermediate as indicated.

PR_65_72_00_00.2020B INTERIOR LIGHTING SWITCHES - GRID MOULDED PLASTIC:

- Pole configurations
  - Single pole, 1 way, 2 way or intermediate as indicated.

PR_65_72_00_00.2020C INTERIOR LIGHTING SWITCHES - PULL CORD:

- Pole configurations - Single pole.

PR_65_72_00_00.2020D INTERIOR LIGHTING SWITCHES - GENERAL PURPOSE SECRET KEY:

- Switch type - Rocker bar - secret key.
- Pole configurations - Single pole, double pole, 2 way or intermediate as indicated.

PR_65_72_00_00.2020F INTERIOR LIGHTING SWITCHES - GRID SECRET KEY:

- Switch type - Rocker bar - secret key.
- Pole configurations - Single pole, 1 way, 2 way or intermediate as indicated.

PR_65_72_00_00.2030A EXTERIOR LIGHTING SWITCHES - METAL CLAD ROTARY:

- Switch type - Rotary disc or lever operating through sealing gland.
- Gangs as indicated.
- Action - Two position.
- Pole configurations as indicated.

PR_65_72_00_00.2030B EXTERIOR LIGHTING SWITCHES - SEALED ROCKER BAR:

- Switch type - Rocker bar with sealed in plastic membrane.
- Gangs as indicated.
- Action - Two position.
- Pole configurations as indicated.

PR_65_72_00_00.2040B TIME SWITCHES - 7 DAY:

- Wire timer and switch circuits to separate terminals.
- Standard - BS EN 60730-2-7.
- Time switch type
  - Quartz stabilized solid state 50 hour nickel cadmium battery backup.
- Contacts duty - Inductive.
- Contacts rating - 15A.
- Special programme facilities
  - Number of "ON" and "OFF" operations - 4
- Programme repeat cycle - 7 day.

PR_65_72_00_00.2050A LUMINAIRE CONNECTORS - GENERAL AND EMERGENCY LIGHTING:

- Connector type
  - Fixed terminal strip, screw cover and cord grip to BS 67.
- Load carrying capacity to match selected luminaire.

PR_65_72_00_00.2050B LUMINAIRE CONNECTORS - GENERAL LIGHTING:

- Connector type
  - 3 pin plug/socket to BS 546.
- Load carrying capacity to match selected luminaire.

PR_65_72_00_00.2050C LUMINAIRE CONNECTORS - CORD GRIP GENERAL AND EMERGENCY LIGHTING:

- Connector type
  - Cord grip type plug/socket and screw on retaining cover to BS 5733 3 pin or 4 pin.
- Load carrying capacity to match selected luminaire.

PR_65_72_00_00.2060A LAMPHOLDERS - BC TYPE:

- Standard - BS EN 61184.
- Lampholder type - Bayonet clip - B22.
- Fixing - Bracket - straight or angle, or suspension as indicated.
- Finish - Manufacturer's standard.
- Material - Heat resistant moulded plastic.
- Ancillaries
    - Cord grip, lampshade ring or protective lampshade ring as indicated.

PR_65_72_00_00.2060B LAMPHOLDERS - ES TYPE:

- Standard - BS EN 60238.
- Lampholder type - Edison screw - E27.
- Fixing - Bracket - straight or angle, or suspension as indicated.
- Finish - Manufacturer's standard.
- Material - Heat resistant moulded plastic.
- Ancillaries
    - Cord grip, lampshade ring or protective lampshade ring as indicated.

PR_65_72_00_00.2070A ISOLATING SWITCHES - BS EN 60669-1:

- Provide isolating switches for fixed appliances.
- Utilization category as indicated.
- Making capacity as indicated.
- Standard - BS EN 60669-1, enclosure box to BS 4662.
- Switch type - Rocker bar.
- Rating as indicated on schedule.
- Pole configuration - DP, three pole or TPN as indicated.

PR_65_72_00_00.2070B ISOLATING SWITCHES - BS EN 60947-3:

- Provide isolating switches for fixed appliances.
- Utilization category as indicated on schedule.
- Making capacity as indicated.
- Standard - Enclosure box to BS 4662, BS EN 60947-3.
- Switch type - Rocker bar.
- Rating as indicated on schedule.
- Pole configuration - DP, three pole or TPN as indicated.

PR_65_72_00_00.2080A FUSE CONNECTION UNITS - SWITCHED:

- Standard - BS 1363-4, enclosure box to BS 4662 and switched.
- Unit type - Rocker bar - plastic.
- Pole configuration - DP.
- Ancillaries
    - Cord outlet or cord grip and fuse as indicated.

PR_65_72_00_00.2080B FUSE CONNECTION UNITS - UNSWITCHED:

- Standard - BS 1363-4, enclosure box to BS 4662 and un-switched.
- Pole configuration - DP.
- Ancillaries
    - Cord outlet or cord grip and fuse as indicated.
    - Lockable fuse carrier.

PR_65_72_00_00.2090A SOCKET-OUTLETS - SINGLE, SWITCHED:

- Standard - 13A socket-outlet to BS 1363, enclosure box to BS 4662.
- Switching - Switched.
- Switch type - Rocker bar - plastic.
- Rating - 13A.
- Ancillaries

    - Plug tops 25% of number of sockets, fused as indicated.
- Gangs – 1

PR_65_72_00_00.2090B SOCKET-OUTLETS - SINGLE WITH INTEGRAL RCD, SWITCHED:

- Standard - Enclosure box to BS 4662, BS 7288.
- Switching - Switched
- Switch type - Rocker bar - plastic.
- Rating - 13A.
- Ancillaries
    - RCD, BS 7288. Mains failure trip, sensitivity 30mA. Plug tops 25% of number of sockets, fused as indicated.
- Gangs – 1

PR_65_72_00_00.2090C SOCKET-OUTLETS - DOUBLE SWITCHED:

- Standard - 13A socket-outlet to BS 1363, enclosure box to BS 4662.
- Switching - Switched
- Switch type - Rocker bar - plastic.
- Rating - 13A.
- Ancillaries
    - Plug tops 25% of number of sockets, fused as indicated.
- Gangs – 2

PR_65_72_00_00.2090D SOCKET-OUTLETS - SINGLE, UNSWITCHED:

- Standard - 13A socket-outlet to BS 1363, enclosure box to BS 4662.
- Switching – un-switched.
- Rating - 13A.
- Gangs – 1

PR_65_72_00_00.2100A COOKER CONTROL UNIT - WITH INTEGRAL SOCKET:

- Standard - BS 4177, enclosure box to BS 4177.
- Unit type - With integral 13A switched socket-outlet and pilot lamp.
- Pole configuration - DP.
- Rating - 45A.

PR_65_72_00_00.2100B COOKER CONTROL UNIT - WITHOUT SOCKET:

- Standard - BS 4177, enclosure box to BS 4177.
- Unit type - With pilot lamp.
- Pole configuration - DP.
- Rating - 45A.

PR_65_72_00_00.2120A CABLE AND APPLIANCE COUPLERS - 16A, 240V SINGLE PHASE, GENERAL PURPOSE:

- Standard - BS EN 60309-2.
- Material - Polycarbonate male and female connectors.
- Rating - Voltage 220 - 240V; Current 16A.
- Configuration - 2PE.
- Colour - 220 - 240V, Blue.
- Ancillaries as indicated.
    - ON/OFF switch; gang combinations 1, 2, 3 and 4; RCD. BS 7288 sensitivity 30mA.

PR_65_72_00_00.2130A TELEPHONE AND DATA OUTLET SOCKETS - GENERAL PURPOSE:

- Standard
    - For jack socket to telephone service provider requirements and enclosure box to BS 4662.
- Size - Standard.
- Circuit configurations as indicated.

PR_65_72_00_00.2140A TELEPHONE CORD OUTLETS - GENERAL PURPOSE:

- Standard - BABT approved.
- Circuit configurations - Single or twin as indicated.

PR_65_72_00_00.2190A SHAVER POINTS - BATHROOM AND WASHROOM USE:

- Provide shaver points, internally switched by plug insertion.
- Standard
    - BS EN 61558-2-9, BS EN 61558-1 and BS EN 61558-2-23, enclosure box to BS 4662.
- Rating - 20VA.
- Components
    - Double wound single phase transformer 240/240V and 110V to BS EN 61558-2-9, BS EN 61558-1 and BS EN 61558-2-23.
    - Internal overload protection.
- Marking - Input and output voltages and "SHAVERS ONLY".

PR_65_72_00_00.2200A INDICATOR LAMPS - GENERAL PURPOSE LED:

- Standard BS EN 62094-1.
- Lamp - LED.
- Lamp rating - 230V supply.
- Lens cover - Moulded plastic.
- Lens colour - BS EN 60073.
- Lens retaining rings - Moulded plastic.

PR_65_72_00_00.3010 EARTHING:

- Ensure metal framework of equipment is bonded to main earth point. Ensure that cable CPC's are connected to earth bar via a dedicated cable, using the body of the panel is not acceptable.
- Provide earth CPC between earth lug on metal box and accessory casing except where accessory is encased in plastic.

PR_65_72_00_00.3020 PROTECTION:

- Ensure there is no physical or electrical damage to accessories when they are removed from their packaging and during installation.
- Provide masking covers for surface mounted accessories to protect surface from paint.
- Where accessories are flush mounted install front plate after painting is finished.

PR_65_72_00_00.3030 FIXING:

- Align accessories horizontally and vertically. Where accessories are grouped, mount horizontally in line and parallel to each other and equidistant.
- Fix cover plates to boxes with brass fixing screws.
- Ensure all screws are aligned.

PR_65_72_00_00.3040 MEASURING MOUNTING HEIGHTS:

- Take measurement for position of electrical accessories to the centre line of equipment from either finished floor or worktop. Where specified height coincides with top of tiling, leave a clear gap of 50mm above tiling.
- Mount equipment below a worktop 100mm below underside of worktop.

PR_65_72_00_00.3050 STANDARD ACCESSORIES MOUNTING HEIGHTS:

Accessory	Location	Height (mm)
Lighting switch		1200
Socket outlet	General	450
	Kitchen	1000

	Above worktop	200
Shaver socket outlet		1000
Fused connection unit	General	450
	Above worktop	200
Fused connection unit controlling	Radiator heater, wall	1800
	Radiator heater, focal point	450
	Tubular heater	450
	Clock	1900
Cooker control unit	Above worktop	200
Cooker connection unit		600
Safety isolating transformer		1200
Room thermostat		1400
Telephone outlet		450
Radio/TV outlet		450
Push button		1200
Fire alarm manual call point		1200
Bell or buzzer		2000
Visible alarm indicator		2000

- See project specific accessory setting out drawing.
- In car parks and garages comply with appropriate petroleum regulation for mounting heights of socket outlets.

PR_65_72_00_00.3070 ACCESSORIES MOUNTING HEIGHTS:

- Provide switches and socket outlets for lighting and other equipment in habitable rooms at appropriate heights between 450mm and 1200mm from finished floor level, in accordance with Building Regulations Approved Document M and BS 8300.

28.0 PR_65_70_46_00 LIGHTNING PROTECTION AND EARTHING COMPONENTS

PR_65_70_46.1000 GENERAL

PR_65_70_46.1010 MATERIALS GENERALLY:

- Use materials and installations methods in accordance with BS EN 62305, BS 7671, BS 7430, Electricity Safety, Quality and Continuity Regulations and Local Electricity Supply Authority Requirements as appropriate.

PR_65_70_46.2010A CONDUCTORS FOR LIGHTNING PROTECTION SYSTEMS - HORIZONTAL AIR TERMINATIONS:

- Use - Horizontal air termination or down conductor.
- Minimum dimension - BS EN 62561-2, BS 62305:2011
- Form - Strip.
- Material - Copper, annealed.
- Coverings - None or PVC.
- Accessories - Ridge Saddle; conductor clips - non-metallic; glazing bar holdfast; slate holdfast; back platebackplate holdfast; all accessories sized to suit conductors.

PR_65_70_46.2010B CONDUCTORS FOR LIGHTNING PROTECTION SYSTEMS - SELF SUPPORTING AIR TERMINATIONS:

- Use - Air termination, vertical.
- Minimum dimension - BS EN 62561-2, BS 62305:2011
- Form - Rod.
- Material - Copper, hard drawn.
- Coverings - None.
- Accessories - Terminal base; ridge saddle; rod brackets; rod to tape coupling.

PR_65_70_46.2010C CONDUCTORS TO EARTHING SYSTEMS TO BS 7430:

- Use – Earthing Conductor
- Minimum dimension - BS 7430, current density 50A/mm^2.
- Form - Strip.
- Material - Copper, annealed.
- Coverings - None.
- Accessories - Conductor clips, metallic.

PR_65_70_46.2020A LIGHTNING PROTECTION CONDUCTOR JOINTS:

- First Conductor
  - Form - strip; material - copper.
  - Dimensions - To BS EN 62561-2, BS 62305:2011
- Second conductor
  - Form - rod; material - copper.
  - Dimensions - To BS EN 62561-2, BS 62305:2011
- Solid joint - Brazed or welded, thermic.
- Disconnecting test joint
  - Square clamp, oblong clamp, plate clamp or screw-down clamp.

PR_65_70_46.2020B EARTHING SYSTEMS CONDUCTOR JOINTS:

- First Conductor
  - Form - strip; material - copper.
  - Dimensions - For conductor current density 50A/mm^2 earthing systems.
- Second conductor
  - Form - rod; material - copper.
  - Dimensions - For conductor current density 50A/mm^2 earthing systems.

- Solid joint - Brazed or welded, exothermic.
- Disconnecting test joint
    - Square clamp, oblong clamp, plate clamp or screw-down clamp.

PR_65_70_46.2030A TAPE FIXING DEVICES:

- Secure bare conductor tape to structure with fixing devices which avoid piercing tape and ensure 3mm (minimum) clearance of tape from structure, at 450mm maximum, centres.
- Material for lightning protection systems
    - Non-conducting.
- Material for system earthing
    - Bronze.

PR_65_70_46.2040B ROD EARTH ELECTRODES FOR SYSTEM EARTHING:

- Standard - BS 7430.
- Form - rod with female thread each end.
- Dimensions
    - Rod Diameter - 15 mm - nominal.
    - Rod Length - 2.4m (2 x 1.2) minimum.
- Earth electrode couplings
    - Use high strength driving cap in contact with driven rod and couplings of compatible material fully enclosing the rod threads.
- Interconnect electrodes using bare copper tape 25mm x 6mm.
- Earth electrodes in drawpits
    - Provide concrete cover, permanently labelled, for electrodes installed through cable drawpit bases.
- Main earth conductor connection
    - Connect main earth conductor to first electrode using heavy duty purpose made silicon aluminium bronze body conductor clamp and high tensile phosphor bronze bolt.
- Material, minimum size as BS 7430 Table 4 - Copper.
- Accessories
    - Rod to tape clamp. Sized to suit earth rod and connector.

PR_65_70_46.2040D BUILDING OR STRUCTURAL ELEMENT EARTH ELECTRODES FOR SYSTEM EARTHING:

- Standard - BS 7430, BS 62305:2011
- Form - Building or structural element, as shown on the drawings.
- Interconnect electrodes using bare copper tape 25mm x 6mm.

PR_65_70_46.2060A EARTH ELECTRODE CLAMPS:

- Connect tape to electrode head using heavy duty purpose made silicon aluminium bronze body connector clamps or leaded gunmetal body connector clamps, and high tensile phosphor bronze bolts to BS EN 12163.

PR_65_70_46.2070A EARTH ELECTRODE INSPECTION FACILITIES:

- Provide enclosure for each connection between earth conductor and associated earth electrode system. Install so that top is flush with finished ground or floor level. Ensure enclosure provides adequate access for testing purposes. Provide pit details for builders work.
- Labelling - Wording, Earth.

PR_65_70_46.2090A MAIN EARTHING CONDUCTOR

- Provide main equipotential bonds in accordance with BS 7671 and any local Distribution Network Operator requirements.
- Armour of SWA cable is not to be use as main earthing conductor
    - Material - Insulated cable, single core to BS 6004.
- Use no joints in main earthing conductor.
- Size 70mm^2 unless specified.

PR_65_70_46.2090A MAIN EQUIPOTENTIAL BONDS:

- Provide main equipotential bonds in accordance with BS 7671 and any local Distribution Network Operator requirements.
- Armour of SWA cable is not to be use as main equipotential bond.
    - Material - Insulated cable, single core to BS 6004.
- Use no joints in main equipotential bonds.
- Size 50mm^2 unless specified.

PR_65_70_46.2100A SUPPLEMENTARY EQUIPOTENTIAL BONDS:

- Provide supplementary equipotential bonds to BS 7430, BS 7671 and BS EN 50310. Do not use joints in supplementing bonds.
    - Material - Insulated cable, single core to BS 6004.

PR_65_70_46.2110A CIRCUIT PROTECTIVE CONDUCTORS:

- Material
    - Insulated cable, single core to BS 6004 as indicated; metallic screwed conduits (excluding flexible); metallic trunking with tinned copper links; armouring and/or metallic sheathing of armoured cables or integral conductor of multi-core cable.
- Size
    - Provide protective conductors sized in accordance with BS 7671 (IET Regulations) 543.1.4 and Table 54.7.

PR_65_70_46.2120 EARTHING CLAMPS:

- Use clamps complying with BS 951, for bonding pipes and earthing of conductors. For bonding of lead sheathed cables use soldered or spring clamps.

PR_65_70_46.2130A MAIN EARTH BARS:

- Material
    - Manufacture earth busbars from hard drawn, tinned, high conductivity copper bar.
- Substation Earth busbar
    - 75 x 13mm cross section 600mm minimum length.
- Main Earth Terminal busbar
    - 25 x 6 mm minimum for incoming live conductor not exceeding 50mm and 50 x 6 mm minimum for incoming live conductor over 50mm^2.

PR_65_70_46.2140 TEST LINKS:

- Provide two test links, in connections between main earth conductors and earth busbar. Fabricate each from two additional sections of earth busbar. Mount one section on stand-off insulators matching earth busbar; use remaining section as removable test link. Secure high tensile brass studs to fixed sections of busbar and drill corresponding clearance holes in test links and provide brass washers, nuts and locking devices to secure frame/neutral earthing and test links.

PR_65_70_46.2150 LUGS/TAGS:

- Provide lugs or tags to enable connection of bonding conductors to equipment earth terminals.

PR_65_70_46.2160 PROTECTIVE CABLE TERMINATIONS:

- For bolted connections use crimp type lugs compressed by automatic tool to achieve correct pressure and crimp depth.

PR_65_70_46.2170 PROTECTIVE CONDUCTOR WARNING NOTICES/LABELS:

- Provide a permanent label durably marked in letters 4.75mm minimum height "SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE", in visible position, at each bonding conductor connection to extraneous conductive parts.

PR_65_70_46.2180 MAIN EARTH CONDUCTOR - WARNING TAPES:

- Provide green/yellow PVC tapes labelled "EARTHING CONDUCTOR" over complete external lengths of main earth conductors at 300mm depth below finished ground.

PR_65_70_46.2190 EARTH BAR LABEL:

- Label earth bar "SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE" with wall mounted laminated plastic tablet engraved in 10mm high red letters on white ground.

PR_65_70_46.3010 CLEAN EARTH DISTRIBUTION:

- Install clean earth distribution in double insulated cables from earth electrodes to equipment points. Mount all busbars with insulators and separate from other earthing systems.

PR_65_70_46.3020 DISSIMILAR METALS:

- Ensure, where dissimilar metals are used for system, that purpose made jointing materials are used such that corrosion and deterioration of the electrical connection are not caused. Ensure bonding connections to other metal parts of building are electrolytically compatible with those metal parts. Use the guidance given in BS 7430 Table 8 when bonding dissimilar materials.

PR_65_70_46.3030A COPPER TAPE JOINTS:

- Provide waterproof protection at joints subject to moisture.
- Joint copper tapes by brazing, using zinc-free brazing metal with melting point at least 600^{O}C or thermic welding.

PR_65_70_46.3030B ALUMINIUM TAPE JOINTS:

- Provide waterproof protection at joints subject to moisture.
- Joint aluminium tapes by welding to BS EN 1011-4.

PR_65_70_46.3040 STRANDED CONDUCTOR JOINTS:

- Provide waterproof protection at joints subject to moisture.
- Joint copper stranded conductors with compression joints to BS EN 61284.

PR_65_70_46.3050A PROTECTIVE CABLE TERMINATIONS:

- For bolted connections use crimp type lugs compressed by automatic tool to achieve correct pressure and crimp depth.
- Make connections between tape and equipment using high tensile grade brass bolts with brass nuts, washers and locking devices. Use phosphor bronze bolts, nuts and washers where connections are liable to corrosion.

PR_65_70_46.3060A EARTH ELECTRODES:

- Location
  - Locate electrodes not less than 2m distant from building/structure protected, and away from telecommunication and pilot cables and metallic fences.
- Driving
  - Drive rods vertically into ground with purpose designed electric hammer. (Where impenetrable strata encountered at shallow depth, drive at 30^{O} to horizontal).
- Depth of rod
  - 2.4m minimum below finished ground surface.
- Depth of Electrode heads
  - Locate electrode heads just below ground level.
- Spacing
  - Where electrodes are installed in a group ensure minimum distance between electrodes is twice depth of rods. Where rods for clean earth are installed ensure distance from any other system rods is six times depth of clean rods.
- Tape Depth
  - Install interconnecting or electrode tape 750mm below finished ground level, rising vertically at each electrode.
  - Connect groups of electrodes to main earth conductor via bolted link in inspection pit as BS 7430 for test purposes.

29.0 AC_70_65_00_00 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES

The electrical contractor is responsible for the inspection and testing of the electrical services. All electrical services are to be certified in accordance with the requirements laid out within BS7671 the Wiring Regulations and the NECIEC.

AC_70_65_00_00.2010A INCORPORATED EQUIPMENT CHARACTERISTICS:

- Obtain and use information from manufacturers of equipment provided.
- Use information provided, for equipment supplied by others and incorporated into installation.

AC_70_65_00_00.2020A PROSPECTIVE SHORT CIRCUIT CURRENT:

- Determine values of I_P by measurement, unless other means are indicated. Determine I_P at all necessary points within installation to confirm correct equipment selections.
- Obtain from supply undertaker written confirmation of maximum and minimum values of I_P at origin of installation. Adjust subsequent measured values of I_P accordingly.

AC_70_65_00_00.2030A INITIAL VERIFICATION:

- Carry out detailed inspection to verify the requirements of BS 7671, Chapter 64.

AC_70_65_00_00.2040A TEST EQUIPMENT AND CONSUMABLES:

- Provide test equipment and consumables to complete tests satisfactorily, and to retest any failed installations following corrective measures.
    - Test equipment quality assurance requirements to BS EN ISO 10012.

AC_70_65_00_00.2050A TESTING

- Carry out in the same order as published the tests required by BS 7671, Section 643 for New Installation or Altered or Added Installation as appropriate.

AC_70_65_00_00.2070A EARTH FAULT LOOP IMPEDANCE:

- Use 25 A test current. Measure and record source impedance (Z_E).
- If alternative LV supply arrangements are available, measure Z_S when using supply with highest impedance.
- Measure Z_S with main equipotential bonding conductors connected. Do not summate values of several parts of each loop.

AC_70_65_00_00.2080 SETTINGS AND ADJUSTMENTS:

- Confirm characteristics and settings of protective devices are within maximum and minimum specified tripping times. Check correct operation of devices. Confirm interlocks and sequences operate safely and as indicated.

AC_70_65_00_00.2090A STANDBY GENERATORS:

- Perform works tests on standby generators and provide test certificates. Comply with BS 5000-3 and BS 5000-11 or BS EN 60034-3 as appropriate.

AC_70_65_00_00.2100A HV AND LV SWITCHGEAR:

- Perform works tests on HV and LV switchgear in accordance with BS EN 62271-200 and BS EN 61439-1, as appropriate, and provide test certificates.

AC_70_65_00_00.2110A HV POWER TRANSFORMERS:

- Perform works tests on HV power transformers in accordance with BS EN 60076-3, BS EN 60076-4 and BS EN 60076-5. Provide test certificates.
- Perform all routine tests.

AC_70_65_00_00.2120A FIRE DETECTION AND ALARM INSTALLATIONS:

- Carry out site testing and inspection and provide test certificates for fire detection and alarm systems in accordance with BS 5839-1.

AC_70_65_00_00.2120E EMERGENCY LIGHTING INSTALLATIONS:

- Carry out site testing and inspection and provide test certificates for emergency lighting installations in accordance with BS EN 50172.

AC_70_65_00_00.2130 CALIBRATION:

- Provide current certificates of calibration for all instruments used during test procedures. Record particular instrument identity on record sheets.

AC_70_65_00_00.2140A CERTIFICATION AND REPORTING:

- Complete and hand over to the Client a Completion and Inspection Certificate to BS 7671 Appendix 6 for New Installation or Altered or Added Installation as appropriate.

AC_70_65_00_00.2150A INSTALLATION CERTIFICATES:

- Provide installation certificates for electrical installations in accordance with BS 7671 (IET Regulations).
- Record details of departures from BS 7671 (IET Wiring Regulations) on certificate.
- Provide copies of calculations justifying departure from BS 7671 (IET Wiring Regulations) and attach to certificates.
- Signed installation certificated must be in place prior to practical completion.

AC_70_65_00_00.2160 RECORDS:

- Record all results and instrument readings on approved Record Sheets and hand over to the client two copies for each inspection and test.
- Hand over copies of complete Record Sheets to
    - Client
- Provide copies of Record Sheets
    - 2

AC_70_65_00_00.3010 CONDUCTIVE PARTS:

- Test conductive parts simultaneously accessible with exposed conductive parts of extraneous conductive parts. Establish that they are either not an extraneous conductive part, or that they are reliably connected by metal to main equipotential bonding.
- Confirm conductive parts which are not extraneous conductive parts are separated from earth by an impedance greater than 50,000 ohms. Confirm other conductive parts are bonded to equipotential zone earth bar by an impedance not exceeding 0.1 ohms.

AC_70_65_00_00.3030A HIGH VOLTAGE TESTS:

- Conduct high voltage tests for equipment indicated. Comply with BS 923-1, BS EN 61180 and BS EN 60060-2. Comply with BS EN 61180.

AC_70_65_00_00.3040A LV BURIED CABLES:

- Test continuity and insulation of buried cables immediately after back-filling. Test continuity and insulation of buried cables prior to handover.

30.0 PR_40_10_57_24 IDENTIFICATION - ELECTRICAL

PR_40_10_57_24.2010A LABELS AND NOTICES:

- Apply identification labels and notices in accordance with BS 7671 (IET Wiring Regulations), section 514 to all electrical cables plant and equipment including components of mechanical systems.
- Identification of protective devices.
    - Diagrams, charts or tables to comply with Clauses 514.9 and 560.7.9.
    - Warning notices, voltages in excess of 250 volts.
    - Periodic inspection and test notices.
    - Residual current device notices.
    - Earth electrode safety electrical connection label.
    - Bonding conductor connector point to extraneous conductive parts label.
    - Earth free local equipotential bonding areas warning notice.
    - Electrical separation areas warning notice.
    - Outdoor equipment socket outlet notice.

PR_40_10_57_24.2020A MATERIALS:

- Use materials for labels and notices with a predicted life equal to or greater than the design life of the electrical cables, plant, equipment or installation to which it refers.
- External
    - Sign written, or stencil in paint compatible with surface.
    - Colour - Background, plant standard finish. Lettering, white.
- Internal
    - Engraved thermosetting plastic laminate.
    - Colour - Background, white or red. Lettering, red or white.

PR_40_10_57_24.2030A FIXING - INTERNAL:

- Fix labels and notices using materials compatible with label or notice and surface to which it is fixed by screws into tapped hole or bolted complete with washer nut and locking device.

PR_40_10_57_24.2040A ARRANGEMENT:

- Obtain approval prior to manufacture, with regard to style, colour, lettering, size and position of all labels and notices.
- Provide sample showing style, colour, lettering and size, for approval.

PR_40_10_57_24.2050A LETTERING AND SIZE OF LABELS AND NOTICES:

- Ensure that all lettering and symbols comply with the requirements laid out in BS 5499-1 for height of lettering where not otherwise indicated. Ensure labels and notices of adequate size for the lettering required, and allow a minimum margin around all lettering of one line space vertically and two letter spacing horizontally.
- Font - Helvetica Medium.
- Size - BS 5499-1 or 5mm minimum high letters.
- All Traffolyte labels are to be glued and screwed to the item of equipment.

PR_40_10_57_24.2060A CONDUCTOR ARRANGEMENT:

- Arrange circuit polarity so that phases read in phase rotation order followed by the neutral, if any, from top to bottom in horizontal conductor layouts and left to right in vertical conductor layouts. Ensure flat horizontal arrays have leading phase to the left and neutral to the right from left to right when viewed from supply point. Arrange phase or live pole of two wire apparatus at top or left hand and neutral and earth both at bottom or right hand side. In all cases, ensure conductor arrangements defined are when viewed from front face of all equipment and terminating facilities. Apply identification markers in accordance with BS 7671 (IET Wiring Regulations), section 514 to all conductor termination points.

PR_40_10_57_24.2070A SAFETY SIGNS:

- Label all electrical plant and equipment using safety sign 8.A.0044 of BS 5499-5 where voltages above

ELV exist.

- Provide supplementary or text signs complying with BS 5499-5 with each safety sign 8.A.0044 as indicated.
- Label all electrical plant and equipment with the labels specified in the appropriate British Standards for that plant or equipment.
- Identify each substation and main switchroom with safety sign 8.A.0044 to BS 5499-5 for any fire extinguishing system and notice giving details of,
    - Name of the Substation or switchroom
    - The presence of Medium and Low Voltages.
    - Administrative instructions for access.
    - Location and method of contacting controlling authority.
    - Actions to be taken in an emergency.

PR_40_10_57_24.2080A PLANT AND EQUIPMENT LABELS:

- Fit labels on all items of plant, equipment, switches, etc., include the following information: service controlled, circuit reference, voltage, type of supply and phase etc., circuit protection type and rating.

PR_40_10_57_24.2090 MAINTENANCE NOTICES:

- Fix notices giving warning of, and instructions on, any special maintenance procedures to plant and equipment.

PR_40_10_57_24.2100 COLOUR CORRECTED LIGHT FITTINGS:

- Fix a warning or identification disc to light fittings containing colour corrected fluorescent tubes or other colour corrected light sources to ensure that maintenance staff install the correct lamps.

PR_40_10_57_24.2110A MOTORS AND STARTERS LABELS:

- Fit identification labels to all motors, starters and starter panels. Ensure positive identification of respective motors and starters. Provide motors with non-corrodible labels attached adjacent to each bearing giving details of the lubricant to be used. Mark direction of normal rotation on motor casing. Provide labels to identify motor equipment fitted with surge suppressors and thermistors stating that insulation test voltages must not be applied to thermistors and thermistor control units. Ensure labelling is compatible with schematic and wiring diagrams, and complies with BS EN 60034-8.

PR_40_10_57_24.2120A LABELLED ACCESSORY PLATES - ENGRAVED:

- Label accessory plates, including lighting switches, socket outlets and connection units to indicate their use. Label by engraving, lettering 6mm high colour red.
- This includes all fused connection units feeding fixed items of equipment that are not provided with RCD protection.

PR_40_10_57_24.2130A SWITCHGEAR:

- Fit labels on switchgear as required by BS EN 60439 to indicate duty of unit, its voltage, phase and current rating, protective device rating size of conductor involved, and all other necessary details.
- Use an agreed serial coding system; provide at the switch a key to the coding system.

PR_40_10_57_24.2140 DISTRIBUTION BOARDS:

- On each distribution board identify every outgoing way with a renewable circuit chart in a transparent plastic envelope permanently fitted inside distribution board cover. Clearly indicate in typed script, circuit identification number, cable size, fuse or circuit breaker rating and a description of item supplied and area supplied by circuit.

PR_40_10_57_24.2150A SCHEMATIC DIAGRAMS:

- Provide a purpose made schematic diagram permanently fixed showing the connections of the equipment and plant.
- Locations and materials as indicated in contract preliminaries.

PR_40_10_57_24.2160A SPECIAL PURPOSE EARTHING:

- Fit labels to special purpose earthing conductors and connection points, describing their purposes and

any instructions necessary for their operation and maintenance.
    - IT equipment "Clean Earths".
    - Telecommunications functional earths as BS 6701.

PR_40_10_57_24.2170A INDICATOR LAMPS AND PUSH BUTTONS FOR POWER SYSTEMS:

- Use indicator lamp and push button colours in accordance with BS EN 60073.
- Indicator lamp
    - Red, danger or alarm; yellow, caution; green, safety.
- Push buttons
    - Red, emergency action; red, stop or off; yellow, intervention; green, start or on.
- Illuminated push buttons - Type a.

PR_40_10_57_24.2180A CONDUIT AND TRUNKING COLOUR CODING:

- In areas of mechanical plant or voids accommodating mechanical services, or where otherwise indicated, identify electrical conduits and ducts in accordance with BS 1710. Apply colour orange to BS 4800 by painting on service as a band over 150mm or applying an adhesive tape type wrap around services over a length of 150mm.
- Place identification colours at bulkheads, wall penetrations and any other place where identification is necessary.

PR_40_10_57_24.2190A CABLE IDENTIFICATION:

- Provide all cables, other than final sub-circuit wiring enclosed in conduits or trunking, with labels fixed at each end of cable either side of wall and floor penetrations at approximately 12m intervals at convenient inspection points by means of non-releasable plastic straps, minimum width 4mm.
- Ensure labels show the reference number of cable.

PR_40_10_57_24.2200A TERMINAL MARKING AND CONDUCTOR IDENTIFICATION:

- Provide for switchgear and control gear elements whose terminals are marked in accordance with BS 5472 (EN 50005) and BS 6272 (EN 50042). Use a unique reference to identify each element in the switchgear or control gear. Mark on or adjacent to each element its reference. Identify each terminal for connection to external wiring or cabling using a reference system complying with BS EN 60445 based on the element reference and the appropriate element terminal reference.
    - Adjacent to terminals.
- Use lettered or numbered ferrules or sleeves to BS 3858 to mark each auxiliary conductor or control cable core with the identity of the terminal to which it is connected and the reference of plant or equipment to which it is connected and the identity of the terminal at the remote end. Ensure that main circuit conductors are identified in accordance with BS 7671 (IET Wiring Regulations) section 514. Ensure that all identification of terminals and conductors is recorded and included on record drawings and in operation and maintenance documentation.

PR_40_10_57_24.2210A UNDERGROUND CABLE IDENTIFICATION:

- Identify external underground cable routes by means of approved markers along their length at distances not exceeding 50m and where a change of direction occurs on such routes. Provide cables markers with a brass plate or impress concrete to clearly indicate the reference of group of cables or reference number of cable and operating voltage of cable. Provide key to any reference system used at switchgear. Mark and protect direct buried cables with plastic tape yellow printed black "DANGER ELECTRIC CABLES" elsewhere.

PR_40_10_57_24.2220A CABLE CONDUCTOR COLOUR CODING:

- Identify cable conductors in accordance with BS 7671 (IET Wiring Regulations) section 514 and Appendix 7; note that a lighting sub-circuit switch wire is a phase conductor in a single phase circuit.

PR_40_10_57_24.2230 CABLE JOINTING AND TERMINATION:

- Connect all cables in the installation so that the correct sequence of phase rotation is maintained throughout. Where straight through joints are approved joint medium voltage conductors as they lie, ensuring their complete length is phased out on completion. Ensure connections at terminations of MV cables are made in the correct phase rotation and ensure cable conductor termination marking if

any, complies with this phase sequence. Where straight through joints are approved on low voltage cables, whether power cables or control or auxiliary cables, joint conductors strictly in accordance with their colour or numeric coding. Where such joints are approved on mineral insulated or other non-coded conductor cables, identify each core at the joint and make the joint core to core.

PR_40_10_57_24.2260A ADDITIONAL SAFETY SIGNS:

- Provide at locations shown or as appropriate safety signs to BS 5499-1.
- Application
    - For main switch and electrical plant room access doors. BS 5499-5, complete with supplementary signs as shown.
    - 6.C.0019. 6.A.002, with supplementary sign "Authorised persons only".
    - 7.A.022
- Application
    - For use with permit to work systems, BS 5499-5, complete with supplementary signs as shown.
    - 6.C.0021. Printed on rigid plastic, with hanging loop, with supplementary wording "Do not operate. Work in progress".
- Application
    - For use at each emergency stop. BS 5499-5, complete with supplementary signs as shown.
    - 9.B.0097. With supplementary sign "Emergency stop push-button".

31.0 PR_20_29_00_00 FIXING TO BUILDING FABRIC

PR_20_29_00_00.1000 GENERAL

PR_20_29_00_00.1010 PREPARATION:

- Mark-out, set-out and firmly fix all equipment, components and necessary brackets and supports.

PR_20_29_00_00.1020 MANUFACTURER'S DRAWINGS:

- Use manufacturer's drawings and templates for purposes of marking and setting out.

PR_20_29_00_00.1030 FIXINGS:

- Ensure structure and fixings are suitable for items to be fixed.

PR_20_29_00_00.1040 LOADING DETAILS:

- Provide loading details for all fixing types.

PR_20_29_00_00.1050 BUILDING-IN BY OTHERS:

- Provide all necessary assistance to enable any item of building-in type to be built in by others.

PR_20_29_00_00.1060 SIZE OF FIXING:

- Use largest size of bolt, screw or other fixing permitted by diameter of hole in item to be fixed.

PR_20_29_00_00.1070 GREASING OF FIXINGS:

- Ensure all bolts, screws or other fixings used are greased or lubricated in accordance with manufacturer's instructions.

PR_20_29_00_00.2010 STANDARDS:

- Ensure that fixings such as expanding anchors are tested for tensile loading in accordance with BS 5080-1.

PR_20_29_00_00.2020 PLUGS:

- Use plugs of suitable size and length for fixings. Use plastic, fibrous or soft metal non-deteriorating plugs to suit application. Do not use wood plugs.
- Ensure that when screw is in place, threaded length is in plug. Ensure plugs used for screw fixing are set-in to correct depth prior to final tightening.

PR_20_29_00_00.2030 SCREWS:

- Use screws to BS 1210. Generally use sherardized steel wood screws for fixing to concrete, brickwork or blockwork.
- In damp or exposed situations use greased brass wood screws.

PR_20_29_00_00.2080 NON-PENETRATIVE SUPPORT SYSTEMS FOR ROOF MOUNTED EQUIPMENT:

- Obtain approval prior to using non-penetrative support systems for roof mounted equipment.

PR_20_29_00_00.3010 DRILLING:

- Drill holes squarely. Use drills of requisite size and depth, and appropriate to fabric. Do not flame-cut holes in metal work.

PR_20_29_00_00.3050 FIXING TO TIMBER RAILS:

- Fix equipment, brackets and supports by drilling hole through timber rail and fixing with bolt, back plate, washer and loose nut.

PR_20_29_00_00.3060A FIXING TO HOLLOW STUD/TILE/BLOCK WALLS:

- Fix equipment, brackets and supports where there is access at rear of wall, by drilling hole through wall and fixing with bolt, back-plate, washer and loose nut.
- Fix equipment, brackets and supports where there is no access at rear of wall, drill hole and use screw anchor type fixing or gravity type toggle fixing.

PR_20_29_00_00.3070A FIXING TO CONCRETE, BRICKWORK OR BLOCKWORK:

- Fix equipment, brackets and supports using wood screws in plugs or, as appropriate, drill holes and fix using steel bolts of grouted bolt type or expanding bolt type fixing.

PR_20_29_00_00.3080A FIXING TO METALWORK:

- Fix equipment, brackets and supports by drilling holes and fixing using set screws or bolts complete with washers, shakeproof washers and loose nuts.

PR_20_29_00_00.3090A FIXING TO STRUCTURAL STEELWORK AND CONCRETE STRUCTURES:

- Provide manufacturer's information on recommended fixing. Obtain approval for any fixing to structure steel work and concrete structures.
- Generally use proprietary fixings to structural steelwork and concrete structures.
- Obtain approval to cut holes in structural steelwork or concrete structures or weld to structural steelwork.

PR_20_29_00_00.3100 NON-PENETRATIVE SUPPORT SYSTEMS FOR ROOF MOUNTED EQUIPMENT:

- Provide manufacturer's information on recommended support systems.
- Obtain the necessary approvals to use non-penetrative support systems as follows:
    - Ensure that the roof build-up is suitable for non-penetrative supports.
    - Ensure that necessary approval is given by
        - The Structural Engineer
        - The Architect
- Mounting positions
- Roof load management parameters (if known)
    - UDL deck loading kN/m2
    - Maximum Point Loads kN
    - Maximum Base Pressures kN/m2
- Components
    - Provide support manufacturer's information on recommended free-standing systems
        - Support leg type
        - Support frame type
- Roof maintenance building clearance
    - Ensure that future roof maintenance access to roof finish is provided under each support system
    - Minimum building clearance
- Documentation required for Project Team approval:
    - CAD drawings of supports
    - Roof load management calculations
    - O&M documentation
    - Warranty information
- Manufacturer

32.0 PR_35_31_68_72 PAINTING AND ANTI-CORROSION TREATMENTS

PR_35_31_68_72.2010A PAINT MATERIALS:

- Use the following materials as appropriate
    - Solvent borne priming paint to BS 7956 for bare woodwork.
    - Red Oxide priming paint for bare iron and steelwork.
    - Zinc Chromate priming paint for bare ferrous and non-ferrous metals.
    - Calcium Plumbate priming paint to BS 3698 for galvanized steel or composite wood/metal components.
    - Undercoating paint for previously primed or painted surfaces before the application of finishing coats.
    - Gloss finishing paint for previously primed or painted/undercoated surfaces.
    - Epoxy resin paint for specialist coatings requiring resistance to acids, alkalis, oils, solvents, abrasion or high humidity.
    - Aluminium paint to BS 388 for structural steelwork, storage vessels, heated metallic surfaces and similar applications where moisture and heat resistant properties are required.
    - Cold galvanizing paint for making good damage to previously galvanized surfaces and protection to galvanized materials modified during installation.
    - Zinc-rich metallic to BS 4652 for bare iron and steelwork where electrical conductivity has to be assured.
    - Black tar-based paint to BS 1070 for moisture resistant protection to metal surfaces where decorating appearance is not important.
    - Bitumen based coatings for cold application to BS 3416 protection to iron and steel, particularly pipelines and fittings for use in contact with potable water.
    - Bitumen based coatings for cold application to BS 6949 not to be used in contact with potable water.
    - Paint services and associated supports/ fixings to the architect's specification where required.

PR_35_31_68_72.2020 PAINT QUALITY:

- Ensure paints used are of quality and type to suit application and that:-
    - Primers have good adhesion, covering power, rust-inhibiting and grain filling properties.
    - Gloss finishing paints are of machine finish grade having high adhesion and high resistance to solvents, mineral oils, cutting oils, detergents, chipping and impact damage.

PR_35_31_68_72.2030 HEAT RESISTANT PAINT:

Use heat resistant paints for applications to surfaces over 80^{o}C.

33.0 PR_75_51_52_00 MOTOR DRIVES - ELECTRIC

PR_75_51_52_00.1000 GENERAL

PR_75_51_52_00.1040A MANUFACTURER FITTED SURGE SUPPRESSORS:

- Supply surge suppressors to star connected motors and to all motors subject to star-delta starting to limit peak voltage to 1200 volts. Fitted by manufacturer.

PR_75_51_52_00.1040B INSTALLER FITTED SURGE SUPPRESSORS:

- Supply surge suppressors to star connected motors and to all motors subject to star-delta starting to limit peak voltage to 1200 volts. Fitted by installer.

PR_75_51_52_00.1050A MANUFACTURER FITTED TRANSIENT SUPPRESSORS:

- Supply transient suppressors in the form of resistor and capacitor networks across the starter contactor coils. Fitted by manufacturer.

PR_75_51_52_00.1050B INSTALLER FITTED TRANSIENT SURGE SUPPRESSORS:

- Supply transient suppressors in the form of resistor and capacitor networks across the starter contactor coils. Fitted by installer.

PR_75_51_52_00.2010A STANDARD OPERATING CONDITIONS:

- Ensure motors, starters and ancillary equipment are suitable for operation at full capacity at heights above sea level not exceeding 1000m, with air cooling at an average temperature over 24 hours not exceeding 35oC dry bulb with maximum conditions of 40oC dry bulb and 50 per cent RH.

PR_75_51_52_00.2010B NON STANDARD OPERATING CONDITIONS:

- Ensure motors, starters and ancillary equipment are suitable for operation at full capacity at heights above sea level above 1000m, with conditions exceeding 40oC dry bulb and 50 per cent RH.

PR_75_51_52_00.2020 MOTORS - GENERAL:

- Standard
- Use motors which conform to BS EN 60034, as applicable, which operate at lowest possible speed, compatible with performance requirements.
- Ratings
    - Select maximum continuous rating (MCR) such that
    - Driven machine operates at correct speed or speeds at design duty.
    - When running continuously at design rated duty, the temperature of the motor parts is within limits defined in BS EN 60034-1.
    - When provided with excess motor current (over-load) protection of thermal overcurrent release type, ensure operation is within tolerances of tripping as defined in BS EN 60947-4-1.
- Insulation
    - Use motors with Class 130 or 155 to BS EN 60085 insulation, with temperature rise as defined in BS EN 60085.
- Conduit entry
    - Fit motor bodies with conduit entry terminal box or cable gland as required, and to suit type and size of cable being terminated.
- Comply with BS EN 60034-5, IEC 60034-5 to achieve the specified degrees of protection classification provided by the integral design.

PR_75_51_52_00.2025A MOTOR EFFICIENCY:

- Supply an IE2 High Efficiency Motor with a minimum efficiency compliant with BS EN 60034-30 as shown in the table below.

Motors Efficiencies (%): BS EN 60034-30 (50 Hz)

Rating	IE2 High Efficiency		
kW	No. of poles		
	2	4	6
0.75	77.4	79.6	75.9
1.1	79.6	81.4	78.1
1.5	81.3	82.8	79.8
2.2	83.2	84.3	81.8
3	84.6	85.5	83.3
4	85.8	86.6	84.6
5.5	87.0	87.7	86.0
7.5	88.1	88.7	87.2
11	89.4	89.8	88.7
15	90.3	90.6	89.7
18.5	90.9	91.2	90.4
22	91.3	91.6	90.9
30	92.0	92.3	91.7
37	92.5	92.7	92.2
45	92.9	93.1	92.7
55	93.2	93.5	93.1
75	93.8	94.0	93.7
90	94.1	94.2	94.0
110	94.3	94.5	94.3
132	94.6	94.7	94.6
160	94.8	94.9	94.8
200 up to 375	95.0	95.1	95.0

PR_75_51_52_00.2025B MOTOR EFFICIENCY:

- Supply an IE3 Premium Efficiency Motor with a minimum efficiency compliant with BS EN 60034-30 as shown in the table below.

Motors Efficiencies (%): BS EN 60034-30 (50 Hz)			
Rating	IE3 Premium Efficiency		
kW	No. of poles		
	2	4	6
0.75	80.7	82.5	78.9
1.1	82.7	84.1	81.0
1.5	84.2	85.3	82.5
2.2	85.9	86.7	84.3
3	87.1	87.7	85.6
4	88.1	88.6	86.8
5.5	89.2	89.6	88.0
7.5	90.1	90.4	89.1
11	91.2	91.4	90.3
15	91.9	92.1	91.2
18.5	92.4	92.6	91.7
22	92.7	93.0	92.2
30	93.3	93.6	92.9
37	93.7	93.9	93.3
45	94.0	94.2	93.7
55	94.3	94.6	94.1
75	94.7	95.0	94.6
90	95.0	95.2	94.9
110	95.2	95.4	95.1
132	95.4	95.6	95.4
160	95.6	95.8	95.6
200 up to 375	95.8	96.0	95.8

PR_75_51_52_00.2030 SLIDE RAILS:

- Fit motors on slide rails or other suitable means of adjustment to facilitate correct alignment and belt

tension.

PR_75_51_52_00.2040 PLINTHS:

- Where plinths are built in by others, provide all necessary assistance and information.

PR_75_51_52_00.2050A MOTOR RATINGS - UP TO AND INCLUDING 0.75KW:

- Single or three phase, totally enclosed, frame cooled or fan cooled. For duty and torque requirements of driven machine.

PR_75_51_52_00.2050B MOTOR RATINGS - ABOVE 0.75KW UP TO AND INCLUDING 4KW:

- Three phase, squirrel cage induction type, totally enclosed, frame cooled or fan cooled. To BS EN 60034-5 and BS EN 60034-6 IP44 - IC 01.411.

PR_75_51_52_00.2050C MOTOR RATINGS - ABOVE 4KW SQUIRREL CAGE, DRIP-PROOF:

- Three phase, squirrel cage, induction type, drip-proof enclosure. To BS EN 60034-5 and BS EN 60034-6 IP22S - IC 01.

PR_75_51_52_00.2050D MOTOR RATINGS - ABOVE 4KW WOUND ROTOR, DRIP PROOF:

- Three Phase, wound rotor, slip type, drip-proof enclosure. To BS EN 60034- 5 and BS EN 60034-6 IP22S -IC 01.

PR_75_51_52_00.2050E MOTOR RATINGS - ABOVE 4KW SQUIRREL CAGE, TOTALLY ENCLOSED:

- Three phase, squirrel cage, induction type, totally enclosed, frame or fan cooled. To BS EN 60034-5 and BS EN 60034-6 IP44 - IC 01.411.

PR_75_51_52_00.2050F MOTOR RATINGS - ABOVE 4KW WOUND ROTOR, TOTALLY ENCLOSED:

- Three phase, wound rotor, slip ring type, totally enclosed, fan cooled. To BS EN 60034-5 and BS EN 60034-6 IP44 - IC 01.411 or IC 01.511 as applicable.

PR_75_51_52_00.2050G MOTOR RATINGS - ABOVE 4KW SQUIRREL CAGE, SMOKESPILL:

- Three phase squirrel cage, induction type for smokespill applications. To BS EN 60034-5 and BS EN 60034-6 IP55, cooling as applicable.

PR_75_51_52_00.2050H ABOVE 4KW SQUIRREL CAGE, ENERGY EFFICIENT DESIGN:

- Three phase, squirrel cage, induction type energy efficient design, totally enclosed, fan cooled to BS EN 60034-5 and BS EN 60034-6 IP55 - IC 01.411.

PR_75_51_52_00.2060A MOTORS - OVER TEMPERATURE PROTECTION, THERMISTORS:

- Fit positive temperature coefficient thermistors to BS EN 60034-11. Provide a minimum of 3 PTC thermistors in each motor with 2 ends terminated in motor terminal box clearly and permanently marked.
    - For motors rated between 30kW and 75kW provide a single thermistor in each phase.
    - For motors rated above 75kW provide two thermistors in each phase.
- Provide control unit to BS EN 60034 to motors fitted with thermistors. Interconnect control unit with thermistors and starter to trip starter when one or all of thermistors detect overheating.

PR_75_51_52_00.2070A INDIRECT DRIVES WITH TOOTHED BELTS:

- Belts
    - Use toothed wedge belts to BS 3790. Provide at least two matched belts for any drive, of anti-static type and rated to transmit full machine power with one belt removed.
- Pulleys
    - Construct pulleys from approved materials and statically balance. Lock close limit bores by keys fitting into machinery shaft keyway.
- Pulley Adjustment
    - Adjust pulley to give alignment and correct belt tension.

PR_75_51_52_00.2070B INDIRECT DRIVES WITH FLAT BELTS:

- Belts
    - Use flat wedge belts to BS 3790. Provide at least two matched belts for any drive, of anti-static type and rated to transmit full machine power with one belt removed.
- Pulleys
    - Construct pulleys from approved materials and statically balance. Lock close limit bores by keys fitting into machinery shaft keyway.
- Pulley Adjustment
    - Adjust pulley to give alignment and correct belt tension.

PR_75_51_52_00.2080A DIRECT COUPLED DRIVES:

- Use an extended motor shaft coupled to machine or a flexible coupling connecting driving and driven shafts, incorporate suitable arrangements for aligning the two shafts.
- Mount motors on a substantial mild steel bed plate fixed to machine casing separately supported or supported entirely from the machine casing.

PR_75_51_52_00.2085 VARIABLE SPEED DRIVE:

- Use variable speed drive to match design and installed flow volumes. Ensure the drive meets the safety requirements of BS EN 61800-5-1.
- Load characteristic - variable torque for fans and pumps; constant torque for positive displacement equipment such as positive displacement pumps and air compressors.

PR_75_51_52_00.2090A GUARDS:

- Totally protect drives and couplings. Fit purpose made guards around all exposed or otherwise accessible drive shafts, pulleys, 'V' belts or couplings.
- Ensure guards comply with National or Local Safety Codes, Acts and Bye-Laws and incorporate following features.
    - Construction to BS EN ISO 12100 and generally of galvanized steel wire mesh.
    - Stiffening within the guards to ensure rigidity and freedom from vibration.
    - Allowance for prime mover adjustment during belt tensioning procedures.
    - Temporary access to all shafts for use of Tachometer.

34.0 SS_75_70_54_10 CENTRAL CONTROL/BUILDING MANAGEMENT

SS_75_70_54_10.300.000 GENERAL
SS_75_70_54_10.300.010 SYSTEM REQUIREMENTS
Select control components and equipment, suitable to meet system objective requirements. Ensure that system safety complies with BS EN ISO 13849.

- Where necessary comply with BS EN 61508.
- Comply with BS EN 15500.
- Comply with BS EN ISO 16484-2.
- Comply with BS EN ISO 16484-3.

SS_75_70_54_10.300.020 CONTROL SYSTEM
Provide a Building Management System (BMS) to meet the particular requirements detailed in 100.000.

SS_75_70_54_10.300.060 CONTROL COMPONENTS MANUFACTURER
Unless otherwise indicated use control components and equipment from one manufacturer throughout.

SS_75_70_54_10.300.090 FINISHES
Ensure all monitoring equipment is designed to common installation practices.

- Provide all equipment as a matching suite.

SS_75_70_54_10.300.100 ELECTROMAGNETIC COMPATIBILITY
Ensure all monitoring system equipment is compatible, and does not adversely affect any other equipment installed in the same location.

Ensure all monitoring system equipment meets the requirements of

- BS 7671 (IEE Wiring Regulations).
- BS EN 50174.
- BS EN 55022.
- BS EN 60801-2.
- BS EN 60950-1.
- BS EN 61000-4-1.

SS_75_70_54_10.300.130 INTEGRATED SYSTEM
Provide integrated system combining the following sub-systems:

- Fire detection and alarm.
- Personal attack alarm.
- Intruder alarm.
- Hazard warning.
- Fixed fire extinguishing.
- Public address.
- Access control.
- Closed circuit television.
- Building management system.
- Heating and ventilation.
- Energy management.
- Staff location/paging.

SS_75_70_54_10.310.020 GENERAL REQUIREMENTS - ELECTRICAL SAFETY
Ensure that the BMS complies with the following EC Directives

- Low Voltage Directive 73/23/EEC and amendment 93/68/EEC.
- Construction Products Directive 89/106/EEC and amendment 93/68/EEC.
- General Product Safety Directive 92/59/EEC.

Ensure that the BMS installation complies with BS 7671 Electrical Installations in Buildings.

Ensure that control panels comply with BS EN 60439-1 Low-voltage Switchgear and Control Assemblies.

SS_75_70_54_10.310.030 GENERAL REQUIREMENTS - ELECTRICAL SUPPLY
Ensure that the BMS can operate when supplied with electricity conforming to BS EN 50160 - Voltage characteristics of electricity supplied by public distribution systems.

SS_75_70_54_10.310.040 GENERAL REQUIREMENTS - EMC
Ensure that the BMS complies with the Electromagnetic Compatibility (EMC) Directive 89/336/EEC.

Ensure that the BMS complies with BS EN 61000-6-3 Generic emission standard, BS EN 61000-6-1 and BS EN 61000-6-2 Generic immunity standard.

Ensure that the BMS meets the EMC requirements of prEN 13646.

SS_75_70_54_10.310.050 GENERAL REQUIREMENTS - EMERGENCY RESTORATION PROCEDURES
Ensure that the BMS fully restores all control and monitoring functions following an emergency shut down period.

Ensure that the start delay times can be adjusted according to the magnitude of the load.

SS_75_70_54_10.310.070 GENERAL REQUIREMENTS - TIME SYNCHRONISATION
Ensure that all time-dependent BMS components are time synchronised via the operator workstation.

Ensure that the BMS can automatically change between British Summer Time (BST) and Greenwich Mean Time (GMT).

Ensure that the BMS can accommodate leap years.

SS_75_70_54_10.310.080 GENERAL REQUIREMENTS - SYSTEM SECURITY

- Provide, as a minimum, password-protected operator access for the following levels.
    - Level 1 - Ability to display all point data.
    - Level 2 - Ability to display all point data and to initiate data logging functions.
    - Level 3 - Ability to display all point data; to initiate data logging functions; and to change set points and time schedules.
    - Level 4 - Ability to display all point data; to initiate data logging functions; to change set points and time schedules; and to change control strategies and schematic/graphics functions and password assignment.
- Ensure that password-protected operator access is set up for both operator workstations and field controllers which have an operator interface.
- Ensure that passwords permit at least 6 alpha/numeric characteristics.
- Ensure that the BMS software is protected from unauthorised entry.
- Ensure that the BMS, and its operation performed under any maintenance contract, complies with BS ISO/IEC 27001 and BS ISO/IEC 17799 Code of practice for information security management.

SS_75_70_54_10.310.090 GENERAL REQUIREMENTS - SYSTEM SOFTWARE
Ensure that IT industry standard operating systems are used.

Ensure that copies of all BMS vendor-specific software are held by an independent third party and that this

software can be released to the client.

Ensure that the ESCROW Agreement is completed and signed.

Ensure that licences to use software applications are owned by the Client.

- Provide application software written in accordance with BS 7649.

SS_75_70_54_10.310.093 GENERAL REQUIREMENTS - CHOICE OF CONTROL STRATEGY
Ensure that the selected control strategies are appropriate for the building services systems and their intended application.

Ensure that selected control strategies are robust and not over complex.

Where a novel control strategy is to be implemented, ensure that testing/evaluation is performed to confirm its suitability.

Ensure that wherever possible selected control strategies are those provided in the BSRIA Library of System Control Strategies: AG 7/98.

SS_75_70_54_10.310.095 GENERAL REQUIREMENTS - DESIGN FOR COMMISSIONABILITY
Ensure that the BMS specification details required for commissioning are made available to the BMS commissioning engineer.

Ensure that all field controllers, sensors and controlled devices are easily accessible and can be removed for testing and future maintenance.

Liaise with the mechanical contractor to ensure that air handling units are provided with appropriate access doors.

Ensure that access is available to all control devices.

Ensure that the requirements of the following documents are met:

Space and Weight Allowances for Building Services Plant - Inception Stage Design. BSRIA. TN 9/92.

Space Allowances for Building Services Distribution Systems - Detailed Design Stage. BSRIA. TN 10/92.

Ensure that sensors are installed correctly in order to give representative readings.

Ensure that reference labels are attached to each control device.

SS_75_70_54_10.310.096 GENERAL REQUIREMENTS - FUTURE SYSTEM EXPANSION
Ensure that the BMS is capable of dealing with a future 20% increase in the number of points without compromising the system's functionality or speed of operation.

SS_75_70_54_10.310.097 GENERAL REQUIREMENTS - DESIGN FOR MAINTAINABILITY
Ensure that a full O&M manual is prepared which reflects any system changes made during the installation and commissioning stages.

Ensure that adequate access to BMS equipment and components is provided.

Ensure that all components and wiring are identified by a consistent numbering system.

SS_75_70_54_10.310.100 GENERAL REQUIREMENTS - SYSTEM SUPPORT
Ensure that a viable strategy is in place to fully support the BMS for a minimum of 10 years from the date of practical completion.

SS_75_70_54_10.310.105 GENERAL REQUIREMENTS - SYSTEM MAINTENANCE
Provide maintenance support for 1 year in accordance with BSRIA BG 4/03 - BMS Maintenance Guide.

SS_75_70_54_10.310.110 OPERATOR WORKSTATION - OPERATIONAL CHARACTERISTICS

- Ensure that the control of plant is independent of the operator workstation.
- Ensure that no data of a control nature is transferred between field controllers via the operator workstation, i.e. data relating to control strategies.
- Ensure that the operator workstation can communicate with all addressable field controllers.
- Provide complete system integrity such that the network of field controllers will continue to fully operate following a failure of the operator workstation.
- Ensure that the appropriate control strategy configuration data can be downloaded to all addressable field controllers.
- Provide a means of displaying and modifying each addressable field controller's control strategy, time schedules and set-points via the operator workstation.
- Allow the operator to re-schedule plant operation times. Ensure that re-scheduling can be applied globally to a number of items of plant at one or more sites (or one or more controllers on one site) as selected by the operator.
- Ensure that the operator workstation incorporates a data storage management system that warns against impending on-line storage overflow and allows for data archiving to, and retrieval from, off-line non-volatile media. Ensure that the operator is prompted at pre-defined intervals to carry out the data archiving procedure.
- Ensure that it is possible to perform a complete backup of the operator workstation comprising control strategies, set-points and logged data.
- Provide an electronic data archival device that uses readily available non-volatile media that is appropriate for long term storage of system software, configuration data and logged data (including alarm data). Note that the use of multiple 3.5 inch disks is not acceptable.
- Allow the transfer of data from the system memory and other storage devices to the archive mediums, and vice versa for the preparation of reports.
- Ensure that the backup data can be fully re-loaded.
- Ensure that selected files from the backup data can be re-loaded.

SS_75_70_54_10.310.120 OPERATOR WORKSTATION EQUIPMENT:

- Standard BS EN ISO 16484-3.
- Workstation
- Personal computer
- Processor

Ensure that the processor speed of each operator workstation meets the data processing requirements.

- Ensure that the processor speed is such that delays in processing system data do not exceed 2 seconds
- Monitor
- Diagonal dimension of the monitor 19
- Protection against reflection.
- User access
- Provide a QWERTY keyboard with full upper/lower case ASCII key-set, numeric keys and mouse.
- Mouse.
- Printer
- Ensure that the printer can print all monitored and logged data (including graphs of logged data); all point data (hard and soft); control logic diagrams and plant/building; schematics in colour; alarm data/text; and system help text.
- Ensure that the automatic printing of alarm data can be switched on/off.
- Ensure that the printer has a minimum output of four pages per minute.

SS_75_70_54_10.310.130 OPERATOR WORKSTATION - MONITORING AND LOGGING FUNCTIONS:

- Ensure that all monitored point data can be displayed at the operator workstation. Ensure that analogue, digital and soft-points can be displayed simultaneously.

- Ensure that all changes made by the operator (e.g. set-point changes) can be logged and identified by both operator and date/time stamp.
- Provide a facility to allow the display, at the operator workstation, of 'real time' data superimposed on plant schematics with a refresh rate not exceeding 20 seconds.
- Ensure that a minimum of four 'real time' data points can be displayed simultaneously, in the form of data plots, with a time delay not exceeding 20 seconds.
- Provide a facility to allow the monitoring and display, on the same 'page', of common criteria/plant functions.
- Ensure that any hard or soft-point log can be displayed and stored on the operator workstation.
- Ensure that logs can be set up from the operator workstation and that logging times and logging intervals are user adjustable between 1 second and 24 hours.
- Ensure that the operator workstation has sufficient data storage capacity to accommodate the defined amount of logged data and that the data can be backed up.
- Provide a facility to allow the simultaneous display of different logged data. Ensure that this function is operator adjustable.
- Provide a facility to allow the export of logged data to other software packages. Ensure that the format of the exported data can be fully defined.

SS_75_70_54_10.310.140 OPERATOR WORKSTATION - GRAPHICAL OPERATOR INTERFACES:

- Provide a software library of plant schematics and symbols, the format/contents of which should be confirmed with the specifier based on samples.
- Provide a facility to allow the operator to generate additional schematics and symbols.
- Ensure that the system can accommodate the addition of 20% extra graphics 'pages'.
- Provide a facility to allow the operator to modify plant schematics and to generate new ones.
- Ensure that graphics can be displayed in a layered approach (building layout graphics down to plant subsystems and components). Ensure that the operator can modify the structure of the layered approach.

SS_75_70_54_10.310.150 OPERATOR WORKSTATION - HELP AND ASSISTANCE:

- Provide a facility to allow the display of help text covering all operator functions and system fault conditions.
- Provide a facility to allow the display (including a hard copy) of points list (hard and soft-points) and control strategy logic schematics.

SS_75_70_54_10.310.160 OPERATOR WORKSTATION - INTEGRATION WITH THIRD PARTY MANAGEMENT SOFTWARE:

- Energy monitoring and targeting software
    - Provide a facility to allow the direct transfer of recorded energy consumption and external air temperature readings from the BMS to the monitoring and targeting software. Ensure that the format of the exported data can be fully defined.
- Maintenance management software
    - Provide a facility to allow the direct transfer between the BMS and the maintenance management software of plant run hours; number and frequency of plant starts; critical alarms requiring immediate attention; and maintenance (non-critical) alarms.
    - Ensure that the format of the exported data can be fully defined.

SS_75_70_54_10.310.170 OPERATOR WORKSTATION - SYSTEM ALARMS:

- Ensure that alarms are displayed on a rolling basis in chronological order.
- Ensure that the operator can acknowledge alarms, including muting of audible or flashing annunciators.
- Provide a facility to silence audible alarms or inhibit flashing annunciators without performing alarm acknowledgement.
- Ensure that alarms can be inhibited for reasons of time and/or priority as selected by the operator.
- Ensure that the BMS can be configured to avoid fleeting alarms, i.e. ensure that alarms can accommodate start-up and shutdown delays.
- Ensure that the operator can alter the limits at which the measured values cause alarms to be

triggered.

- Ensure that alarms can be limited to the source items(s) of plant.
- Ensure that alarm limits can accommodate sliding limits, e.g. set-point changes.
- Ensure that alarms can be differentiated by means of alarm type and identification.
- Ensure that alarms can be prioritised (including a high priority that will be annunciated regardless of other activity) and a low priority or information status that is only annunciated on demand.
- Ensure that visual, audible and printed annunciation of alarms, or any combination of these, can be selected by the operator.
- Ensure that the reception and acknowledgement of alarms can take precedence over other operations. However, ensure that the reception of alarms does not hinder user log-in.
- Allow the user to acknowledge alarms individually and on a group basis. Acknowledgement should include muting or flashing annunciators.
- Provide distinction between active alarms whose conditions are not cleared and unacknowledged alarms.
- Provide an alarm-latching facility with manual reset.
- Ensure that alarm data provides condition identity; condition value; alarm source; alarm time and date; and acknowledgement status.
- Ensure that the alarm file can be sorted by the above criteria.
- Allow alarms to be automatically redirected to other user interfaces.
- Provide sufficient data storage capability for the storage of alarms.
- Ensure that any stored alarm data can be analysed in conjunction with other monitored conditions or stored logged data.
- Ensure that an alarm review facility is available.
- Allow the display of stored alarm data based on user definable selection criteria.
- Ensure that the operator can define the requirement for acknowledgement of alarms; a time programme for annunciation of alarms to different destinations; and text messages associated with alarm conditions.

SS_75_70_54_10.310.180 FIELD CONTROLLERS - MODES OF OPERATION:

- Ensure that the field controllers perform all control actions independently of the operator workstation.
- Ensure that all field controllers can operate independently and in real time following a failure of the BMS communication network.
- Ensure that field controllers can operate with the loss of shared data through the use of default values and final data reading before the loss of network communications.

SS_75_70_54_10.310.190 FIELD CONTROLLERS - PHYSICAL CONSTRUCTION:

- For internal plant room applications, construct field controller enclosures to give a minimum degree of protection to IP54 in accordance with BS EN 60529. Where the field controller is fitted inside a control panel that is protected to IP54 then the field controller protection can be reduced to IP41. For external applications, construct field controller enclosures to IP65.
- Where an enclosure is to be provided ensure that field controller enclosures are lockable.
- Ensure that modular construction is used for field controllers. Ensure that this allows the removal and replacement of devices without the need for rewiring of field wiring.

SS_75_70_54_10.310.200 FIELD CONTROLLERS - TERMINATIONS:
Use terminals of the screw down clamp-type fixed to purpose made mountings.

Segregate into groups terminals carrying different voltages (in accordance with BS 7671).

SS_75_70_54_10.310.210 FIELD CONTROLLERS - FUTURE EXPANSION:
Make provision for a future 20% increase.

SS_75_70_54_10.310.220 FIELD CONTROLLERS - CONTROLLER INPUTS:
Ensure that the interfaces for the field controllers are appropriate for gathering data from sensors and devices. Ensure that the following requirements are met.

- Analogue input
- Variable currents (4-20 mA), variable voltages (0-10V) or variable resistances.
- Ensure that the routines necessary to process analogue inputs are resident at the field controller.
- Ensure that a minimum and maximum limit value can be defined for each analogue input. Ensure that each limit is associated with a configured response.
- Ensure that the field controller can detect open or closed circuit faults and raise an alarm on the operator workstation.
- Ensure that non-linear inputs can be calibrated/ scaled.
- Ensure that it is possible to define a relationship between an analogue point threshold value and a digital point status.
- Digital inputs
- As derived from volt-free contacts (max 24 volts/20mA). Allow the interface to be selected to monitor a normally open or normally closed circuit.
- Ensure that the routines necessary to process the digital inputs are resident at the field controller.
- Pulsed inputs
- As derived from volt-free contacts (max 24 volts/20mA) at a pulse frequency of up to 32Hz.
- Ensure that the routines necessary to process pulsed inputs are resident at the field controller.
- Ensure that the field controller has the following capabilities.
- Storage of cumulative totals daily; weekly; monthly; yearly; and continuously.
- Operator re-set facility of cumulative totals via the operator workstation.
- Facility to combine counts from separate pulsed inputs.
- Ability to calculate the number of pulses per unit time through addition and/or subtraction.
- Ability to compare the number of pulses with pre-set limits on the basis of total number of pulses per unit time and the time required for a total number of pulses.
- Ability to convert pulsed readings into quantifiable values.
- Alarm facility based on a user-defined limit being exceeded.
- Ensure that the inputs which are used to monitor fluctuating pulse rate (e.g. maximum demand meter for electricity) have operator adjustable limits.
- Ensure that when data for pulsed inputs is recorded, the record includes both the pulse count and logging intervals for cumulative counts.
- Run-time totals
- Include run-time totalling routines to enable the operator to record cumulative run-time for each item of plant selected.
- Provide the operator with the option to set a different maximum run-time for each item of plant selected.
- Ensure that when the maximum run-time has been reached an alarm is signalled to the operator.
- Ensure that the operator workstation can be used to interrogate field controllers for a point-by- point summary of run-time totals and run-time limits.
- Ensure that it is possible for the user to set an initial value of hours run other than zero.
- General
- Ensure that all inputs can be scanned at intervals not exceeding 1 second.
- Ensure that all inputs are protected against spurious out-of-range signals including those caused by contact noise or bounce.
- Ensure that errors introduced by the analogue to digital conversion of inputs do not exceed 0.1% of the analogue value.

SS_75_70_54_10.310.230 FIELD CONTROLLERS - CONTROLLER OUTPUTS:

- Ensure that isolation between controllers and networks meet the requirements of prEN 13646.
- Ensure that the field controllers' interfaces are capable of providing control signals to actuators and switching devices.
- Ensure that routines are configurable, such that one or more events may be enabled in direct response to any defined logical relationship between the status of a number of physical or soft- points.
- Ensure that in the event of power failure, output devices can be driven to their pre-set, fully open/closed position.
- Provide the following interface characteristics:

    - Analogue output. As variable currents (4-20mA) or as variable voltages (0-10V). Ensure that it is possible to characterise analogue outputs in order to obtain a near linear response from the controlled items of plant.
    - Digital output. Ensure that digital outputs can be selected as 'normally closed' or 'normally open'.
- Ensure that errors introduced by the digital to analogue conversion of outputs do not exceed 0.1% of the digital value.
- Ensure that the field controller is capable of receiving feedback signals which allow the comparison between an output signal to a controlled device and its actual condition.

SS_75_70_54_10.310.240 FIELD CONTROLLERS - POSITIVE FEEDBACK:

- Ensure that the field controllers can include routines necessary to confirm that specific items of plant are functioning correctly. Ensure that this can be performed by monitoring physically separate but functionally related sensors, switches or transducers.
- Ensure that an alarm is raised if the expected response has not been established by a pre-set time following switching on of plant. Ensure that it is possible to operate any specified standby plant. Provide the operator with a facility to adjust the pre-set time delay.
- Ensure that the field controllers are capable of using measured feedback from an actuator position to give a percentage open reading.

SS_75_70_54_10.310.250 FIELD CONTROLLERS - DATA MONITORING AND LOGGING:

- Ensure that hard and soft-points associated with a field controller can be logged.
- Ensure that the BMS operator can set the start/stop times and logging frequency at the operator workstation.
- Ensure that logging is selectable between fixed periods or on a rolling basis.
- Ensure that each log can be defined in terms of log identification (point identification); units; and date/time stamp.
- Ensure that the operator can select all physical and soft-points for logging.
- Ensure that the field controller has sufficient memory to log the equivalent of seven days data at 15 minute intervals for 50% of the total number of physical points on the field controller.
- Ensure that when the logging capacity of a field controller is exceeded, the data can be automatically downloaded to the operator workstation and archived.

SS_75_70_54_10.310.260 FIELD CONTROLLERS - ENVIRONMENTAL CONDITIONS:

- Ensure that field controllers are suitable for operating normally within the following environmental ranges:
    - Temperature 0 to 50°C
    - Relative humidity 10% to 90% non-condensing.
- Ensure that the field controllers will operate in the electrical environment associated with building services plant rooms.
- Ensure that the EMC requirements specified in SS_75_70_54_10 are met.
- Ensure that the field controllers are protected against the effects of moisture, dust, dirt and gases.

SS_75_70_54_10.310.270 FIELD CONTROLLERS - INTERNAL POWER BACKUP:

- Ensure that a rechargeable battery or capacitor, if specified, can hold the controller's volatile memory for a minimum period of 72 hours.
- Ensure that a non-rechargeable battery, if specified, can maintain the controller's clock function for a period of two years.
- Ensure that the battery is easily replaceable.
- Ensure that the interval between battery maintenance inspections is not less than 12 months.
- Ensure that any battery monitoring functions defined in the Particular Inspection can be met.

SS_75_70_54_10.310.280 FIELD CONTROLLERS - MEANS OF CONFIGURATION:

- Ensure that the field controllers can be fully configured directly via a laptop type computer and via the operator workstation.
- Ensure that the field controllers can be configured through the use of a configuration interface with

full upload and download capability.
- Ensure that configuration details can be easily altered by system operators.
- Ensure that access to make configuration alterations is restricted to operators with access authority through the use of passwords.

SS_75_70_54_10.310.290 FIELD CONTROLLERS - USER INTERFACES:
- Ensure that all field controllers can be accessed through the use of portable computers.
- Ensure that access allows the display of all configuration details associated with the field controller along with:
    - Password protection for access with a minimum of two access levels.
    - Ability to display all point data (both hard and soft).
    - Ability to initiate and display logged data.
    - Ability to display and alter set-points and time schedules.
    - Ability to make alterations to control strategies.
- Ensure that field controllers incorporate a panel-mounted operator interface. Ensure that the interface includes the ability to:
    - Provide password protection for access with a minimum of two access levels.
    - Display all physical point data.
    - Display and alter set-points and time schedules.
    - Display the current date and time.
    - Review and acknowledge alarms.
    - Access logged data.

SS_75_70_54_10.310.310 OCCUPANT CONTROLS - TELEPHONE-BASED:
- Ensure that the PABX can be integrated with the BMS.
- Ensure that the occupant control functions can be performed via occupants' telephones.
- Ensure that an alpha/numeric code can be used to change each specified control set-point.
- Ensure that the database relating specific telephones to specific items of plant can be easily altered and expanded.

SS_75_70_54_10.310.320 OCCUPANT CONTROLS - OFFICE IT/INTRANET BASED:
Ensure that the occupant controls are TCP/IP compatible.

SS_75_70_54_10.310.330 CONTROL FUNCTIONS AND ROUTINES - GENERAL:
Provide a facility to automatically cycle selected actuators through their full range of movement outside normal operating periods with a periodicity set by the operator (in addition to normal automatic or manual control). Ensure that the cycle finishes as one complete operation. Ensure that any alarm conditions raised during the operation are inhibited as necessary.

Provide a facility to drive actuators to their open or closed positions at the end of plant operating periods.

SS_75_70_54_10.310.340 CONTROL FUNCTIONS AND ROUTINES - BASIC CONTROL FUNCTIONS:
- Ensure that configuration routines necessary for direct digital control (DDC) are resident at the field controllers.
- Provide DDC of plant through algorithms giving proportional plus integral plus derivative control (PID).
- Provide two-position control.
- Provide raise-lower or three-point control.
- Allow the selection of either proportional control (P) or proportional and integral control (P+I) or proportional and integral plus derivative control (P+I+D) modes independently for each relevant item of plant. Ensure that proportional, integral and derivative action times can be adjusted by the user.
- Allow the combination of more than one control loop by 'cascading', i.e. using the output signal from one control loop as the input signal to another control loop.
- Provide logic modules covering
    - Logical combination of digital variables.
    - Logic timer module.
    - Logic readback module.
    - Logic counter module.

    - Logic delay module.
    - Logic hours run module.
- Provide the following logic functions:
    - AND.
    - NOT AND (NAND).
    - NOT OR (NOR).
    - OR.
- Provide the following function modules as a minimum:
    - Filter (applies exponential filter with gain to input signal).
    - Rescale from (rescales an input of 0 to 100 to a user defined output and limits at these values).
    - Rescale to (rescales the input to the output of 0 to 100 and limits at 0 and 100).
    - Limit at (limits the output at user specified values).
    - Limit to (limits the output to 0 or 100 percent at values specified by the user).
    - Logarithm of input; Square root of input; Add to input; multiply by input; divide by input.
    - Minimum (to select the minimum value from two or more inputs);
    - Maximum (to select the maximum value from two or more inputs);
    - Average (to calculate the average value from two or more inputs).
    - Analogue gate (digital signal switches output between two analogue input signals).
    - Comparator (to compare two inputs, when input X is greater than input Y output of one is produced otherwise the output is zero).
    - Enthalpy (to calculate the enthalpy value from a temperature input and humidity input).
    - Hysteresis (changes a digital state if the input changes outside a defined band).
    - Analogue to digital converter (to change analogue value to binary).

SS_75_70_54_10.310.350 CONTROL FUNCTIONS AND ROUTINES - CONTROL INTERLOCKS:

- General
- Frost protection
    - Provide frost protection routines to operate plant and pumps in order to protect building services systems and their components from frost damage.
- Provide the following two stages of protection:
    - Ensure that when the outside temperature falls to the operator set minimum frost-protection temperature, the selected pumps start and circulation is established through pipework systems and their components. Allow the operator to pre-select which plant is to be started. The automatic standby plant is to operate on failure of the duty plant.
    - Ensure that when the return temperature falls below the operator pre-set minimum, the full frost-protection facility is initiated. Ensure that for heating systems, the heat source is turned on and operated to maintain the return flow temperature above the pre-set minimum. Ensure that specified protective devices activate for other liquid systems.
- Provide a facility to allow frost protection to be logged together with data and time.
- Building/plant protection
- Provide protection routines to operate the plant in order to protect the building fabric and its contents against the effects of low internal temperatures and of condensation.
- Ensure that if the internal air temperature falls below the pre-set protection temperature, the heating system and related plant is turned on and heat supplied to maintain the air temperature at or above the protection set-point temperature.
- Ensure that the building/plant protection routine overrides other control functions unless otherwise specified.
- Ensure that protection operates whenever the normal heating is switched off.
- Safety interlocks
- Ensure that all safety interlocks are hardwired and have precedence over all other control functions.
- Ensure that safety interlocks can only be reset manually and locally (not from the operator workstation).
- Ensure that all hardwired safety interlocks have corresponding software interlocks to prevent cascading nuisance alarms.

SS_75_70_54_10.310.360 CONTROL FUNCTIONS AND ROUTINES - TIME SCHEDULES:

- Ensure that each field controller is capable of enabling plant according to multiple pre-set time programmes. Ensure that it is possible to schedule each item of plant for a minimum of three separate switching periods per 24 hours. Ensure that separate schedules can be defined for each day of the week.
- Ensure that individual time schedules can be grouped to form global time schedules.
- Ensure that time schedules can be defined on a weekly basis on a single 'page/screen'.
- Ensure that time schedules can be defined 12 months in advance.
- Provide a time schedule override facility to accommodate holiday periods, etc.
- Allow fixed extensions and contractions to time schedules. Ensure that the time schedule reverts to the 'normal' switching periods following the extension/contraction period.
- Allow time schedules to be copied from existing schedules.
- Ensure that time schedules can be linked to optimum start/stop control facilities.
- Provide an optimum start/stop override facility for user-defined override days. Ensure that optimum start/stop control is enabled following the override period.
- Provide automatic switching between BST and GMT and back. Provide an operator override facility.
- Ensure that time schedules can accommodate leap years.

SS_75_70_54_10.310.370 CONTROL FUNCTIONS AND ROUTINES - PLANT START/STOP CONTROL:

- Ensure that field controllers are capable of automatically enabling standby plant on failure of duty plant. Ensure that the field controllers can automatically report plant failure alarms at the operator workstation. Ensure that the failure of a flow switch or other device does not continuously cycle plant.
- Ensure that if a flow switch fails the operator has the option to force either the duty or standby plant to come on.
- Provide the operator with the option to override any start/stop action configured within the field controllers. When reverting to normal automatic control, ensure that the original program is automatically reinstated and updated to the correct time.
- Provide delayed plant-starting facilities in order to reduce power surges. Ensure that it is possible to start plant sequentially by adjusting the delay period for each item of plant.
- Ensure that delayed plant-starting occurs following power failure/re-instatement and plant shut down/restart on fire/fireman override.
- Provide the operator with a facility to specify minimum on/off cycle times and/or the maximum number of starts per hour for specified items of plant.
- Provide a plant protection routine that enables the operator to select and automatically run items of plant for short periods during out of season shut-down. Ensure that the run periods are operator adjustable.

SS_75_70_54_10.310.380 CONTROL FUNCTIONS AND ROUTINES - SEQUENCE CONTROL:

- Provide sequence control routines to automatically sequence the operation of multiple items of plant by monitoring load parameters and efficiently matching the plant to the load.
- Ensure that it is possible to define different automatic sequences of control.
- Provide the operator with a facility to override the automatic sequence and define an alternative sequence.
- Ensure that the set-point values for each control action are variable and adjustable by the operator. Ensure that associated alarm limits are modified automatically.
- Allow the operator to adjust switching control differentials to prevent short cycling.
- Ensure that the routines also include a facility to operate all plant ancillaries associated with sequence control unless they have been specifically excluded.
- Ensure that the routines include the facility to proceed with the defined sequence when one of the items of plant in the sequence is isolated or fails to operate (unless the safety requirements dictate otherwise). Ensure that failed items of plant are removed from the sequence.

SS_75_70_54_10.310.390 CONTROL FUNCTIONS AND ROUTINES - PLANT ROTATION CONTROL:

- Ensure that relevant field controllers are capable of alternating the lead plant items where duty and standby equipment is installed. Ensure that this is achieved both by an operator command and on a time-scheduled basis.

- Ensure that the rotation control can be provided on the basis of run hours, elapsed time and calendar basis.
- Provide routines to ensure that when the maximum number of start/stop cycles for a particular plant is reached, then its schedule is automatically modified, e.g. by rotating the standby equipment or changing the lead machine.
- Ensure that each item of plant operated under rotation control can operate at any stage of the rotation sequence.
    - 1-2-3.
    - 2-1-3.
    - 3-2-1.
- Ensure that the plant rotation control can accommodate a plant failure condition, in such a way that a failed item of plant is 'replaced' by the next in the rotation cycle. Ensure that an alarm condition is raised in response to plant failure.
- Ensure that rotation control can be initiated outside normal operating periods.

SS_75_70_54_10.310.410 CONTROL FUNCTIONS AND ROUTINES - OPTIMUM START/STOP FOR COOLING SYSTEMS:

- Provide an optimum-start routine for the cooling system to compute the daily minimum pre-cool period necessary to achieve target comfort conditions at occupation start time. Provide an optimum stop routine to compute the earliest time for the cooling system to be shut down in order to retain minimum comfort conditions in the space at the end of occupation.
- Ensure that the optimum start/stop routines have access to the system real-time clock, calendar facility and time programme to define the occupation periods.
- Ensure that routines are capable of operating the ventilation system for building purging prior to optimum start of cooling plant.
- Ensure that it is possible to apply optimum start/stop control both to individual zones and overall plant operation.
- Provide routines to operate chillers and ventilation plant as necessary to achieve the required target conditions while ensuring that heating and cooling systems do not conflict in any controlled zones.
- Provide the operator with the facility to adjust the following cooling system optimum start/stop parameters.
    - Target temperature for optimum start.
    - Maximum pre-cool period.
    - Earliest time for building purging during out of hours period.
    - Inside and outside temperature limits for building purging.
    - Separate time/temperature relationships for optimum start and optimum stop.
    - Minimum space temperature during building purging.
- Ensure that the internal and external air temperature sensors associated with the optimiser are positioned correctly in order to provide representative readings.

SS_75_70_54_10.310.440 SYSTEM COMMUNICATIONS - GENERAL:

- Ensure that the system communications allows the full transfer of monitored, logged, alarm, backup and configuration data between the operator workstation and addressable field controllers.
- Ensure that the communication protocol selected seeks to achieve error-free data transfer. Ensure that the protocol includes an error detection check; includes an error correction and/or re-try technique; limits re-transmission; and raises an alarm condition on failure.

SS_75_70_54_10.310.450 SYSTEM COMMUNICATIONS - COMMUNICATION DEVICES:

- Provide an ISDN link.
- Provide a broadband link.
    - TCP/IP

SS_75_70_54_10.310.470 SYSTEM COMMUNICATIONS - DIRECT INTEROPERABILITY:

Ensure that each of the protocol's objects and attributes are consistent with the achievement of the specified level of direct interoperability.

SS_75_70_54_10.310.490 SENSORS AND DETECTORS - GENERAL:

- Interface sensors with controllers and indicators via amplifiers or transmitters, where necessary.
- Ensure that all signals are compatible with interfaces fitted to associated field control devices.
- Ensure that the performance of the sensors and detectors are not adversely affected by the following variations in power supply conditions: 230V+10%, -6%.
- Ensure that connections to sensors and detectors are of a screw down clamp type or self-locking connectors.
- Ensure that sensors, detectors and meters are installed in accordance with the manufacturer's instructions and recommendations.
- Ensure that calibration conditions for meters are fully documented in the O&M manuals and clearly marked on or adjacent to the meters.
- Ensure that any calibration and maintenance requirements for sensors, detectors and meters are documented in the O&M manuals.

SS_75_70_54_10.310.500 SENSORS AND DETECTORS - TEMPERATURE SENSORS:

- Standard
    - BS EN 60730-2-9
    - BS EN 14597
- Use thermocouple assemblies consisting of element, sleeve and connector.
- Connect thermocouple assemblies to
    - A digital indicator/control unit.
    - An analogue indicator/control unit.
- Method
- Directly.
- Indirectly.
- Sensor
- Enthalpy.
- Ductline.
- Surface.
- Room.
- Immersion.
- Outside air.
- Indicator
- Time constant
- Space/outside air temperature - 300s still air.
- Duct air temperature - 120s @ 1m/s.
- Water - 30s @ 1m/s.

Ensure that temperature sensors comply with the minimum requirements of the following table.

Table 1 Temperature sensors - minimum requirements

Fluid	Temperature range deg C	Sensor accuracy deg C
Air	- 10 to + 40	+/- 0.5
Flue gas	+ 30 to + 850	+/- 3.0 (0.75% of FSD above 450˚C)

Chilled Water	- 10 to + 30	+/- 0.25

Water	- 10 to + 150	+/- 0.5

SS_75_70_54_10.310.510 SENSORS AND DETECTORS - HUMIDITY SENSORS:

- Type duct mounted and wall mounted
- Application used to measure humidity in air streams and spaces
- Standard - BS EN 60730-2-13.
- Measurement
- Relative humidity.
- Indicator
- Time constant - 300@ 1m/s.

Ensure that humidity sensors comply with the minimum requirements of the following table.

Table 2 Humidity sensors - minimum requirements

Sensor	Humidity range	Sensor accuracy

Humidity	10 to 90%	+/- 5% RH

SS_75_70_54_10.310.520 SENSORS AND DETECTORS - AIR VELOCITY SENSORS:

- Method
- Pitot static tube.

Ensure that air velocity sensors comply with the minimum requirement of the following table.

Table 3 Air velocity sensors - minimum requirements

Sensor	Sensor range	Sensor accuracy

Pitot static tube	3 to 80 m/s	+/- 2% of reading

Thermo-electric anemometer	0 to 20 m/s	+/- 3% of reading or +/- 0.1 m/s whichever is greatest

SS_75_70_54_10.310.530 SENSORS AND DETECTORS - AIR PRESSURE SENSORS:

- Use pressure transducers manufactured in stainless steel.
- Connect pressure transducers, via matched transmitters to
- Single way display/alarm/control unit.
- Indicator

Ensure that air pressure sensors comply with the minimum requirements of the following table.

Table 4 Air pressure sensors - minimum requirements

Sensor	Sensor range	Sensor accuracy
Air pressure	-	+/- 2% of reading

SS_75_70_54_10.310.535 SENSOR AND DETECTORS - FLOW SENSORS:

- Standard - BS EN 60730-2-18.
- Sensor
- Differential pressure transducer.
- Electro-magnetic meter.
- Sensor range as described below
- Sensor accuracy as described below
- Time constant 5 seconds.
- Indicator.

SS_75_70_54_10.310.540 SENSORS AND DETECTORS - FLOW METERS:

- Application main LTHW and CHW systems
- Ensure that meters comply with the minimum requirements of the following table.

Table 5 Flow meters - minimum requirements

Meter	Meter range	Meter accuracy
Fuel flow meter	0 to 10 Hz	3% of reading
Water flow meter	>> 5:1	2% of reading
Electricity meter	-	1.5% of reading

SS_75_70_54_10.310.545 SENSORS AND DETECTORS - LEVEL SENSORS:

- Application all water tanks
- Provide liquid level detectors and connect, via matched amplifiers, to
- Single way display/alarm/control units.

- Sensor
- Use capacitance electrodes manufactured from stainless steel and PTFE insulation for use on conductive liquids with a minimum conductivity of 0.01 S/m.
- Use conductivity electrodes manufactured from stainless steel, either single or multi-tipped.
- Float type to BS EN 60730-2-16.
- All level sensors to be suitable for potable water.

SS_75_70_54_10.310.545A DIFFERENTIAL PRESSURE SENSORS
Differential pressure sensors shall be supplied and installed across all filters, such that when the differential pressure across the filter exceeds a pre-set value, a digital signal is sent to the outstation. The differential pressure, as measured by sensing tubes is applied to two sides of a diaphragm and when exceeding a value, the spring-loaded diaphragm moves to actuate the switch. Include for all accessories necessary for its proper and efficient installation.

Differential pressure sensors suitable for duct mounting shall be supplied and installed adjacent to all fans to detect a positive pressure at the discharge over and above atmospheric pressure. The sensing tube for the high pressure side shall be so arranged to present the open end facing and parallel to the air flow. When the differential pressure drops below a pre-set value after the initial flow is established (delay by software timer), a digital signal is sent to the outstation. The BMS and Automatic Controls Specialist shall include for all accessories necessary for its proper installation. For two stage fans, the differential pressure shall relate to a value below the first stage.

Differential Pressure sensors are to be provided in the CHW and LTHW systems at the extremities of each branch circuit. Variable speed pumping to heating and chilled water systems will be controlled by means of monitoring these transducers, with the pumps ramping up in speed until the required differential pressure set point is available at each of the sensor locations. Due to the varying nature of the system dynamics, it is not possible to identify a single index circuit; therefore, the pumps shall modulate to maintain the minimum required differential pressure at the branch forming the index circuit at any point in time.

In the event of a multiple DP sensor failure pumps are to be configured to produce 100% (this figure is adjustable and to be confirmed during commissioning procedure) of design duty.

SS_75_70_54_10.310.546 SENSORS AND DETECTORS - OTHER SENSORS:
- Type
    - CO2.

SS_75_70_54_10.310.565 TRANSDUCERS:
Use transducers to receive 0-20V DC signal from controller and to convert it to proportional 0-15 psi output. When using transducers use electromagnetic actuators.

- Transducer
- Electro-hydraulic.

SS_75_70_54_10.310.600 SWITCHES AND THERMOSTATS
SS_75_70_54_10.310.605 AIR DIFFERENTIAL PRESSURE SWITCHES:
- Pressure switches shall be of industrial quality. Those for compressed air measurement shall have a nominal setting of 5.5 bar and a differential not exceeding 0.6 bar. Those for vacuum shall have a nominal setting of 200 Torr and a differential not exceeding 20 Torr.
  Pressure switch enclosures shall be to protection class IP54 with exception of those at roof plant level which shall be IP65 and electrical quick-break contacts shall be minimum rated at 250V AC, 10A resistive. Contacts shall be configured for changeover action.
  Pressure connections shall be screwed to accept standard compression type couplings of a type suitable for the duty.

SS_75_70_54_10.310.615 AIR SENSOR - INSERTION TYPE:
- Use proportional type insertion sensor.
- Sensor

- Averaging type temperature sensor for mounting over face of air flow in an air-handling unit or in ductwork adjacent to a heating coil.
- Thermistor type temperature sensor, minimum stem length 200mm for mounting in the air flow or distribution ductlines.

SS_75_70_54_10.310.635 AIR THERMOSTATS - REMOTE BULB TYPE:

- Connect via
- Cable
- Capillary
- Ancillaries
- Clamp-on detector for pipelines.
- Solar collector detector.
- Immersion detector and pocket.
- Insertion detector.

SS_75_70_54_10.310.640 AIR THERMOSTATS - FROST PROTECTION TYPE:

- Application all fresh air intake ventilation systems
- Standard
- BS EN 60730-2-9
- BS EN 14597
- For space mounting use frost protection thermostats with temperature range of 0-20°C and with SPST switching action and electrical rating of 20 amps resistive.
- For heater battery protection use frost protection thermostats consisting of a gas filled sensing element and a bulb, a directly adjustable set point and switching differential.
- For compensated systems use external frost type thermostats with proportional type sensor, the whole unit being weather-proofed.
- Ancillaries
- Clamp-on temperature detector.
- Immersion type temperature detector.
- Controller.
- Start-up switching and indication.
- Manual or automatic reset facility.

SS_75_70_54_10.310.645 WATER IMMERSION THERMOSTATS:

- Standard
- BS EN 60730-2-9
- BS EN 14597
- Use proportional type immersion thermostats with rigid sensing elements ensuring 50mm minimum length is immersed. Use separable pockets, screwed 15mm BSP.
- Pocket material
- Stainless steel.

SS_75_70_54_10.310.700 ACTUATORS:

- Include position feedback devices suitable for connection to the BMS.
- Ensure that actuators incorporate a disconnection device to allow manual operation of the valve or damper in the event of actuator failure.
- Where line voltage actuators are used, provide local means of isolation by manual isolator or plug and socket connection.
- All actuators to have visual indication of position

SS_75_70_54_10.310.800 VALVES AND DAMPERS:
SS_75_70_54_10.310.805 MOTORISED VALVES:

- All control valves and actuators shall be suitable for the maximum working pressures and temperatures of the appropriate systems and be capable of closing against the closed head pump pressure and ultimate peak circulating pressure.
  Control valve actuators shall be modulating type.

The schedule indicates the estimated control sub- circuit resistances to be used for tendering.
Ensure that the control valves selected for installation shall be sized for the actual pressure drop of the selected coil, and not for the design estimation i.e. data obtained via the WP 6300 Trade Contractor.
Modulating valves shall be selected to have an authority between 0.5 and 0.6.
Select valve bodies to be suitable for their designated service but shall comply with the following:
1. Sizes 15-50mm - screwed connections.
2. Sizes 65mm and above - flanged.
Two and three port modulating control valves shall be of the single seated plug or rotating shoe types. No plugs, shoes or trims shall be constructed of materials liable to corrode or cause sticking. Mixing valves in diverting applications shall generally have an equal percentage characteristic and those in mixing applications shall have a linear characteristic. Three-port valves shall be designed to give a constant flow characteristic. Valves are to be provided with standard connection types to the satisfaction of WP 6300 Trade Contractor. Jointing method is to be confirmed by WP 6300 Trade Contractor.
Rangeability shall not be less than 100:1. All control valves shall be suitable for operating at the maximum system differential pressure, the valves linkages and actuator shall be appropriately sized and of suitable construction.
Two position valve bodies shall conform to the requirements of the above modulating valves with the exception of characteristics and rangeability.
All valves greater than 25mm shall be fitted with valve position indicators. Where power failure to a valve may constitute a safety hazard (e.g. steam/HPHW applications) the valve shall incorporate a spring return device that will move the valve to the safe position on power failure.
Valves shall be supplied complete with actuators and linkages and be supplied to site ready assembled and adjusted for stroke.

- Standard
- BS EN 60730-2-8.
- Type
- Single seat.
- Double seat.
- Three-way mixing.
- Three-way diverting.
- Butterfly.
- Multi-port.
- Low flow.
- Pilot operated.
- Material
- Brass to BS EN 12163, BS EN 12164 or BS EN 12167.
- Copper alloy to BS EN 1982.
- Cast iron to BS EN 1561.
- Cast steel to BS EN 10213.
- Connections
- Screwed to BS 21 and BS EN 10226-1.
- Ancillaries
- Position indicator.
- Locking device.
- Control device and linkage mechanisms.
- Actuating motive power
- Solenoid.
- Electric motor.

SS_75_70_54_10.310.900 DAMPERS:
SS_75_70_54_10.310.905 MOTORISED DAMPERS:
Where motorised dampers are depicted in the schedules or drawings the BMS and Automatic Control Specialist shall provide and fit the damper actuators to the dampers that will be supplied and installed by the Installer.
Control damper actuators shall be suitable for the working pressure, size of damper and torque requirement of

the appropriate system.
Damper actuators may be direct or remote mounted. Both shall be securely fitted to the damper by the BMS and Automatic Control Specialist using the manufacturer's recommended mounting instructions. When remote mounted actuators are used the installation and correct setting of the linkage mechanism shall be the responsibility of the BMS and Automatic Control Specialist. The setting of the linkage and any adjustment of damper movement shall be performed at the commissioning stage.
Damper actuators shall be of two types - modulating or On/Off, as required to achieve design intent.
Modulating actuators shall be supplied with 24V AC and shall be positioned by an analogue signal from the BMS.
On/Off actuators shall be supplied with 24V AC Open/Close signals from digital outputs on the BMS.
Dampers shall be fitted with a direction reversing switch, position indication and actuator feedback position indication. Auxiliary switches shall be fitted for indication to remote devices. Where damper assemblies are greater than $1m^2$ are required, the damper motors shall be electrically connected as master slave units. Where damper motors are required to fail open or closed or provide an instantaneous open to closed or vice versa reaction, this shall be effected by a spring return mechanism activated by a break in the electrical supply to the motor.

Use motorised control dampers manufactured and installed in accordance with DW 144.

- Actuating motive power
- Electric motor.

SS_75_70_54_10.320.000 INSTALLATION:
SS_75_70_54_10.320.050 FIXING AND CONNECTION - CABLING INSTALLED AS PART OF THE BMS CONTRACT:
Plan and install all building management monitoring systems cables in accordance with the cable manufacturer's recommendations.

Label and record all monitoring cables in accordance with

- General
- This part of the specification covers extra-low voltage wiring (as defined by BS 7671), i.e. signal and data communications wiring.
- Install all cabling in accordance with BS EN 50174.
- All cabling must be adequately protected from the environment through which it passes to avoid the possibility of mechanical damage or electromagnetic interference.
- Install cabling and conduits associated with sensors in a manner that prevents spurious transfer of moisture and heat etc. from external sources to sensing devices.
- Ensure that all wiring is carried out in a neat manner by skilled operatives. Clip wiring to form a loom and route it to avoid interference with the correct operation or maintenance of other components.
- Cable type and application

Ensure that the types of cable installed do not prejudice satisfactory operation of the BMS.

- Ensure that the type of cables, installation and planning comply with the BMS manufacturers recommendations and the project's electrical specification.
- Ensure that the cross-sectional area of cables is sufficient to ensure that sensor circuit resistance limits are not exceeded.
- Ensure that the method of installation and routing of cables does not compromise the satisfactory operation of the BMS.
- Ensure that the following minimum separation distances (in mm) between data/analogue signal cables and power cables are adhered to (not required if data/signal cables are in steel conduit or trunking).

Table 7 Minimum separation distances between signal cables and power cables

Signal cable	Power cable Unscree	Power cable Armoured

	ned	steel wire

Plain	150 mm	125 mm

Unscreened twisted pair	75 mm	50 mm

Screened	0 mm	0 mm

- Identification
    - Ensure that all cables have identification sleeves at their terminations which combine the requirements of BS 7671 with those for specific circuit identification. Ensure that the identification is consistent with the relevant wiring diagrams.

SS_75_70_54_10.320.060 FIXING AND CONNECTION - USE OF EXISTING CABLE AND WIREWAYS:
Confirm by testing or obtain appropriate certificates from original suppliers that any existing means of network communication is of a suitable standard for satisfactory operation of the BMS.

- Ensure that any tests performed comply with BS EN 50174.
- Ensure that the potential corruption of data cannot arise from:
    - Other installations not connected to, but in close proximity to, the route of existing cabling
    - Other electrical services using existing cabling
    - Other adjacent cabling.
- State in writing at the time of tender whether or not existing cabling is suitable.

SS_75_70_54_10.320.070 FIXING AND CONNECTION - CONNECTION TO PLANT AND CONTROL EQUIPMENT:
- General
- Provide all devices and terminals necessary to connect the BMS to items of plant and control equipment.
- Take account of any existing services that have to remain in continuous operation. Agree with the Project Supervisor the method by which the BMS equipment can be installed without disrupting the operation of the building services.
- Where plant and control equipment are supplied by others, provide the Project Supervisor with adequate details of installation requirements. Provide this information in time and in sufficient detail to enable any other installers and their suppliers to incorporate the BMS connection facilities before delivering their equipment to site.
- Where plant is subject to warranty by others, obtain clearances in writing from those concerned that the proposed modifications do not invalidate the warranties.
- Ensure that modifications carried out as a result of the contract are fully documented and do not affect the satisfactory operation of safety devices connected to any plant or systems affected directly or indirectly by the BMS works. Carry out proving tests to the satisfaction of the Project Supervisor.
- Ensure that the use of existing relays, contactors, starters and switches as part of the BMS installation is fully documented.
- Where controls equipment is to be installed on or attached to plant Contractor is to ensure that any openings or fixing points are adequately sealed to prevent water ingress or system air leakage.
- Safety interlocks
- Provide interlocks as scheduled to establish and maintain safe/pre-determined plant conditions under all modes of operation including loss, reduction and restoration of power.

- Ensure that all safety hard-wired interlocks are wired to failsafe on loss of power, or on relay coil failure, or on open circuit, e.g. cable breakage.
- Ensure that all interlocks use voltage-free contacts and 24v AC or DC relays and field wiring.
- Complete all wiring and testing of all hard-wired safety interlocks to ensure safe and/or sequenced operation of the plant before the BMS is set to work. Arrange interlocks to prevent unsafe or out of sequence operation of the plant by the BMS.
- Ensure that plant does not operate using the BMS until all interlocks have been tested to the satisfaction of the Project Supervisor.
- Manual control
- Provide manual control facilities to enable plant maintenance/facilities staff to operate essential plant in the event of BMS failure and for routine test purposes. Ensure that the facilities include:
- Start/stop operation of the plant.
- Automatic operation of motorised control devices such as valves and dampers, etc. if the BMS is operating.
- Manual setting of motorised control devices such as valves and dampers, etc. if the BMS has failed.
- Ensure that the manual control facilities do not override safety devices or hard-wired interlocks.
- Volt-free contacts
- Ensure that the contact materials are suitable for use in the installation and at the required voltages and currents.
- Use screw down or locking spade terminals for electrical connections to volt-free contacts.
- Relays
- Use demountable relays of the totally enclosed type.
- Use screw down clamp or locking spade-terminals, and ensure they are shrouded.
- Signalling from starters
- Control equipment
- Obtain advice from the relevant supplier when additional facilities are to be fitted to control equipment supplied by others.
- Use the knockouts, cable routes and terminals, etc. incorporated into the design of control devices.
- Packaged plant

Ensure that connections to packaged plant are made within the packaged plant control panel. Fit an additional enclosure where this is not possible. Ensure that all connections between the BMS and packaged plant are 24v maximum.

SS_75_70_54_10.320.080 FIXING AND CONNECTION - ADDITIONAL PROVISIONS FOR RETROFIT INSTALLATIONS:

- Arrange for any necessary control modifications to existing plant to be carried out by the original supplier (with the exception of starter panels). Give the supplier details of the requirements for connection of equipment to the BMS. State the name of the supplier in the Tender together with a priced schedule for the necessary work.
- Where details of existing plant are not available from the original supplier or from record documents, provide a specialist conversant with the particular type of plant to carry out any necessary modifications. Provide the specialist with the details of the BMS connections required. State the name of the specialist in the Tender together with a priced schedule for this work. Advise the Project Supervisor of any difficulties with connections.
- Advise in writing at the time of tender of any potential delay to the contract arising from the difficulty of providing the necessary BMS connections to the plant.
- Use existing relays and volt-free contacts where feasible.
- Fit auxiliary contacts to contactors, etc. where adequate space is available. Install additional relays if the space is not adequate.
- Obtain advice from the original supplier when additional facilities are to be fitted to existing control equipment.
- Use the control manufacturer's standard accessories to provide any additional contacts, limit switches and potentiometers, etc.
- Use the knockouts, cable routes and terminals, etc. incorporated into the design of control devices wherever possible. Obtain approval from the Project Supervisor for ad hoc fixings and modifications to

control devices before action is taken on site.

SS_75_70_54_10.320.090 FIXING AND CONNECTION - CABINETS FOR BMS EQUIPMENT:

- Construct BMS equipment enclosures to give the minimum degree of protection to IP54 in accordance with BS EN 60529. Where the enclosure is fitted inside another panel (e.g. a motor control centre) the protection can be reduced to IP41.
- Ensure that access doors are of a rigid construction and mounted on stout metal hinges capable of supporting the full weight of the open door. Ensure that doors will not sag or drop when open. Fit doors with stout locking handles to prevent access by unauthorised personnel.
- Allow safe access to the BMS equipment where the BMS equipment is incorporated into another control panel without having to isolate the panel.

SS_75_70_54_10.320.100 FIXING AND CONNECTION - CONTROL PANELS:

- Control panel design
- Ensure that the requirements of prEN 13646 are met.
- Ensure that the layout of control panels reflects the layout of the plant being served. Ensure that indicators and controls for associated plant are grouped.
- Ensure that all doors on panels containing exposed dangerous voltages are provided with interlocked isolators such that the door cannot be opened except with the isolator in the 'off' position. Ensure that isolation complies with BS 7671.
- Ensure that equipment that requires on-line adjustment and testing by non-electrically qualified personnel is accessible and usable without interrupting the supply or overriding safety interlocks. Ensure that in general, field controllers are not located within control panels where isolation is necessary to gain access.
- Design panels to maintain all components within their environmental tolerance limits taking into account ambient environmental conditions. Install fans with thermostatic control and air extract grilles and air intake grilles with replaceable filters where mechanical ventilation is required to control the environmental conditions. Ensure that the specified ingress protection (IP) ratings are maintained.
- Control panel construction
- Construct control panels to IP54. Construct the panels using sheet steel, folded and seam welded to form a rigid self-supporting structure. Ensure that bracing and stiffening is used as necessary to take the weight of internal components and control assemblies. Ensure that no sharp corners are present.
- Ensure that control panels weighing more than 50 Kg including installed components are fitted with eyebolts to facilitate delivery and installation.
- Ensure that panels are provided with adequate undrilled and/or detachable gland plates of sufficient size and strength to accept glands for all types of cable conduits and cable trunking intended for termination within the panel.
- Arrange all wiring within the panel in looms and/or perforated trunking. Ensure that all cables are run continuously from terminal to terminal without intervening joints.
- Ensure that all terminations are fully shrouded, recessed or otherwise protected against accidental contact.
- Ensure that where live equipment cannot be isolated it is covered with a Perspex shield carrying appropriate warning labels in addition to specified shrouding.
- Ensure sufficient spare capacity in cable ways and trunking to comply with BS 7671.
- Ensure that flexible looms are used to connect door mounted to interior-mounted components such that wires will not weaken or break with repeated door openings. Arrange the loom to avoid pinching or looping when the door is closed and ensure that it is fully supported at each end.
- Control panel labelling
- Ensure that all panels and individual panel sections are provided with exterior labels to BS 5499-5 indicating the voltage within the panel along with clear warnings of risk and instructions for isolation. Display requirements for informing the BMS supervisor and/or disabling alarms prior to isolation of control circuits.
- Label all switches, controls and indicators on control panels as to function and associated plant.
- Fix a notice to the front of the panel warning of the need for isolation elsewhere if the panel does not totally control the electricity supply to associated plant.
- Identify all cables with permanently fixed ferrules. Ensure that the numbering corresponds to the

numbers fixed to the terminals. Ensure that identification and coding matches that used on the design drawings, schematics and schedules.

SS_75_70_54_10.320.110 SENSORS - GENERAL:

- Ensure that sensors can be removed for testing and maintenance.
- Ensure that a tight-sealing test hole is provided adjacent to every duct sensor. Ensure that Binder test points, or similar, are provided for pipe sensors.
- Provide a sufficient length of spare cable so that the sensor can be removed without disconnecting the wiring.
- Mark and record the location of concealed sensors (e.g. in false ceilings and shafts, etc.).
- Provide a labelling plate for each sensor.
- Take account of the active and inactive sections of a sensor probe.
- Take into account the effects of orientation on the functioning of the sensor.
- Take into account:
    - Minimum/maximum ambient temperature.
    - Ambient humidity.
    - Vulnerability to spray water and/or vibration.
    - Explosion protection.
    - External influences.

SS_75_70_54_10.320.120 TEMPERATURE SENSORS:

- Pipe-mounted immersion sensors
    - Ensure that the full active length of the sensor is immersed in water.
    - Install sensors against the direction of flow.
    - Install at the correct angle.
    - The sensor should be installed diagonally in a bypass pipe or in a bend if the active length of the sensor probe is longer than the diameter of the pipe.
    - Allow an adequate space between the sensor and the obstruction so that the sensor can be removed from the immersion pocket.
    - Ensure that immersion pockets are made from stainless steel of the appropriate pressure rating.
    - Ensure that immersion pockets are filled with a heat conducting compound.
    - A test point or an additional immersion pocket, adjacent to the sensor, should be provided for test purposes.
    - An adequate distance (10 x pipe O) between the mixing point and the sensor should be provided when mixing water at different temperatures to take account of stratification.
- Surface temperature sensor - water
    - Ensure a smooth clean contact surface and fill the space between the sensor and the pipe with a heat conductive compound to improve thermal conductivity.
- Immersion sensors for air (ducts)
    - The full active portion of the sensor probe should be exposed to the air flow.
    - Ensure that the active portion of the probe is located central to the airflow.
    - A test hole should be provided adjacent to every sensor with plug when not in use.
    - Probe-type sensors should not be used in areas where stratification can occur, e.g. downstream of heating and cooling coils, etc. (see averaging sensors).
    - Sensors which are positioned near to coils should be shielded against the radiative heat transfer.
    - Return air duct sensors should be located near to the occupied space to avoid heat gain or loss and radiant effects influencing readings.
    - Sensors must be positioned in an area of representative air flow. This applies to all duct sensors but particularly the return air sensor which may be located in the ceiling plenum.
    - The likely cleanliness of the air should be considered when selecting sensors.
    - Sensors representing zone temperature should be offset to account for heat gains e.g. space temperature stratification or if light fixtures are used as the return air path.
    - Sensors should only be used in return air ducts where air is continuously extracted.
- Capillary sensors with probes
    - The device head must be higher than the sensor probe.

- The sensor probe should be tilted downwards.
- The ambient temperature at the device head must always be higher than the temperature to which the sensor probe is exposed.
- The sensor element must always point downwards. The capillary should not form a U-shape.
- The capillary should not be bent too tightly (radius of bend >50mm).

- Averaging sensor (for use in ducts/AHU)
  - Allow a distance of at least 50 mm between any heat exchanger and the sensor.
  - The entire length of an averaging sensor must be fully inside the air-duct.
  - The sensor element must be evenly distributed over the full cross-section and adequately secured to prevent vibration.
  - The sensor element should be installed in the air flow, downstream of the eliminator plate when air washers are used for humidification.
- Frost protection thermostat
  - Leave a spare capillary loop of 20 cm to enable sensor testing outside the duct/unit.
  - The measuring head and the test loop of the thermostat must be located inside the ductwork and downstream of the heat exchanger if the ductwork is outdoors or in an unheated space.
  - The capillary should be installed in the air flow, downstream of the first heating coil exposed to frost. The capillary must be installed diagonal to the heat exchanger pipes or in a serpentine manner at right angles to the pipes.
- Room sensor
  - Sensors should be installed at a height of 1.5 m in occupied spaces and at least 50 cm from any adjacent walls.
  - The sensor should be located in an area representative of the entire control zone.
  - The sensor should be located away from heat sources, e.g. office IT equipment.
  - The sensor should be located in the area it controls.
  - Sensor locations near air currents generated by diffusers or openable windows, for example, should be avoided.
  - The sensor must not be exposed to direct solar radiation.
  - Avoid external walls except were unavoidable. Use insulated backplates.
  - Avoid recesses and alcoves.
  - The conduit entry points to the sensor wall box should be sealed where there is a risk of air from another zone flowing over the sensor element.
  - Do not install near or under lamps or above radiators.
  - Avoid chimney walls.
  - Do not install directly adjacent to doors.
  - Do not install behind curtains.
  - Do not fit to walls concealing hot-water pipes.
- Outdoor air temperature sensors
  - Do not install on facades affected by significant rising heat, or facades which will be heated by solar radiation (fix sensors to a north-facing wall or use solar shields).
  - Avoid chimney walls and other walls subject to high internal heat gains.
  - Do not install under eaves.
  - Do not install above windows.
  - Do not install above ventilation extracts.
  - Ensure accessibility for inspection/verification
  - An alternative to an external mounting is to locate the sensor in the AHU intake duct. This should ideally be upstream of the intake damper. Where this is not possible it must be a suitable distance before re-circulated air and mechanical devices to avoid their effects.

SS_75_70_54_10.320.130 HUMIDITY SENSORS:

- Humidity sensor/stat. - duct
  - The air velocity in the vicinity of the sensor must not exceed 10 m/s (a perforated steel plate cover can be used).
  - The sensor must not be located in deadlegs (super-saturation can occur in areas where there is no air flow).
  - A test hole must be provided downstream of the sensor, plugged off when not in use.
  - The sensor should be positioned beyond the spray distance of humidifiers.

- Humidity sensor/stat. - room
    - The sensor should be installed at a height of approximately 1.5 m in the occupied space and at least 50 cm from the adjacent wall.
    - Avoid locations where the sensor will be exposed to direct solar radiation.
    - Avoid external walls except were unavoidable. Use insulated backplates.
    - Avoid alcoves and recesses.
    - Do not install near lamps or above radiators.
    - Do not fit to chimney walls.
    - Do not fit directly adjacent to doors.

SS_75_70_54_10.320.140 PRESSURE SENSORS:

- Pressure - general
    - Pressure sensors are affected by orientation.
    - The pressure tubes must be provided with a binder point near the device head for test purposes.
    - The connection must be fitted with a bypass with a stop valve to avoid overload on one side when manipulating the sensors and to enable zero calibration. Isolating valves should also be fitted.
    - The sensor should be installed on a vibration-free surface or vibration-proof base.
    - The pressure-tapping point must not be located in turbulent air flow. Provide 6 x O/D upstream and 6 x O/D downstream of straight duct or pipe without obstructions.
- Pressure - air
    - Probes for measuring static pressure should be installed parallel to the flow.
    - The differential pressure measuring tube should be correctly sized.
    - The tapping point should not be located where it will be affected by obstructions to the flow.
- Pressure - liquids
    - Use a damping coil to avoid transferring vibrations (horizontal loops to avoid trapped air bubbles and condensate).
    - The device must always be installed in a location which is lower than the sensing point.
    - Do not measure at the top of a pipe (trapped air, bubbles) or at the bottom (dirt).
- Pressure - gases
    - When measuring vapour gases the device must always be installed in a location which is higher than the sensing point.
    - Measure at the top of the pipe to prevent condensate from entering the pressure tube.

SS_75_70_54_10.320.150 FLOW VELOCITY/FLOW RATE SENSORS:

- Differential pressure for flow monitoring - liquids
    - There should be no stop valves or balancing valves between the sensing points on the pipework.
- Differential pressure for flow monitoring - air
    - Ensure a steadying zone upstream and downstream of the orifice plate/flow grid, etc.
    - The flow or differential pressure must not be monitored where there is a variable resistance such as a filter or fan, etc.
- Velocity sensors
    - Sensors should be positioned at an adequate distance from bends, tees, fans and coils such that the centre line velocity is representative of the average velocity.
    - A single point sensor should be located at a distance from the centre of the duct equal to 0.25 x the duct radius.
- Wilson flow grid
    - Averaging velocity sensors across the duct, e.g. Wilson flow grid or multi-point averaging pitot tubes, should be used where the minimum separation distance from a flow disruption is not available. Ensure that the Wilson flow grid is sized correctly for each duct size.

SS_75_70_54_10.320.160 INDOOR AIR QUALITY SENSORS:

- CO2 and mixed-gas sensors - room mounted
    - Ensure that the sensor is located in a representative location, e.g. on an open wall 1.5 to 3 m above the floor.

- Ensure that the sensor is not mounted in niches or bookshelves or behind curtains.
- Ensure that the sensor is not located where people are continuously present (within 1 or 2 metres).

- CO2 and mixed-gas sensors - duct mounted
  - Ensure that the sensor is located in the return air duct as close as possible to the room extract point(s).
  - Ensure that the sensor is located in the vertical position.
  - Ensure the correct orientation of the duct probe with respect to the airflow.
  - Ensure that the sensor is not installed in a vertical position with the head at the bottom.

320.170 ACTUATORS:

- Securely mount actuators to rigid members, free from vibration or distortion in accordance with manufacturer's recommendations. Select mounting positions to require minimum linkages, and to avoid angular drive to operating levers. Allow access for servicing and replacement.
- Ensure that actuators and linkages for valves and dampers operate smoothly from fully open to fully closed without binding and with adequate torque to overcome the resistance of the actuator mechanism and the flow and to provide the specified close off ratings.
- Ensure that linkages are clearly marked with the clamping position such that after maintenance or replacement the mechanism is able to operate correctly.
- Fit actuators with visual position indication.
- Ensure that there is sufficient space above the actuator so that it may be removed for testing or maintenance.
- Include position feedback devices suitable for connection to the BMS.
- Ensure that actuators incorporate a disconnection device to allow manual operation of the valve or damper in the event of actuator failure.
- Ensure that actuators are electrically and mechanically protected from the effects of valve or damper seizure.
- Use 24v actuators wherever possible. Where line voltage actuators are used, provide local means of isolation by manual isolator or plug and socket connection.
- Ensure that, during commissioning, valve actuators are fitted in a fully closed/bypass position where they are being fitted to valves which push against a spring.

SS_75_70_54_10.320.180 VALVES:

- General
- Ensure that valves have the correct authority without excessive pressure drop.
- Ensure that valve bodies are suitable for the medium, the temperature and the pressure of the fluid system.
- Ensure that valves will pass the required flow at a pressure drop within the maximum differential pressure rating of the valve.
- Check for out-of-balance forces, particularly during operation of a three-port valve.
- Where possible ensure that valves are not installed with their spindles in the horizontal position. If valves cannot be installed with their spindles in the vertical position ensure that they are as near as possible to the vertical.
- Ensure that valves are not installed with the actuator at the bottom.
- Modulating valves
- The following additional considerations apply for modulating valves:
- Ensure system operating pressures, test pressures, pump heads and pressure drops through heat exchangers and associated pipework are known before control valves are selected.
- Select valves to provide an authority of 0.3 to 0.5 for diverting applications and 0.5 for mixing applications.
- Select valves with port characteristics appropriate for the intended function.
- Ensure that all modulating control valves are selected for equal percentage or linear characteristics according to system type, to provide near linear characteristics between the valve position and heating/cooling power as delivered to the air or water-based system.
- Ensure that the rangeability of the selected valves is large enough to provide stable control under low load conditions.

SS_75_70_54_10.320.190 VALVE SIZING REQUIREMENTS

- All types of valves and applications
  - Parameter - Body pressure rating.
  - Requirements - To exceed system test pressure.
- All 2-port valves
  - Parameter - Close-off pressure rating.
  - Requirements - To exceed pump or system full differential pressure.
- All 3-port valves
  - Parameters - Close-off pressure rating.
  - Requirements - To exceed out of balance pressures
- All types of valves and applications
  - Parameters - Maximum leakage coefficient.
  - Requirements - 0.05% kv.
- 2-port isolation valves
  - Parameters - Pressure drop at full flow.
  - Requirements - Select at line size for minimal pressure drop.
- 2-port modulating valves
  - Parameters - Pressure drop at full flow.
  - Requirements - Select kv value for pressure drop within an agreed range.
- 3-port modulating valves
  - Parameters - Pressure drop at full flow.
  - Requirements - Select kv value for 30% - 50% authority against coil or circuit pressure drop.
- Isolation valve
  - Parameter - Characteristic.
- Modulating valves (plant valves and zone reheater coil valves)
  - Parameters - Characteristic.
  - Requirements - Equal percentage.
- Modulating valve (fan coil units)
  - Parameters - Characteristic.
  - Requirements - Equal percentage (preferred) or linear.
- Modulating valves (independently pumped mixing and injection circuits)
  - Parameter - Characteristic.
  - Requirements - Linear.

SS_75_70_54_10.320.200 DAMPERS

Provide visual position indicators on all damper actuators installed so that they can be seen from the plantroom floor.

Ensure that damper characteristics are as linear as possible.

Ensure that modulating dampers are sized correctly to give adequate authority.

SS_75_70_54_10.320.210 COMMUNICATION NETWORKS - GENERAL

- Ensure that all addressable control devices can be addressed over the communications network.
- Ensure that no cross corruption of data occurs when the BMS shares a communication network with other IT-based systems. Ensure that permission has been given by the IT manager to connect BMS components onto the IT network.
- Ensure that network testing, identification and documentation comply with BS EN 50174.
- Ensure that all network devices such as routers and bridges are compatible with the network and are capable of operating such that the required throughput of data is achieved.

SS_75_70_54_10.320.220 COMMUNICATION NETWORKS - STRUCTURED CABLING

- Ensure that the selected BMS components are suitable for operating on the structured cabling system.
- Ensure that the selected BMS topology (star wired, chained or bus-based) is appropriate for the structured cabling system.

- Ensure that each addressable BMS device can be addressed over the structured cabling system.
- Where BMS components are specified to be powered from the structured cabling system ensure that the power available is sufficient. Ensure that overheating of the structured cabling system will not occur.
- Ensure that any changes to the structured cabling system are reflected in updated documentation.

SS_75_70_54_10.320.230 COMMUNICATION NETWORKS - INTRANET AND INTERNET APPLICATIONS
Ensure that the BMS devices to be directly connected onto the Intranet/Internet are TCP/IP compatible.

Ensure that the data security requirements of BS ISO/IEC 27001 and BS ISO/IEC 17799 are met.

SS_75_70_54_10.320.240 COMMUNICATION NETWORKS - MAINS-BOURNE SIGNALLING
Comply with the requirements of BS EN 50065-1.

Provide the necessary equipment to ensure that there is no mutual interference between the signalling system of the electricity utility and mains-borne signalling of the BMS.

SS_75_70_54_10.320.280 INTEGRATION WITH FIRE DETECTION SYSTEMS - INTEGRATION FOR CONTROLS
- Application smoke damping and fire damper switching logic
- Use volt-free contacts and 24v AC or DC interlocks.
- Use relay logic and/or microprocessor-based logic.
- Ensure that building services control actions operate correctly in response to the status of the fire detection system.

SS_75_70_54_10.330.330 CONTROLS CIRCUITS:
- Supply Voltage
    - Ensure control circuits are 230 volt AC or DC or 230 volt AC single phase connected one single phase to neutral only.
- Circuit Voltage
    - Where control circuits are taken outside the panel use 24 volt operating supply.

SS_75_70_54_10.330.350 CONTROL PANELS:
- The motor control centres (MCPs) are to house the motor drives and outstations and are to be internally divided into an LV power section and an ELV controls section The MCPs. Panels are to be compartmented to BS EN 60439-1 with internal sub division to form 2. Each compartment/drive is to have a minimum provision of a switched isolator, control switches, indicator lamp, motor starter, door lock, label and warning light. The drive will operate in conjunction with the Automatic Controls when the switch is in auto position. Where detailed in the specification further lamps and switches are to be provided. Ensure an ammeter can be safely clipped on to measure motor currents. Provide 20% spare compartments with switches/fuses to meet the compartments maximum capacity. Spare compartment sizes are to be ranged to match that of those provided. All safety interlocks shall be hardwired to prevent operation of plant in the hand mode when a related safety fault has occurred. Each MCP is to contain a 13A socket outlet. Each MCP is to have a "clean earth bar" connected to the buildings clean earth system.
  The BMS/Controls Trade Contractor is to prepare schematic, GA and wiring drawings and issue these to the WP 6300, 6500, 7000 Trade Contractors, MF llp, Commissioning Consultant and Mace in accordance with the Mace interface schedule TP2000 and in accordance with the pre-construction and Commissioning Manager's requirements. The WP 6300, 6500 and 7000 Trade Contractors care to forward all details of ordered plant drives as early as possible to the BMS/Controls Trade Contractor. The MCC is to be constructed with rigid framed enclosures and panels with zinc coated mild steel, 2mm thick to IP54. Round all edges and corners, paint the panels with grey wear resistant paint. Provide suitable ventilation to the panel to ensure the internal components do not exceed the manufacturers temperature limits when the surrounding room temperature is 40°C. Where necessary install appropriately sized anti-condensation heater, which is energised when the panel is switched off. Provide 4 removable lifting eyes to the top of each panel in excess of 40kg. Provide blanking plugs, remove the lugs and seat the holes once installed in position. Floor mounted panels are to contain a 100mm deep plinth constructed of channel iron or zinc coated sheet steel. No live

components are to be fixed to the floor, roof or sides of the panel, or less than 150mm from the bottom of the panel. All panel doors are to have lockable hand operated fastenings and are to be provided with keys.
All the equipment supplied by the BMS/Controls Trade Contractor is to be protected against physical damage and from ingress of water, dust or any other contaminants during delivery and installation. Filters are to be cleaned on completion to ensure that they are not blocked with builders' debris.
The MCP is to incorporate a separate full load rated four pole isolator, mounted so that it can be operated when the panel doors are shut.

- Design the bus bar including fixing to carry the full load current scheduled and a 3 phase symmetrical short circuit current of 30kA for 1 second. Design all equipment and wiring for 50Hz, 400V or 230V plus 10% or -6%. Construct equipment to operate in temperatures of up to 40 deg C and humidities up to 90%RH with occasional occurrences of moderate condensation. All materials are to be resistant to mould growth and attack by vermin.
  Gland all cable and conduit entries to maintain IP54 rating. Ensure any trunking entering the panel forms a 75mm water tight upstand to form a water tight junction between the trunking and panel.
  Terminate all incoming and outgoing cables in terminal blocks ensuring all terminal blocks and internal cable ways are sized to suit the cables detailed by the electrical contractor.
  Protect all cables serving sub circuits (packaged plant, motor drives etc.) against overload and short circuit faults with mcbs sized to suit the plant electrical duties of the installed plant. Ensure suitable discrimination between any sub circuit fusing, the control panel fusing and the panel's main fuse.
  Ensure all contactor/fuse combinations provide class C coordination as defined in BS EN 60947-1.
  Shroud all cable terminals and all live parts against accidental direct contact when testing and inspecting the panel.
  Install measures to prevent electromagnetic interference with the panel in operation.
  Test and commission the panel before it leaves the factory to dielectric test to BS EN 60439-1 and full operation testing. Provide certification of the tests prior to MF llp being invited to inspect the panel and witness the tests at the factory (allow 10 days' notice to MF llp).
  The BMS/Controls Trade Contractor is to measure and record all motor currents on the final installation and set motor overloads to nameplate full load current.
  Identify and mark all cables, cable terminals, fuses, switchgear and other components within the MCC with permanent labels and detail these on as installed drawings.
  The BMS/Controls Trade Contractor is to provide control circuits for contactors operating at 230V, circuit wiring of at least 1.5mm2 sized so that any voltage drop during motor starting does not prevent correct operation of the served devices. Control relays are to be plug in type to BS800 & BS 5992, suitably rated for the control devices, contactors to be enclosed in dust proof cover.
  Provide front rotary hand/off/auto switches for all drives, arrange for auxiliary contacts to signal to Automatic Controls when in auto position.
  Provide front lamps for each drive for run (green) and trip/fault (red). Provide a panel live lamp (white) and live lamps (white) for packaged plant. Lamps to be extra low voltage with integral transformers, easily replaceable. A push to make lamp test button is to be provided on each panel to illuminate all lamps on being activated.
  Screw fixed permanent engraved labels are to be provided for each switch and lamp. A label is also to be provided for each openable panel door to read ' WARNING - ISOLATE PANEL BEFORE MAINTENANCE'.
  Provide for O&Ms:
  i) Description of panels operation.
  ii) Schematic, GA and wiring diagrams of panel.
  iii) Inspection and test certificates.
  iv) Data sheets and manufacturer addresses for all components.
  v) Recommended list of spare parts.
  vi) Schedule of advised periodic inspection and maintenance operations
  The BMS/Controls Trade Contractor is to supply, install test and commission web browsable native BACnet to IP routers in each MCC. The BMS/Controls Trade Contractor is responsible for providing graphical representations of all controls points and systems associated with the MCP or outstation. These are to be store in the local web browsable IP routers. The exact format of the graphical representations is to be agreed with the Commissioning Consultant, Mace and MF llp.
  All MCPs are to provide electrical power supplies to the adjacent TCP/IP hub including a clean earth

connection for this hub.

SS_75_70_54_10.340.000 WORKMANSHIP:
SS_75_70_54_10.340.010 GENERAL:
Install pipeline control components in accordance with manufacturer's instructions.

Install ductline control components in accordance with DW 144 and manufacturer's instructions.

Install control components in accordance with manufacturer's recommendations, in positions indicated.

SS_75_70_54_10.340.020 APPEARANCE:
Arrange, support and clip all control wiring, pneumatic tubes and capillaries to present a neat appearance, with other services and the building structure.

SS_75_70_54_10.340.030 INSULATION:
Where control components are incorporated in insulated pipelines, ductlines or equipment, provide details for approval of method proposed to insulate component.

SS_75_70_54_10.340.040 SUPPORTS:
Arrange supports for control components to ensure no strain is imposed on components.

SS_75_70_54_10.340.050 ACCESS:
Arrange control components to ensure adequate access for operation and maintenance.

SS_75_70_54_10.340.080 POWER OPERATED CONTROLS:
Install power operated controls in accordance with manufacturer's instructions and relevant standards.

SS_75_70_54_10.340.110 ANCILLARIES:
Install ancillaries in accordance with manufacturer's instructions.

SS_75_70_54_10.340.120 ENCLOSURES:
Install enclosures where indicated, providing space for access and maintenance.

SS_75_70_54_10.340.130 BUILDING MANAGEMENT SYSTEM INSTALLATION:
Install commission and set to work building management system in accordance with the manufacturer's recommendations.

SS_75_70_54_10.340.140 BUILDING MANAGEMENT SYSTEM CABLE INSTALLATION:
Plan and install all building management monitoring systems cables in accordance with the cable manufacturer's recommendations.

Label and record all monitoring cables in accordance with,

SS_75_70_54_10.340.150 BUILDING MANAGEMENT SYSTEM QUALITY CONTROL:
Handle, store and install equipment and components of the building management system in accordance with the manufacturer's recommendations.

Inspect all equipment and components on delivery, before fixing and after installation and reject and replace any which are defective.

Record all commissioning tests and site modifications to hardware or software, and revise operating and maintenance instructions accordingly.

SS_75_70_54_10.340.160 CONTROL SYSTEM FUNCTION CHARTS:
Prepare function charts for the control system in accordance with BS EN 60848. Obtain approval of function chart before design of system hardware or writing control software.

- Function chart format.

- Combined function chart/circuit diagram.

SS_75_70_54_10.350.000 COMMISSIONING

- Perform system commissioning in accordance with 251.040.

SS_75_70_54_10.360.000 DEMONSTRATION AND HANDOVER

SS_75_70_54_10.360.010 WITNESSING REQUIREMENTS:

- Ensure that the project supervisor's nominated representative implements the following witnessing requirements. Ensure that on-site commissioning staff facilitate the witnessing process.
- Ensure that the BMS hardware is installed in accordance with the specification.
- Verify any operator software and associated graphics.
- Witness completely the control of any main and/or critical items of plant along with a random sample of other points.
- If less than 300 points, witness all points. Between 300 and 1, 00 points witness 50% (minimum of 300 to be witnessed). If more than 1,000 points witness 20% (with a minimum of 500 points witnessed).
- Reserve the right to witness 100% of the points if the failure rate is greater than 5%.
- Witness a sample of specific functions, e.g. 10% of alarms and 10% of data logging.
- Witness one of several identical items of plant in detail with the others witnessed on a random basis.
- Verify the system security access.
- Verify that all safety-related functions perform to that specified, e.g. plant shutdown on fire condition.
- Verify all plant restarts according to that specified after building power failure and local power failure.
- Witness all power meter data-points to ensure that they match the meters.
- Ensure that trend logs are used when witnessing points in order to monitor the performance of control actions.
- Verify the handover of all operating manuals and system documentation.
- Verify the handover of backup copies of software.
- Verify the completion of any specified system operator training.

SS_75_70_54_10.360.020 OPERATOR TRAINING:

- Ensure that training is completed before the BMS is handed over.
- Ensure that each trained operator signs a training acceptance certificate(s).
- Provide training off-site at the BMS suppliers training facility. Complement this off-site training with 'hands on' on-site training.
- Provide appropriate reference and training manuals for the operator.
- Basic operator - Ensure that the operator is trained to:
    - Call up and view point-data from plant schematics and/or points lists.
    - Acknowledge system alarms.
    - View trend logs.
- Intermediate operator - In addition to the requirements for a Basic operator, ensure that the operator is trained to make basic alterations to the BMS including changes to:
    - Time and occupancy programmes.
    - Control set-points.
    - Setting up trend logs.
    - Setting up alarm routines.
    - Ensure that the operator is also trained for testing and routine inspection of sensors and actuators.
- Advanced operator - In addition to the requirements for an intermediate operator, ensure that the operator is trained to:
    - Add or change graphics/schematics.
    - Change control strategies.
    - Add analogue and digital inputs/outputs to the system.
    - Back-up the system and archive logged data.
    - Re-load system software/configuration details.
    - Add/modify passwords/monitor system security.

SS_75_70_54_10.360.030 OPERATION AND MAINTENANCE MANUALS:

- Ensure that an initial draft of the O&M manual is submitted for approval prior to commissioning.
- Ensure that the O&M documentation is produced as the work proceeds and is updated when necessary. Ensure that this work commences at the start of the contract and is added to/updated as the contract progresses.
- Ensure that approved final copies of the O&M manuals are provided at handover.
- Ensure that the O&M manual is properly indexed. Ensure that terminology and references are consistent with the physical identification of component parts.
- Ensure that the O&M manual includes the following and is included in the site health and safety file:
    - A written description of plant operation.
    - Control strategy/logic diagrams recording the final version of configuration software installed at handover.
    - Details of system application software configuration.
    - A points list including hard and soft-points (all points should have a unique mnemonic).
    - A description of user adjustable points.
    - Commissioning record details.
    - Detailed data sheets for all control components and equipment.
    - Wiring circuit details including origin, route and destination of each cable.
    - Basic security access to the system.
    - Comprehensive instructions for switching on, operation, switching off, isolation, fault finding and procedures for dealing with emergency conditions.
    - Instructions for any precautionary measures necessary.
    - Instructions for the routine operation of the control system including simple day-to-day guidance for those operating the control system with limited technical skill.
    - Instructions for servicing and system upkeep.
    - A provision for update and modification.
- Ensure that the O&M manual includes comprehensive system operating instructions.
- Provide as built panel drawings, schematics and layout drawings for O&M Manuals.

SS_75_70_54_10.360.040 SOFTWARE:

- Ensure that a copy of the configuration software is held both on and off-site.
- Ensure that, as alterations are made to the configuration software, all previous versions of the software are archived.
- Ensure that changes made to the software are recorded in the O&M manual with the reasons why changes were made.
- Ensure that all passwords are provided at handover.

SS_75_70_54_10.360.050 POST-HANDOVER CHECKS:

- Ensure that the following post-handover checks are performed:
- Global level checks
- internal air temperature
- relative humidity
- ventilation
- Energy consumption (ensure that the pulse-input counters match the meters).

Check that each of the above meets the specified requirements.

- System level checks
- Control strategies. Check that any suspect control strategies are appropriate for the intended application. Check that the suspect control strategy has been implemented and commissioned correctly. Check that the control strategy is still appropriate for the intended use.
- Network communications. Check that all relevant field controllers communicate properly. Check for correct sharing between controllers of relevant data and correct inter-controller operation.
- Control set-points. Check that the set-points in question are correct and appropriate for the actual operating conditions.
- Control loop settings. Check that the control loop settings result in accurate and stable control. Check

that all self-learnt characteristics are valid.

- Control zones. Check that the control zones are appropriate.
- Occupant controls. Check that occupant controls work correctly.
- Sub-system/component level checks
- Sensors. Check the accuracy and location of any suspect sensors.
- Actuators. Check that any suspect actuators operate correctly.
- Dampers and valves. Check that any suspect dampers and valves are not jammed and that they operate as intended.

35.0 BS APPENDIX

BS 21:1985
Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions).

Partially superseded by BS EN 10226-1:2004

BS 5499-5:2002
Graphical symbols and signs. Safety signs, including fire safety signs. Part 5 Signs with specific safety meanings

BS 7649:1993
Guide to the design and preparation of documentation for users of application software

BS 7671:2008
Requirements for electrical installations. IEE Wiring Regulations. Eighteenth edition

BS EN 10213:2007
Steel castings for pressure purposes

BS EN 10226-1:2004
Pipe threads where pressure tight joints are made on the threads. Part 1 Taper external threads and parallel internal threads. Dimensions, tolerances and designation

BS EN 12163:1998
Copper and copper alloys. Rod for general purposes

BS EN 12164:1998
Copper and copper alloys. Rod for free machining purposes

BS EN 12167:1998
Copper and copper alloys. Profiles and rectangular bar for general purposes

BS EN 14597:2005
Temperature control devices and temperature limiters for heat generating systems

BS EN 15500:2008
Control for heating, ventilating and air-conditioning applications. Electronic individual zone control equipment

BS EN 1561:1997
Founding. Grey cast irons

BS EN 1982:2008
Copper and copper alloys. Ingots and castings

BS EN 50065-1:2001
Specification for signalling on low-voltage electrical installations in the frequency range 3 kHz to 148.5 kHz. Part 1 General requirements, frequency bands and electromagnetic disturbances

BS EN 50160:2007
Voltage characteristics of electricity supplied by public distribution networks

BS EN 55022:2006+A1:2007
Information technology equipment. Radio disturbance characteristics. Limits and methods of measurement

BS EN 60439-1:1999
Specification for low-voltage switchgear and control gearcontrolgear assemblies. Part 1 Type-tested and partially type-tested assemblies

BS EN 60529:1992
Specification for degrees of protection provided by enclosures (IP code)

BS EN 60730-2-13:2008
Specification for automatic electrical controls for household and similar use. Particular requirements. Part 2-13 Particular requirements for humidity sensing controls

BS EN 60730-2-16:1998
Specification for automatic electrical controls for household and similar use. Particular requirements. Part 2-16 Particular requirements for automatic electrical water level controls of the float type for household and similar applications

BS EN 60730-2-18:1999
Specification for automatic electrical controls for household and similar use. Particular requirements. Part 2-18 Particular requirements for automatic electrical water and air flow sensing controls, including mechanical requirements

BS EN 60730-2-8:2002
Specification for automatic electrical controls for household and similar use. Part 2.8 Particular requirements. Electrically operated water valves, including mechanical requirements

BS EN 60730-2-9:2002
Specification for automatic electrical controls for household and similar use. Part 2-9 Particular requirements. Particular requirements for temperature sensing controls

BS EN 60801-2:1993
Electromagnetic compatibility for industrial-process measurement and control equipment. Part 2 Electrostatic discharge requirements

BS EN 60848:2002
GRAFCET specification language for sequential function charts

BS EN 60950-1:2006
Information technology equipment. Part 1 Safety. General requirements

BS EN 61000-4-1:2007
Electromagnetic compatibility (EMC). Part 4-1 Testing and measurement techniques. Overview of IEC 61000-4 series

BS EN 61000-6-1:2007
Electromagnetic compatibility (EMC). Generic standards. Part 6-1 Immunity for residential, commercial and light-industrial environments

BS EN 61000-6-2:2005
Electromagnetic compatibility (EMC). Generic standards. Part 6-2 Immunity for industrial environments

BS EN 61000-6-3:2007
Electromagnetic compatibility (EMC). Generic standards. Part 6-3 Emission standard for residential, commercial and light-industrial environments

BS EN ISO 16484-2:2004
Building automation and control systems. Part 2 Hardware

BS EN ISO 16484-3:2005
Building automation and control systems. Part 3 Functions

BS ISO/IEC 17799:2005
Information technology. Security techniques. Code of practice for information security management

BS ISO/IEC 27001:2005
Information technology. Security techniques. Information security management systems. Requirements

prEN 13646:1999
Building control systems. Equipment characteristics