

MEP Performance Specification

Ysgol Eirias
Demolition Enabling Works

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1 Introduction

This report outlines the proposed MEP scope of works relating to the Demolition Enabling works for the Victorian section of Block A (referred to as Block A in this report, distinguished from the more modern section of Block a, referred to as “Block A extension” in this report) of Ysgol Eirias, situated to the south of the Ysgol Eirias site.

It is proposed that the project is split into two phases to minimise costs associated with temporary plant hire.

Phase 1

Phase one covers the proposed demolition of the majority of Block A, while leaving the mechanical boiler room and the electrical switch room operational, secure and weathertight.

Phase 2

Phase two covers the provision of the following temporary plant:

- Packaged boiler room
- External Calorifier
- External GRP Kiosk for Electrical services and LV Panel Board

This report provides details of phase one to a stage 4i level of detail in accordance with BSRIA BG 6 2018, with an outline scope of works for phase two.



1.1 Site Location

The map extract below identifies the approximate location of Block A of Ysgol Eirias.

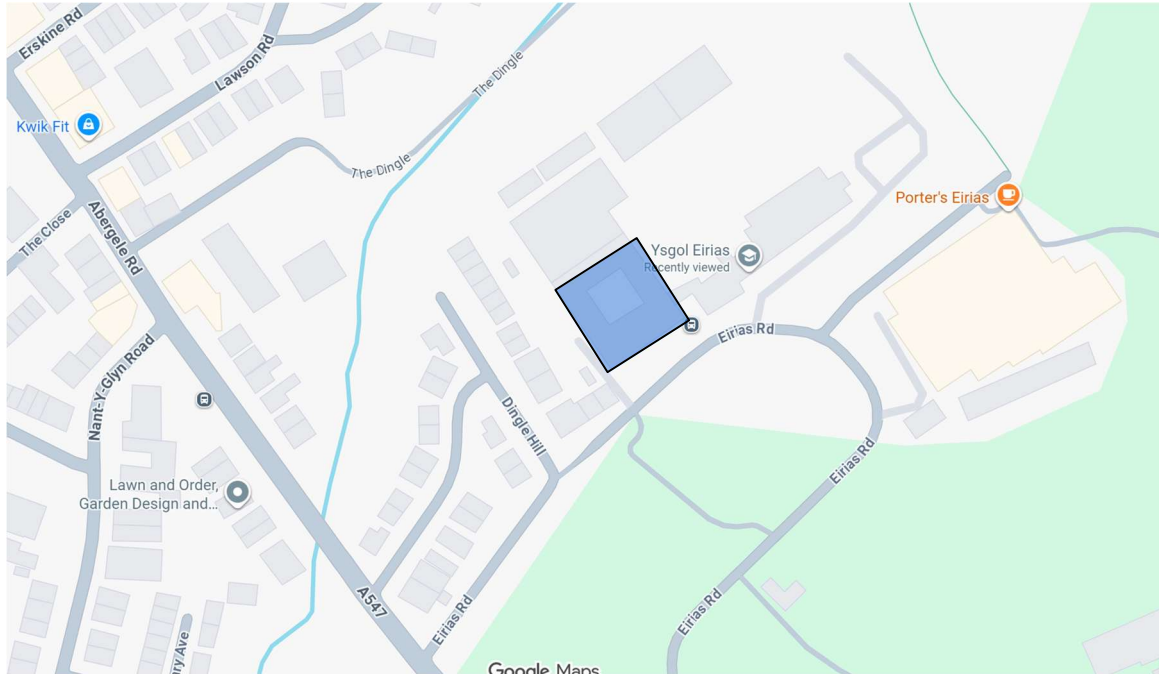


Figure 1 - Map of area surrounding Ysgol Eirias

The Block A boiler room is located on the ground floor, through the entrance arch from Eirias Road, and on the left.

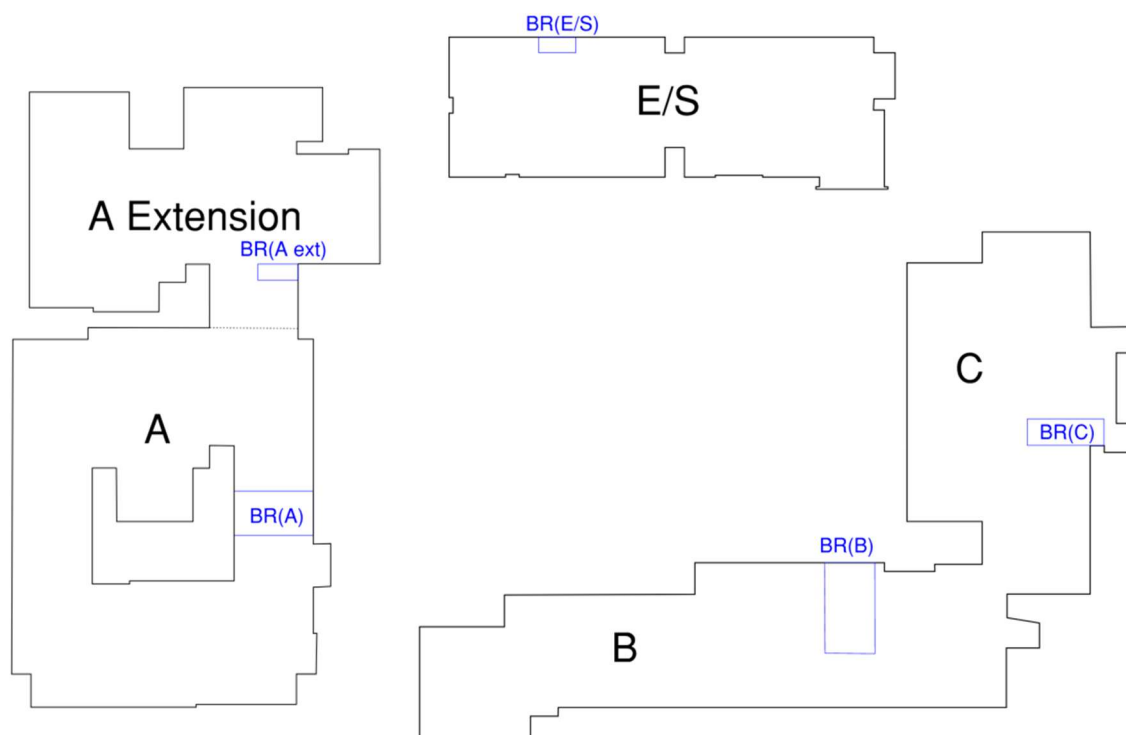


Figure 2 - Ground floor Block plan with boiler rooms highlighted in blue.

1.2 Purpose of specification

This document sets out and describes the respective MEP services systems and installations that comprise the Demolition Enabling Works at Ysgol Eirias.

The design has currently been developed to a RIBA Stage 4i level of detail. The contractor shall take full responsibility for the development of the design to installation stage and the execution of the works in accordance with these Tender Deliverables, the main contract documentation, and any applicable legislation, regulations and design guidance.

This specification is not a comprehensive materials and workmanship specification. The contractor shall make allowance for workmanship and materials to be in accordance with general NBS specifications and good practice and to align with the existing building materials used. If in doubt the contractor shall state assumed workmanship and materials specifications in the tender return and review existing items on site where necessary.

This document provides a Scope of Works, describing system objectives, system performance and design criteria. As such, this document and its contents are part of the overall contract documentation. This document should be read in conjunction with the Main Contract documentation, including but not limited to the Main Contract Preliminaries, Drawings, Architectural documents, Tender Deliverables and all specialist consultant information.

If it is found that any item conflicts with or contradicts anything within the Main Contract documentation, it is incumbent upon the Sub-Contractor to highlight such conflict or contradiction to the Main Contractor,



MEP Scope of Works

2 Preliminaries

so that modification can be made to either this document or the document with which such item conflicts or contradicts. It will not be acceptable for a Sub-Contractor to choose to adopt or comply with one of the documents over an item (or items) where a conflict or contradiction exists.

The MEP Services related documentation, produced by Stantec, makes up the formal MEP design specification documentation, comprising of the following:

- MEP Scope of Works - this document which sets out the Tender Deliverables, performance requirements for the respective services systems.
- MEP Drawings including layouts and indicative plant schedules.

2 Preliminaries

2.1 Contractor responsibilities

- Satisfy themselves, and confirm in writing, that they have fully understood the responsibilities placed upon them by this specification and accompanying drawings and schedules.
- Undertake all the works described within this specification.
- Verify and complete the design and installation.
- Validate adaptations in section 3.
- Provide tender return for phase 1 works.
- Provide indicative costing for phase 2 works.
- Take their own dimensions from site for the setting out of all plant and equipment and shall be responsible for the accuracy of those dimensions.
- Be responsible for leaving uncompleted sections of work in a safe condition and shall include for any temporary works necessary to give reasonable protection from un-authorized interference.
- Ensure all plant, equipment and materials shall be protected against damage or adverse weather conditions until Practical Completion is achieved. Any plant, equipment or materials that have suffered damage from incorrect storage, handling or installation or lack of adequate protection shall be replaced prior to system hand over.
- Ensure all services shall comply with CDM requirements for installation, commissioning and ultimately maintenance and replacement of any component item.
- Provide evidence of testing and inspection and commissioning.
- Provide all plant / equipment identification, asset tagging and ceiling access points labelling.
- Provide detailed drawings of all builder's work requirements in sufficient time for their incorporation in the natural course of construction of the Works.
- Ensure all builders work details and locations of all installations shall be confirmed by the Contractor and coordinated / approved by Structural Engineer, prior to commencement of works.
- Ensure all builders work holes up to and including 50mm are fire stopped where required by the Contractor undertaking the electrical works. Fire stopping shall match the fire rating of the wall. If the wall is not fire rated, then the builders work hole shall be made good.
- Provide detailed manufacturers' construction drawings of all works associated with the installations inclusive of all setting out requirements.



MEP Scope of Works

2 Preliminaries

- Provide all supports, brackets and fixings to support the building services systems.
- Ensure all new equipment and components are easily obtainable within the relevant trade. All materials and equipment shall comply with the relevant British standards and shall be purchased new from the preferred manufacturers supplier lists.
- Provide an EU Declaration of Conformity for all equipment materials and components.
- Ensure the installation is designed and installed in accordance with EMC standards, regulations and best practise.
- Allow for the production of red-line as-installed drawings of the MEP installations and provide as-installed drawings.
- Demonstrate all systems, plant and equipment to the Client and Client's representative.
- Fully test and commission MEP systems prior to handover.
- The Contractor shall issue prior to handover, certificates confirming full compliance with the applicable codes and standards.
- Provide As-Built drawings that fully describe the installation. These shall be provided in a CAD DWG format and PDF.
- Provide Operation & Maintenance manuals that are fully informative and enable the Client to safely operate and maintain the various different systems.
- Provide risk assessments and method statements for all works and input into the site health and safety file.
- Attend site meetings on the agreed basis
- Co-ordinate with other trades to ensure final setting out of all electrical services and installed equipment are fully accessible for future maintenance.
- Co-ordinate with other trades to ensure all voids, risers and ceilings are fully coordinated.
- Provide final connection of power supplies and communication cabling to equipment.
- Provide weatherproofing around internal/external services penetrations through the envelope.
- Provide plant bases / plinths and support framework.
- Provide all labelling, tagging and signage.

2.1.1 Contractors Design Portion (CDP)

Certain aspects of the design and installation shall fall within the Contractors Design Portion; in this case those elements are listed below:

- Bracketry and supports
- Building Management System
- Demolition plan
- Coordinated trench plan

2.1.2 Specialist Design Portion

The following aspects are required to be designed by different specialists before work is started, as the project is reliant on their input:



- Structural engineer to confirm boiler room and switch room in Block A, and the Block A extension can remain standing when the rest of the Block is demolished.

2.2 Health and Safety

2.2.1 CDM Regulations

The assessment is based on the assumptions that:

- a) The Contractor shall be competent in the type of work being carried out.
- b) The Contractor shall be aware of the normal hazards associated with the work in question and will implement appropriate control measures to protect the health and safety of operatives and others who might be affected by the work.
- c) The Contractor shall comply with the health, safety and environmental requirements of any Act of Parliament, any instrument rule or order made under any Act of Parliament or any regulation or bye-law of any local authority or any statutory undertaking which has any jurisdiction with regards to its Work or services in respect of or upon the site or with whose systems the same are or will be connected.
- d) The Contractor shall comply with relevant and applicable Guidance Notes, Standards, Codes of Practice and other like documents.
- e) The Contractor shall provide separate design risk assessments to the Principal Designer describing how it is intended to deal with all issues which are identified as the Contractor's responsibility under Regulation 9.

2.3 Design Responsibilities

Due to the nature of the project, the contractor shall make reasonable allowances to survey the necessary systems detailed within this specification, all allowances and assumptions shall be highlighted to the client team on his / her tender.

The MEP Contractor shall make reasonable allowance for developing the current Stage 4i design through to working drawings at RIBA Stage 5 for construction and installation purposes including validating assumptions noted in section 3 and include in final design.

The Contractor remains responsible for the production of installation drawings, coordination drawings, record drawings etc.

The specification and drawings do not relinquish the sub-contractor from undertaking any works required for statutory or regulatory requirements or works that any competent contractor, familiar with works of this type could reasonably anticipate.

The contractor shall have no entitlement to claim for additional cost or time as a result of anything he, or his specialist supply chain, could have reasonably anticipated was necessary to install, coordinate, test, set to work, operate, and maintain the services. The finished works shall be fit for their intended purpose.



MEP Scope of Works

2 Preliminaries

The Contractor is responsible for the following documentation:

- Working co-ordinated drawings.
- Record drawings.
- Technical submittals for all plant and equipment.

Liaising with the Client, CDM co-ordinator, Contractor and others as necessary to help ensure co-ordination of the work with related building elements and services.

The Contractor shall be responsible for the procurement, installation, testing and commissioning of M&E services, including the adequate support of all new services, their final on-site co-ordination, provision of Builders Work In Connection (BWIC) requirements, the production of installation drawings, carrying out of testing & commissioning and the production of record documentation (operating & maintenance manuals & as built drawings). Any alternatives proposed shall be agreed by the Client.

The Contractor shall submit design documentation for review, including drawings, schematics, technical schedules.

2.4 Legislation, Guidance and External References

The design has been carried out in accordance with the following documents:

- Building Regulations and Approved Documents;
- CIBSE Design Guides and Technical Memorandum;
- IET Regulations (BS7671) Latest Edition;
- Health and Safety Executive Guidelines;
- Health and Safety at Work Act and other Statutory Health and Safety Documents;
- Construction (Design and Management) Regulations (CDM) 2015;
- The Control of Noise at Work Regulations;
- Manufacturers' recommendations.
- HSE Regulations;
- EN's, ISO's and British Standards in particular ISO 14644-1:2015
- Water Regulations, including and local byelaws.
- Electricity at Work Act 1989
- BS 7430
- BS EN 60439: Low-voltage switchgear and control gear assemblies
- External / 3rd Party Documentation including design team, client and specialist information:
 - » Architectural Design Documentation.
 - » Structural Engineering Design Documentation.
 - » Interior Design Documentation.
 - » Specialist Designers / Suppliers.

To ensure compliance with the documents listed above, a further detailed review and intrusive investigation shall be undertaken by the appointed contractor.



2.5 Design life

The design life of engineering services systems shall be as defined in CIBSE Guide M and BS 7543 and as follows below:

The systems associated with the temporary works are intended to solely to support the demolition of Phase 1 of the project. The design life shall therefor be considered to commence from the date of Practical Completion of the Contract. Given the temporary nature of the installation, the required life does not need to exceed 5 years,

Static component parts of new pipework systems conveying fluids shall be suitable for use without replacement during the required services life of the systems (assumed to be 50 years for the purpose of this section). Moving parts of such systems shall be suitable for a service life of not less than 15 years before their replacement is necessary.

Static components or assemblies of components of all new domestic water, gas, and mechanical ventilation systems shall be suitable for a service life of not less than 20 years before their replacement is necessary. Moving parts of such plant shall be suitable for a service life of not less than 15 years before their replacement is necessary.

Component parts of ductwork system, electrical switchboards and switchgear, electrical control panels, fire alarm systems, cabling and cabling containment system shall be suitable for a service of not less than 25 years before their replacement is necessary.

Luminaries and component parts thereof shall be suitable for a service life of not less than 10 years, before their replacement is necessary.

Adequate protection shall be provided against corrosion to all components that may be subject to the external air, and such components shall be designed to require no maintenance against corrosion for the first five years after Practical Completion.

2.6 Testing and commissioning

The project requirements shall include testing, setting to work, commissioning and witnessing in accordance with the BSRIA Commissioning Guides, CIBSE, BS7671, BS5266, and BS5839.

The MEP Contractor shall ensure that the installation and testing/setting to work/commissioning of all systems including the controls is completed at least two weeks prior to handover. This final two weeks shall be treated as a proving period when the systems shall be left to run with controls systems trend logging a sample number of parameters and providing a printout record based on a two-day period (to be agreed with the employer/contract administrator) and to be kept demonstrating that the system has been set up correctly. The Controls Specialist shall adjust the parameters should the system operation be found not to be acceptable.



3 Preferred manufacturers

Design has been carried out with the following product lines, and suppliers shall therefore be equal and approved, subject to technical submission review, to:

- External below ground LTHW pipework: Rauthermex by REHAU
- Mechanical boiler room: ICS
- DHW buffer vessel: Rycroft
- LV Panel: Schneider
- GRP Enclosure: Adept GRP – VR 15

4 Assumptions / Unknowns

The following assumptions have been made and will need to be confirmed by the contractor before works are carried out. The contractor is to include for validation of these items in their cost and inclusion into the final construction stage design:

1. The extent of heating provided to Block B from Block A boiler room is unknown. Through discussion with site staff, it has been assumed that approximately a third of Block B, exclusively on the courtyard side of the circulation spaces, is fed from Block A boiler room.
2. It is assumed that domestic hot water provision for Block A extension is met entirely from the hot water generation boiler room in Block A extension.
3. The flow and return temperatures have been assumed to be 80/60 based on the specs of the boilers. This shall be confirmed by the contractor.
4. The existing incoming location of LTHW into the Block A extension is currently unknown. This is discussed further in section 4.2.2.
5. The routing and distribution of electrical supply cables between Block A and Block A extension are not clear. It is assumed that services may be routed through the original Block A building, requiring rerouting.
6. The electrical loads connected to SW PANEL A and other distribution boards within Block A extension is assumed based on maximum rated capacities, actual connected loads may vary and shall be confirmed.
7. The existing condition and capacity of the main switchboard (Schneider I-Line 800A) and associated protective devices are assumed adequate and compatible to support the cable rerouting works.
8. The interconnection and integration of systems such as public address, CCTV, access control, and communication networks between Blocks A extension and B are not fully known; These systems shall remain operational during works with minimal disruption.



MEP Scope of Works

5 MEP Services Installation, Maintenance and Replacement Strategy

9. Precise locations of fire alarm panels, control wiring routes, and any associated power supplies within the demolition zone require confirmation on site.
10. Existing LV cables serving the site are in suitable condition to be reused, jointed and extended as indicated. The contractor shall carry out surveys to validate the condition and precise routing of existing cables.

5 MEP Services Installation, Maintenance and Replacement Strategy

Boiler room and switch room access is via existing external doors at ground level. It is envisaged that these will be utilised for strip out, installation and future maintenance purposes.

External trench works shall be carried out utilising appropriate hoarding to segregate from occupied areas.

High level / ceiling void works shall be carried out utilising appropriate Mobile Elevated Working Platforms (MEWP) in combination with appropriate segregation of the occupied areas.

Boiler flue works will be carried out utilising appropriate scaffold and Mobile Elevated Working Platforms (MEWP) in combination with appropriate segregation of the occupied areas.

Phase 2 packaged plant installation shall be carried out utilising a flatbed loader crane (HIAB) accessed via existing vehicular access routes.



6 Mechanical Services Scope of Works

6.1 Phase 1 Works

Phase 1 includes the demolition of the majority of Block A, whilst keeping the boiler room (and electrical switch room) standing. This will require the rerouting of the LTHW and DHW pipework to run through trenches (as shown in drawing 01993-STN-XX-XX-DR-ME-012000).

6.1.1 General

The Contractor shall procure, install, commission and set to work the mechanical systems as outlined in the following sections, including:

- Domestic Hot and Cold Water Systems
- Heating Systems
- Expansion Capacity
- Thermal Insulation
- Vibration Control
- Mains water
- Natural Gas

6.1.2 Specialist Contractors

The contractor shall appoint specialists to complete the following contractor design portions and specialist design portions:

- Building Management Systems alterations
- Pipework Expansion
- Structural
- Flue modification works

6.1.3 Strip Out and Demolition

The demolition proposals must consider the phasing requirements to retain the existing Block A boiler room and switch room during phase 1. Structural and architectural advice shall be provided by others to determine the extent of the temporary works and weather proofing required to achieve this. The extent and methodology of demolition shall be determined by others, contractor to ensure this is carried out before demolition starts.

The Contractor shall include for the isolation, decommissioning, disconnection and strip out of existing redundant services as described below, prior to the demolition of the existing Block A building.

The strip out services shall be carried out in a careful, safe and logical manner paying particular attention to retained services.



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All redundant services, plant and equipment shall be removed off site or, if in acceptable condition, offered back to the council as spares after removal from the existing installation.

There is extensive, deteriorated asbestos throughout Block A, which shall be removed in a safe manner, in line with the relevant statutes and HSSE protocols.

The Mechanical boiler room and electric switch room in Block A be retained. Structural engineering advice shall be obtained relating to any associated works required to the extent of demolition works possible whilst retaining the plantrooms along with any temporary works required.

All mains water feeds to areas planned for demolition shall be disconnected and all above and below ground water services stripped out.

All LTHW, DHW, MCWS and Natural Gas pipework serving solely Block A shall be stripped out.

6.1.4 Trench Excavation

Due to the complexity of existing services, as shown by the GPR surveys carried out previously, all trench work shall be carried out by hand with a high level of care, to avoid damaging or cutting existing services in the area. Indicative trench details are provided on drawing 01993-STN-XX-00-DR-ME-012000, however services routes may require minor alterations to allow for coordination with existing services.

6.1.5 Low Temperature Hot Water Pipework

6.1.5.1 General

All above ground LTHW systems shall be installed using medium grade steel pipework and fittings complete with 50mm thick mineral fibre insulation, carried through pipe supports for the following functions:

- Frost prevention
- Protect personnel from injury
- Physical protection

6.1.5.2 New Installation

New Low Temperature Hot Water (LTHW) systems shall be provided utilising mild steel pipework and fittings. LTHW flow pipework shall originate from their corresponding pump sets in the Block A boiler room to refeed the existing circuits. New LTHW return pipework branches shall combine within the boiler room and connect to the existing plate heat exchanger. The flow and return pipework shall cross the plantroom at high level. At the building perimeter, the pipework shall drop to low level, convert to pre-insulated plastic, and pass through the external wall to run below ground.

The pipework penetration shall be sealed and sleeved to prevent water ingress and preserve the fire rating of the existing structure.

New LTHW pipework shall be compatible with the existing system material and jointing method.

The external pipework shall follow the route shown on drawing 01993-STN-XX-00-DR-ME-012000.



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Underground LTHW pipework shall be installed using a proprietary pre-insulated plastic pipe system with MDPE core, and shall be capable of continuous high temperature operation without degradation. The technical design intent is based on the use of the Rauthermex system by REHAU. However, similar and approved alternative products may be acceptable subject to acceptance through the technical submission review process.

6.1.6 Domestic Hot Water Pipework

New Domestic Hot Water (DHW) systems shall be provided utilising copper table X pipework and fittings. DHW flow and return pipework shall originate from the existing hot water buffer vessel in the Block A boiler room. The flow and return pipework shall cross the plantroom at high level. At the building perimeter, the pipework shall drop to low level, convert to pre-insulated plastic, and pass through the external wall to run below ground.

All new DHW pipework shall be insulated as outlined in section 8.3 with insulation carried through supports.

The pipework penetrations shall be sealed and sleeved to prevent water ingress and preserve the fire rating of the existing structure.

New DHW pipework shall be compatible with the existing system material and jointing method.

The external pipework shall follow the route shown on drawing 01993-STN-XX-00-DR-ME-012000.

Underground DHW pipework shall be installed using a proprietary pre-insulated plastic pipe system with MDPE core, and shall be capable of continuous high temperature operation without degradation. The technical design intent is based on the use of the Rauthermex system by REHAU. However, similar and approved alternative products may be acceptable subject to acceptance through the technical submission review process.

6.1.7 Temporary Boiler Exhaust Flue

The proposed demolition of block A will impact on the existing boiler flue. The existing flue shall be partially stripped out from a point just inside the boiler room to the current discharge location. The remaining flue within the boiler room shall be retained for future extension, subject to condition.

On completion of the Block A phase one demolition works, the retained flue shall be extended, in the same material and size as existing, to a point at least 3m above the new boiler room roof level, including an appropriate discharge cone. The flue shall match the materials and jointing methods of the existing installation.

The boilers will not be operational during the flue modification works, so these elements should be programmed accordingly.

6.2 Phase 2 Works

The proposed works include the following elements which are outlined on the external drawings.



6.2.1 Strip Out and Demolition

Phase 2 includes the full demolition of the remaining Block A boiler room.

The Contractor shall include for the isolation, decommissioning, disconnection and strip out of existing redundant services as described below, prior to the demolition of the existing Block A building.

The strip out services shall be carried out in a careful, safe and logical manner paying particular attention to retained services.

All redundant services, plant and equipment shall be removed off site or, if in acceptable condition, offered back to the council as spares after removal from the existing installation.

There is extensive, deteriorated asbestos throughout Block A boiler room, which shall be removed in a safe manner, in line with the relevant statutes and HSSE protocols.

All LTHW, DHW, MCWS and Natural Gas pipework serving the Block A boiler room shall be stripped out.

6.2.2 Packaged Boiler and Calorifier Plant

Phase 2 involves the final demolition of the Block A boiler room and the temporary provision of packaged boiler and calorifier plant to meet the heating and hot water loads of Block A Extension and Block B, currently provided by Block A plant.

The proposed location for the temporary plant is indicated on drawing 01993-STN-XX-XX-DR-ME-012000, however this shall be confirmed with the stakeholders and end users.

The unit shall have a small external housing(s), or boxing in, to allow for the incoming and outgoing connections to rise above ground level, convert pipe material, and connect to the boiler room connection points.

6.2.3 Natural gas pipework modifications

The existing incoming gas supply that currently feeds Block A and Block A extension, shall be reconfigured to feed the temporary boiler plant and the Block A Extension water heater plant and canteen kitchen. The pipe shall run underground before surfacing into the housing and connecting to the temporary boiler plant connections in accordance with manufacturer instructions.

The gas pipe installation shall be phased in the following way:

- Initially, the gas pipework from the temporary plant room shall be installed up to a point adjacent to the existing natural gas pipework ready for connection. The final connections to the temporary boiler room shall be isolated and locked closed to prevent the operation of both plant rooms simultaneously.
- The new pipework shall be connected to the existing mains as shown on the drawing to allow connection from the existing incoming main to the temporary boiler room and the Block A Extension. The redundant pipework shall be stripped out.
- In order to facilitate the activation of the new boiler plant, the gas supply to the Block A boiler room shall be isolated and locked to prevent the simultaneous operation of both plant rooms.



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- The contractor shall maintain the connection to both boiler rooms to facilitate the sequencing of works noting that only one plant room can be in operation at any time, with the inoperative boiler room isolated and locked off.

On completion of the new system, the block A plant room supply shall be permanently isolated, disconnected and stripped out.

6.2.4 Mains cold water pipework modifications

The existing incoming mains cold water supply that currently feeds Block A boiler room, shall be reconfigured to feed the temporary boiler plant.

The section of pipe running from the turn into the existing Block A boiler room till the proposed turn off to the temporary packaged boiler room shall be upgraded to match the incoming mains pipe.

This shall then split to feed the temporary packaged boiler plant in one way, and Block A Extension in the other.

The pipework connecting to the temporary boiler plant shall be 75mm diameter with material and construction chosen to match the existing mains cold water connection. The pipework shall run underground before surfacing into the housing and connecting to the temporary boiler plant connections in accordance with manufacturer instructions.

The pipework connecting to Block A Extension shall remain as existing.

6.2.5 LTHW F&R pipework modifications

The underground LTHW pipework provided as part of phase 1 will require modification to remove the feed from the Block A boiler room and join the block A extension and Block B systems to the single temporary boiler room. As shown in drawing 01993-DSTN-XX-00-DR-ME-012000, the pipework shall exit the boiler room, drop to below ground trench, traverse, and then split to separately feed Blocks B and A Extension. Both runs shall then connect into retained pipework from phase 1 as shown, adding in radiused bends in accordance with manufacturer's instructions where appropriate.

Existing underground pre-insulated plastic pipework set for removal shall be stripped out. It may be reused if in acceptable condition and of a suitable size.

6.2.6 DHW F&R pipework modifications

The underground DHW pipework provided as part of phase 1 will require modification to connect the Block B pipework to the temporary calorifier plant. Layout as shown in drawing 01993-DSTN-XX-00-DR-ME-012000, the pipework shall exit the domestic water storage tank to feed Block B. This pipework shall then connect into retained pipework from phase 1 as shown.

Existing underground pre-insulated plastic pipework set for removal shall be stripped out. It may be reused if in acceptable condition and of a suitable size.



6.3 Mechanical Schedules

6.3.1 Pre-insulated Below Ground Plastic Pipework Schedule

- Basis of design manufacturer – REHAU
- Basis of design product - RAUTHERMEX
- Continuous design temperature – 80°C
- Minimum cover depth – 800mm
- Insulation thermal conductivity – 0.33 W/m · K

6.3.2 Packaged Boiler and Calorifier Plant Schedule

The temporary boiler room spec below is the “Boiler room 600” from ICS. The DHW storage cylinder is based off the Ormandy Rycroft Buffer Vessel. Similar alternative products can be used if approved through technical submission review process.

Parameter	Units	Value
Overall output	kW	600
Domestic plate heat exchanger output	kW	128
Block A extension LTHW output	kW	186
Block B LTHW output	kW	189
Boiler room dimensions (L x W x H) (not including exhaust flue)	mm	3410 x 2440 x 2590
Boiler room weight	kg	4300
Domestic water tank storage	L	4000
Electrical connection	-	16A 5-pin CEE Plug
Electrical Supply	-	400V, 3Ph, 50Hz 40A, 6.5KW
External storage tank dimensions (dia x H) (not including insulation)	mm	1350 x 3050
Domestic water tank dry weight	kg	770
Overall ground space required dimensions (L x W x H)	mm	4500 x 2440 x 2590



7 Electrical Services Scope of Works

7.1 Phase 1 Works

7.1.1 General

The Contractor shall design, procure, install, commission, and set to work the electrical systems required for the demolition enabling works during phase 1 at Block A, including but not limited to:

- Power Distribution Systems
- Fire Alarm and Detection Systems (including panel relocation)
- New Cable installation
- Cable Diversions and Rerouting
- Earthing and Bonding Systems

7.1.2 Scope of Works

The scope of electrical works covers the demolition enabling works during phase 1 for the original Block A building, which is currently non-operational and unused. The Block A extension, which is attached to Block A but remains fully functional, will continue to be operational and supplied with power throughout the demolition process. Blocks B, C, D, and E/S function independently from Block A and its extension, with Block B currently acting as the main operational hub for the school.

The existing fire alarm system includes Gent Vigilant Compact addressable fire alarm panels. As part of the demolition enabling works, the fire alarm panel currently located within the demolition zone in Block A (in corridor A083) shall be relocated to the retained Block A extension to maintain full fire detection and alarm coverage.

Block B hosts the primary public address system, CCTV monitoring, access control, and other critical security and communication systems serving the whole school campus. It has its own communications room and Openreach connection separate from those in Block A extension. Similarly, Block A extension has a dedicated communications room and Openreach connection.

The exact routing and interconnection of these services between Block B and Block A extension are not fully confirmed but are believed to involve cabling routes through the original Block A building. As such, the scope includes:

- Surveying and verifying all electrical and communication service routes feeding between Block B and Block A extension to identify any cables passing through the demolition zone.
- Surveying, tracing and verifying all existing electrical and extra low-voltage services associated with Block A, the Block A Extension and Block B, including power, IT/data, public address, CCTV, access control, intruder alarm, BMS, class change bell, intercoms and all associated, controls and cabling.



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- Designing and installing diversions or alternative routes for any electrical or communication cabling currently routed via the old Block A to maintain continuous connectivity and functionality across all blocks.
- Coordinating with the school's IT and security teams to ensure no disruption occurs to public address, CCTV, access control, and other critical services.
- Isolating, disconnecting, and removing all redundant electrical infrastructure within the demolition zone of Block A.
- Protecting all existing external ducting and cable routes supplying Blocks B, C, D, and E/S to avoid disruption.
- Relocation of fire alarm panel currently situated within the demolition zone to suitable location within the retained Block A extension. This includes removing the existing fire alarm loop within the original Block A and reconnecting the loop in the Block A extension to maintain full fire detection coverage and system integrity.
- Providing temporary power supplies or contingency arrangements where necessary to support phased demolition work.
- Ensuring continuous supply to all occupied and retained areas, including the Block A extension and the boiler room, throughout demolition and construction phases.
- Maintaining power supplies for general lighting, power outlets, and mechanical equipment within the boiler room, which is retained during demolition.
- Supplying detailed as-built drawings, test certificates, and operation manuals covering all new electrical installations associated with enabling works.
- Compliance with all applicable standards, regulations, and codes of practice including BS 7671 and CDM regulations.

This scope ensures that demolition of the original Block A can proceed safely without interrupting power, communications, fire safety and security systems critical to school operations.

7.1.3 Specialist Contractor

The Contractor shall appoint suitably qualified and experienced specialist subcontractors to undertake the following portions of the works:

- **Electrical Cable Diversion and Rerouting:** Specialists with experience in low voltage underground cable installation, jointing, and testing shall carry out the rerouting of all electrical cables affected by the demolition enabling works. This includes installation of new underground ducting, direct burial cables, and associated civil works such as trench excavation and reinstatement.
- **Fire Alarm System Relocation:** A certified fire alarm contractor shall be engaged to safely disconnect, relocate, reinstall, and commission the fire alarm panel currently located within the demolition zone. They shall ensure full integration with the existing fire alarm network and compliance with BS 5839 standards.



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- **Testing and Commissioning:** Accredited electrical testing and commissioning specialists shall carry out all necessary verification tests on new and modified electrical installations, including insulation resistance, earth fault loop impedance, polarity, and functional testing of fire alarm systems.

The main contractor, shall coordinate closely with all the appointed specialist subcontractors, and other trades to ensure seamless integration of their works. They must comply fully with relevant British Standards, statutory regulations, health and safety requirements, and provide all necessary certifications and documentation upon completion.

7.1.4 Strip Out and Demolition

The demolition proposals must consider the phasing requirements to retain the existing Block A boiler room and switch room during phase 1. Structural and architectural advice shall be provided by structural engineers and architects to determine the temporary works and weather proofing required to achieve this.

Phase 2 of these proposals allow for the full demolition of the Block A boiler room and switch room.

Prior to demolition, the Contractor shall safely disconnect and remove all electrical services within the demolition zone, including redundant distribution boards (e.g., DB-LP1, DB-LP2), and cabling. All works shall be carried out to ensure safety and protection of remaining operational services.

The strip out and demolition works shall be carefully planned and executed to ensure the safe removal of all redundant electrical systems within the original Block A, while maintaining uninterrupted power and services to the retained boiler room, switch room, Block A extension, and other operational school buildings.

All electrical equipment, distribution boards (including DB-LP1 to DB-LP4) and associated cabling located within the demolition zone that serve only the old Block A shall be identified, isolated, disconnected, and removed in a controlled manner prior to demolition.

The contractor shall coordinate closely with site management and other trades to ensure that all live services feeding operational areas are protected and remain fully functional throughout the works.

Asbestos or other hazardous materials encountered during strip out shall be handled in accordance with all relevant health and safety regulations and specialist removal procedures.

All penetrations in fire-rated walls or floors created as part of the strip out shall be adequately fire-stopped to maintain the integrity of the building fabric.

Removed materials and equipment shall be disposed of responsibly off-site or handed back to the client if deemed reusable.

Temporary protections, barriers, and signage shall be installed as necessary to safeguard personnel and prevent unauthorized access to demolition areas.

The contractor shall ensure that all strip out activities comply with current legislation, best practice, and the project's health and safety requirements.



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7 Electrical Services Scope of Works

As part of the demolition enabling works at Ysgol Eirias, specific existing electrical services within the original Block A shall be isolated, stripped out, and removed to facilitate the installation of new electrical systems and enable safe demolition.

The Contractor shall refer to the strip-out and services alteration drawings for details of the proposed works.

The scope of strip out and alteration of electrical works shall include but not be limited to:

- Isolation and removal of all redundant distribution boards (DB-LP1, DB-LP2, DB-LP3, DB-LP4) and associated cabling located within the demolition zone serving only the old Block A.
- Disconnection and removal of all cabling, containment systems (conduits, trunking, cable trays), supports, fixings, and accessories within the demolition footprint.
- Protection and retention of all electrical services supplying the retained boiler room, main switch room, Block A extension, and external ducts feeding Blocks B, C, D, and E/S.
- Relocation of fire alarm panels and control systems located within the demolition zone.
- Isolation of power supplies affecting demolition areas while maintaining supply to operational areas.
- Coordination with DNO for disconnection and removal of existing LV supply cable and utility connection.

The Contractor shall undertake a detailed site survey to fully understand existing electrical services, cable routes, access constraints, building fabric details, and any site-specific conditions that may impact the strip out works. No claims for additional costs will be accepted due to lack of site knowledge or insufficient survey.

Prior to commencement of strip out, all relevant power supplies must be isolated except those required to maintain temporary operations. The Contractor shall ensure that electrical installations retained or newly installed comply with BS 7671 (IET Wiring Regulations) and are tested and commissioned in accordance with relevant standards before handover.

All materials removed from site shall be safely disposed of or returned to the client if deemed reusable. Fire stopping shall be reinstated to all penetrations formed during strip out works to maintain fire integrity.

7.1.5 Electrical Main Switch Panel

The existing main power distribution panel at Ysgol Eirias is a Schneider I-Line panel board rated at 800A, located in the Block A main switch room. Distribution boards on site are Square D by Schneider Electric. These existing panels will be retained and remain fully operational throughout the demolition enabling works.

As part of the Phase 1 enabling works, the incoming cable supplying SW PANEL A (serving the assembly, catering, and hall areas within Block A extension) currently routed through the original Block A building will be removed and rerouted externally. This cable diversion will be installed underground, directly buried in a new trench outside the demolition zone to maintain continuous power supply to the Block A extension.



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All modifications to cabling shall comply with BS 7671 (IET Wiring Regulations) and relevant British Standards. Protective devices, labelling, and circuit identification on the existing panel boards shall be updated as necessary to reflect changes in cable routing.

The contractor shall coordinate cable rerouting works with other site activities to minimize disruption and ensure uninterrupted power supply to Block A extension and the wider school campus. Proper fire stopping, containment, and mechanical protection shall be provided for all rerouted cables in line with project requirements.

All works shall include testing, commissioning, and updating of as-built documentation to reflect the revised cable routes and ensure ongoing compliance and maintainability.

In this project phase, the contractor shall undertake the following in relation to the existing main switchboard:

- Modify existing cable terminations and feeder arrangements as required to facilitate rerouting of cables away from demolition zones, particularly those feeding the Block A extension (assembly, kitchen, hall).
- Remove feeders and distribution boards located entirely within the demolition footprint (such as DB-LP1 and DB-LP2), ensuring their loads are safely disconnected and re-provisioned from retained or temporary distribution sources.
- Re-route existing cables externally via new underground ducts to maintain uninterrupted supply to all operational buildings and plant.
- Update all labelling and documentation associated with modified circuits to reflect current configuration accurately.

All modifications shall maintain compliance with BS 7671 and associated standards, ensuring segregation, operational safety, and protection coordination within the panel board. The contractor shall verify that all altered protective devices remain correctly rated and set for the modified distribution arrangement.

The contractor shall provide detailed Stage 4 drawings documenting all modifications, cable rerouting routes, terminations, and removals. These shall include updated single-line diagrams, panel schedules, and cable schedules coordinated with mechanical and other services.

Testing of all modified circuits shall be completed prior to energisation, including insulation resistance, earth continuity, polarity verification, earth fault loop impedance, and protective device functionality.

The contractor shall ensure safe isolation procedures are implemented during modifications to avoid disruption to live services feeding retained buildings and critical systems.

Cable Schedule and Required Changes for Demolition

The table below shows the main switchboard feeders, their destinations, cable sizes, protective device ratings, existing routing information, and the required modifications or actions to be undertaken during the demolition enabling works.



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Cable Reference	Destination Panel / Load Area	Cable Size (mm ²)	Protection (A)	Existing Cable Routing	Required Action for Demolition
Cable-1	Main Panel New C (Block C)	185	250	Routed externally via ducts	No action required
Cable-2	Hutment / Block D	25	125	Routed externally	No action required
Cable-3	DB-LP1 (Boiler House)	25	100	Routed internally through old Block A	Feeder and DB shall be removed if DB is serving only block A
Cable-4	DB-LP2 (Music Room A14)	25	80	Routed internally through old Block A	Feeder and DB to be removed if DB is serving only block A
Cable-5	Assembly / SW-PANEL-A (Block A Extension)	70	160	Routed internally through old Block A	Cable replacement identified: New cable externally routed to enable demolition works.
Cable-6	ZEROX	10	32	Unknown	Confirm route; remove the supply if within the demolition area.
Cable-8	Block E&S Main Feed	70	200	Routed externally	No action required
Cable-9	Main School Distribution / Backbone	95	200	Routed externally	No action required
Cable-10	DB-LP3 (Corridor Adjacent Class A13)	25	100	Routed internally through old Block A	Feeder and DB to be removed if DB is serving only block A



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Cable-11	DB-LP4 (Corridor Adjacent A8)	25	100	Routed internally through old Block A	Feeder and DB to be removed if DB is serving only block A
Cable-12	Boiler Electrical Supply	6	32	Routed internally through old Block A	Supply shall be maintained to the boiler room; the boiler room is also retained during demolition.

The contractor shall verify all cable routes on site prior to commencement of demolition works. Where cable routes are found to traverse the demolition footprint or are otherwise at risk, the contractor shall design and implement appropriate rerouting or temporary supply arrangements to maintain continuous power supply to all affected areas.

Notes:

- Cables routed internally through the old Block A fabric are within the demolition footprint and require careful management, including removal of associated distribution boards where applicable.
- Unknown cable routes shall be confirmed on site, electrical contractor to include for detailed survey and tracing prior to works commencing.

This schedule shall be used to coordinate electrical enabling works, ensuring all affected feeders are appropriately managed to maintain site operations during demolition. All modifications shall comply with current standards and be carried out by accredited contractors.

All sub-main cabling shall be completed using armoured cables with XLPE and LSZH insulation and sheath. All sub-main cables shall be provided with a full-size auxiliary CPC. Sub-main cables installed underground shall be provided with an integral CPC so that the CPC is protected by the cable armour. Cable joints shall not be permitted except where indicated in the Contract Documentation and with the express permission of the Contract Administrator.

All cables passing through walls and floors shall be sleeved using an appropriate section of duct. Where ducts enter or exit a building, the aperture between the cable and duct shall be packed to a depth of 300mm with mineral fibre insulation, sealed against the ingress of gas and water using inflatable airbags and then capped using at least 30mm of non-hardening mastic or fire-stopping compound. Neither mortar nor cement nor concrete shall be accepted.

Each cable shall be identified by its circuit reference at the point where it emanates from the main switchboard and at the point it passes through a floor plate. The label at the switchboard shall also identify the size of cable and the number of cores. Each label shall be engraved from multi-layer, laminated thermosetting plastic and secured to the cable using cable ties. Note that this requirement applies to incoming data and telecoms cables as well as power cables.

All penetrations shall be fire stopped in accordance with the building fire strategy.



7.1.6 New Installation

7.1.6.1 New cable installation from Block A to Block A Extension

The existing 70 mm² 3-core Steel Wire Armoured (SWA) cable supplying the Block A extension currently routes internally through the old Block A fabric scheduled for demolition. To facilitate the demolition works while maintaining uninterrupted power supply, a new 70 mm² 3-core SWA cable shall be installed externally between the main switch room in Block A and the Block A extension.

The existing cable tray within the switch room and along the internal route shall be reutilised to support and route the new cable safely up to the point of exit to the external trench.

At the exit point, the cable will transition from the existing internal cable tray to the external trench system. The trench is a combined mechanical and electrical trench located outside the building. The electrical section of the trench starts at approximately 400 mm wide, and then gradually widens as it joins the mechanical section further along the route.

The new cable shall be carefully routed from the cable tray into the electrical portion of this combined trench, ensuring smooth bends and compliance with minimum bending radii to prevent damage.

Within the external trench, the cable shall be laid on a prepared bedding of clean, compacted sand as per specification, with appropriate mechanical protection from external factors.

All cable routing, supports, and transitions shall maintain segregation from other services where applicable, ensuring ease of access for future maintenance and compliance with safety regulations.

The Contractor shall coordinate closely with mechanical and electrical (steams to ensure proper integration of the cable installation within the combined trench and to avoid clashes or damage to other services.

- The cable shall be 70 mm², 3-core Steel Wire Armoured (SWA) cable, suitable for low voltage power distribution.
- The cable shall have XLPE insulation with a Low Smoke Zero Halogen (LSZH) outer sheath to meet fire safety requirements.
- The cable shall be designed and manufactured to comply with BS 6622 and BS EN 50288 standards.
- Rated voltage: 600/1000 V.
- Current carrying capacity shall be suitable for the maximum expected load of 90 kW (approx. 153 A) with a protective device rating of 160 A.
- The cable shall be armoured with galvanized steel wire for mechanical protection suitable for direct burial underground installation.
- The cable route shall be installed within externally protected underground ducts to avoid mechanical damage and interference with demolition works.

The installation shall include:



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- The installation shall include suitable cable supports, fixing, and segregation from other services to prevent damage and ensure maintainability.
- Cable bending radius shall comply with manufacturer's recommendations to avoid damage during installation.
- Routing the new cable through externally protected underground ducts that avoids the demolition zone.
- Mechanical protection and segregation of the cable route in compliance with BS 7671 and relevant standards.
- Provision of suitable cable terminations with approved glands and lugs at both ends.
- Incorporation of jointing chambers or draw pits where necessary, using approved LV joint kits installed by accredited personnel.
- Coordination with civil works for trenching, duct installation, and reinstatement.
- All works shall be carried out following asbestos clearance and applicable health and safety regulations.

Testing and Commissioning

- Upon completion of installation, the cable shall undergo insulation resistance testing, continuity testing, and voltage drop verification to ensure compliance with design parameters.
- Test results shall be documented and submitted as part of the commissioning package.

Table 1 CABLE SIZE AND VOLTAGE DROP CALCULATION

Parameter	Value
From	Main Panel Board
To	Assembly / SW-PANEL-A
Type of Circuit	3Ø
Cable Length (mtrs.)	40
Estimated Connected Load (kW)	90.00
No. of Run	1



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Cable Size (mm²)	70
Protective Device (A)	160
Full load current (A)	153.0
% Voltage Drop	0.90

Note: The estimated connected load is unknown, however, 90 kW represents the maximum load that can be connected to this 160 A board serving the entire Block A extension. Therefore, the cable sizing and voltage drop calculations have been based on this maximum design load to ensure adequate capacity and compliance with standards.

To calculate the earth fault loop impedance Z_s for the new cable installation, need to consider the following:

- Conductor resistivity (from BS 7671 typical values):
Phase conductor resistance $R_{ph} \approx 0.387 \Omega/km$
Protective conductor resistance $R_{pc} \approx 0.387 \Omega/km$ (same size assumed)
- Neglect reactance for Z_s calculation (worst case, conservative)
- Source impedance Z_{source} : Assume typical value from DNO supply (e.g., 0.05 Ω)

Earth fault loop involves current flowing out via phase conductor and returning via protective conductor, hence, total cable resistance for earth fault path,

$$R_{total} = (R_{ph} + R_{pc}) \times \frac{Length}{1000} R_{total} = (0.387 + 0.387) \times \frac{40}{1000} = 0.774 \times 0.04 = 0.03096 \Omega$$

Assuming source impedance $Z_{source} = 0.05 \Omega$:

$$Z_s = 0.03096 + 0.05 = 0.08096 \Omega$$

Earth Fault Loop Impedance, $Z_s \approx 0.081 \Omega$

Notes:

- Existing electrical test certificate value, $Z_s = 0.06 \Omega$
- Design value, $Z_s \approx 0.081 \Omega$
- This value is an estimate; actual Z_s depends on exact source impedance and cable installation conditions.
- The calculated Z_s should be verified by on-site testing after installation.



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- For compliance with BS 7671, this Z_s must be less than the maximum permitted earth fault loop impedance for the protective device used (for 160A MCCB, typically around 0.2 Ω or lower depending on device characteristics).

All cabling shall be installed in accordance with the manufacturer's recommendations and the following requirements to suit the demolition enabling works:

- Cables shall be installed to allow adequate air circulation around each cable to prevent overheating.
- No joints shall be permitted between equipment items unless approved jointing chambers are provided.
- Cabling shall be supported continuously throughout its length using appropriate means such as conduit, catenary (only in concealed areas or ceiling voids), or cable trays.
- Vertical cable runs shall be supported on cable ladders or cable trays, except for subcircuit drops within walls or cable groups exceeding eight cables.
- Cabling shall be installed so that it can be readily withdrawn to facilitate future relocation or rewiring.
- In rendered walls, chases, or concrete structures, cables shall be enclosed within concealed conduit and located such that withdrawal for maintenance is feasible.
- When passing through stud partitions, cables shall be installed through properly sized and bushed access holes positioned vertically or horizontally aligned.
- In accessible locations, cables shall be secured using approved fixing methods to maintain position and prevent sagging.
- Cabling shall not be fastened or tied in inaccessible locations such as cavities or stud partitions; conduits shall be used in these areas to permit cable draw-in and withdrawal.
- In accessible false ceilings, cables shall be clipped at maximum 1000 mm intervals to permanent building structures. Cables shall be routed clear of ceiling tiles and run over pipework and ducting using catenary or cable trays.
- Steel conduits shall protect cabling in locations exposed to potential mechanical damage or as specified.
- Cables shall not be bent beyond the manufacturer's recommended minimum bending radii to prevent damage.
- Adjacent circuits and submain cable groups installed over common routes shall be spaced with a minimum gap of one cable diameter.
- Cable groups shall comprise no more than four cables per group when mounted on catenary (horizontal runs) or cable trays (vertical runs), maintaining equal spacing between groups.
- Single-core conductors forming a circuit or submain shall be grouped together and fixed securely to cable trays.



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Additionally, all mains and submains cabling shall have individual phase conductors transposed approximately one-third along their route length to ensure complete phase rotation and minimize electromagnetic interference.

Only primary containment is shown on the project drawings. The Contractor is responsible for supplying, sizing, laying out, and installing any additional secondary containment necessary to complete the installation.

The containment system (excluding conduit) shall maintain at least 25% spare capacity after installation of all base-build cabling to allow for future upgrades.

The Contractor shall design and provide suitable supports and fixings for all containment based on cabling loads and types.

Submain cables shall be secured to ladder trays or cable trays using cleats and steel cable ties.

All service penetrations through building structures shall be fire-stopped by the Contractor in accordance with BS 9999: Code of Practice for Fire Safety, BS 476: Fire Tests on Building Materials and Structures and using third-party certified fire stopping products suitable for their location.

7.1.7 Cable Trench (External)

The Contractor shall excavate, prepare, backfill, and reinstate a single underground trench to accommodate the new 70 mm² 3-core Steel Wire Armoured (SWA) cable between the main switch room in Block A and the Block A extension.

Contractor shall:

- Excavate the trench to a minimum depth of 450 mm below finished ground level, providing adequate cover and protection for the cable in accordance with relevant standards and regulations.
- Ensure the trench is kept free from water, debris, roots, and sharp objects during excavation and installation.
- Provide suitable shoring or supports as necessary to maintain trench stability and ensure safety for personnel.
- Place a minimum 75 mm thick bedding layer of clean, well-graded, salt-free sand or fine gravel at the bottom of the trench, compacted and free from stones or sharp objects that could damage the cable.
- Lay the 70 mm² SWA cable directly on the prepared bedding, ensuring no mechanical stress or bends beyond the manufacturer's recommended minimum bending radius.
- Position the cable centrally within the trench to allow uniform cover on all sides.
- Install a continuous detectable warning tape or marker strip approximately 200 mm above the cable to alert future excavators to underground cabling.
- Backfill the trench in layers not exceeding 150 mm thickness, compacting each layer to prevent settlement.



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- Use well-graded, inorganic, free-draining material for backfill, excluding large stones or organic matter within 300 mm of the cable.
- Reinstall paved or trafficked areas to match existing construction standards and finishes; reinstall landscaped areas with a minimum of 150 mm topsoil and re-turf disturbed lawn areas to match existing.
- Comply with all applicable health and safety legislation, including CDM 2015 regulations, providing appropriate barriers, signage, and protections during all trenching works.
- Provide as-built drawings showing accurate cable route and depth upon completion of trench installation.
- Coordinate with cable installation teams to ensure the trench is adequately prepared for cable laying.
- This specification ensures that the underground trench installation is carried out safely, complies with all standards, and provides durable protection for the new cable link between Block A and the Block A extension.

7.1.8 Fire Alarm Control Panel

The Contractor shall ensure uninterrupted operation of fire alarm systems by relocating or replacing control panels within demolition zones.

The existing fire alarm system includes Gent Vigilon Compact addressable fire panels. As part of the demolition enabling works, the fire alarm panel currently located within the demolition zone in Block A (in corridor A083) shall be carefully relocated to the retained Block A extension to maintain full fire detection and alarm coverage.

The contractor shall:

- Carefully disconnect and remove the existing fire alarm panel and associated wiring within the demolition area.
- Design, supply, and install fire alarm panel at new location within the Block A extension, ensuring full integration with the existing Gent Vigilon addressable system.
- Re-route all affected fire detection devices, call points, sounders, and wiring to the new panel location.
- Ensure all installation work complies with BS 5839 Part 1 (Code of Practice for Fire Detection and Fire Alarm Systems for Buildings) and any other relevant standards.
- Conduct full system testing and commissioning after relocation, including device addressing, functionality checks, and integration with the school's fire safety management systems.
- Provide updated as-built drawings showing the new fire alarm panel location, cable routes, and device positions.
- Coordinate with the client and other contractors to ensure minimal disruption to fire safety coverage during relocation works.



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- Provide all necessary certifications, commissioning reports, and operation and maintenance manuals upon project completion.

The fire alarm system must remain fully operational throughout the demolition enabling works to ensure the safety of school occupants and compliance with statutory requirements.

7.1.9 Existing ELV services

As there was no safe access available to the original Block A during site visit, due to the presence of asbestos, the routing and interconnection of existing extra-low-voltage services within, through and between Block A, the Block A Extension and Block B were not fully identified at the time of design. Accordingly, all existing electrical and low-voltage services associated with these areas shall be treated as live and operational unless and until they are positively identified and confirmed redundant. This shall include, but not be limited to, IT/data, telephone, security systems, intruder alarm, CCTV, access control, BMS, class change bell, reception desk systems, intercoms, and any other associated services.

The primary server room is located in the Block A Extension at Level 0 and has an Openreach incoming feed routed externally. Block B has a separate server room with its own externally routed Openreach connection. Based on the current information and provided that both server rooms retain power, demolition of the original Block A is not expected to interrupt the campus data network as the Openreach connections enter externally and the server rooms lie outside the proposed demolition zone. This is subject to the existing shared structural wall between the original Block A and the Block A Extension being capable of being retained in isolation when Block A is demolished, which shall be confirmed by others.

It is currently envisaged that no works will be required to the core data network on this basis. However, the Contractor shall carry out intrusive surveys to identify and verify all extra-low-voltage services and any associated containment, interconnections or local panels within the parts of Block A to be demolished. Any such services, equipment, panels or connections serving retained areas and found within the demolition zone shall be diverted and relocated to the Block A Extension, including any connections running from Block B to Block A or from Block B through Block A to the Block A Extension, which shall be rerouted so that retained services are no longer dependent upon the original Block A or its internal containment routes.

Any changes affecting telecoms or data shall be coordinated with the telecom provider, with signed test and continuity records obtained after any temporary or permanent arrangements are commissioned. Location and power arrangements for all on-site server rooms and communications equipment shall be confirmed on site before commencement of demolition or power diversion works.

No cable, containment, device, panel or associated equipment serving retained areas shall be cut, disconnected, removed or made dead until it has been positively identified and either confirmed redundant or replaced by an approved alternative arrangement. Any services discovered during demolition to serve retained areas shall be protected, traced and incorporated into the final diversion and relocation strategy before the works proceed further.



7.2 Phase 2 Works

During Phase 2, the remaining retained parts of Block A, including the existing electrical switch room and boiler room, are demolished. These areas were retained during Phase 1 to maintain services while the remainder of Block A was demolished. As part of Phase 2, a new temporary external low-voltage electrical distribution arrangement shall therefore be provided outside the demolition area to enable demolition of the remaining retained areas and to maintain supplies to the retained parts of the school.

7.2.1 Electrical Kiosk

A new temporary external low-voltage panel board shall be provided to maintain supplies to the retained buildings and the temporary containerised boiler plant following demolition of the remaining retained parts of Block A. The new distribution board shall be installed outside the demolition area and shall form the primary temporary LV distribution point for the Phase 2 arrangement.

The distribution board shall be installed inside a factory-built GRP weatherproof roadside-type enclosure of approximate external dimensions 2000 mm (W) × 1500 mm (D) × 2000 mm (H). The enclosure shall be suitable for outdoor installation, with double doors, secure locking, appropriate ingress protection, internal mounting provisions and clearances adequate for the selected panel board and cable terminations.

The temporary external electrical panel board and kiosk are proposed outside the demolition zone and adjacent to the substation. The proposed location shown on the drawings is indicative only, final location shall be verified and confirmed at a later stage following coordination with DNO (SPEN), site layout, demolition sequence, mechanical plant arrangement, access requirements, maintainability, service routes, existing infrastructure and all statutory or client constraints. The final position shall allow safe installation, operation, maintenance, access and cable routing.

7.2.2 LV Panel board

The new low-voltage distribution board shall be a wall- or floor-mounted MCCB panel board suitable for an 800 A three-phase incoming supply and a minimum of 10 outgoing MCCB ways. The board shall be configured to accommodate the existing Phase 2 outgoing feeders and spare capacity, with busbars, neutral and earth bars, main incoming device and outgoing protective devices sized for the total load.

A new low-voltage incomer cable shall be provided from the existing on-site substation (07/8578/026) to the new temporary external distribution board. Based on information received from SPEN, the existing incomer cable is 1 × 185 mm². The final incomer cable size and arrangement shall be confirmed following completion of the load analysis and agreement of the DNO proposal, cable route and length, installation method, ambient conditions, maximum diversified load, protective device characteristics, prospective fault current and permissible voltage drop.

A low-voltage diversion and alteration application has been submitted to SP Energy Networks (SPEN) under case reference 01882857. SPEN have advised that, their scope will be limited to arranging isolation at the substation, removal of the existing fuses and reconnection of the new incomer cables to the substation LV board on an agreed date. All other works associated with the new incomer and outgoing distribution, including new cable installation, terminations at the temporary external distribution board, containment, civil works, testing and commissioning, shall be carried out under this contract.



7.2.3 Outgoing Cables

New sub-main cables shall be provided from the external distribution board to supply the retained buildings and the temporary containerised boiler plant. These shall include the necessary supplies to Block B, Block C, Block D, Block E/S, the Block A Extension and the temporary boiler installation, together with any other retained distribution points identified through the final phasing and coordination process. Cable sizes for all outgoing circuits shall be designed and verified at a later stage based on actual connected and diversified loads, final board location, final cable route lengths, voltage drop, earth fault loop impedance, installation method, grouping, ambient temperature and coordination with the selected protective devices.

New LV submain cables shall be installed from the proposed external LV panel to the existing LV switch room, following the agreed Phase 2 cable routing. At the existing switch room, the new submains shall be jointed onto the existing outgoing cables which serve Blocks B, C, D and E/S, at locations beyond which the cables leave the switch room and run externally towards each block. The intent is that new cables are provided only between the external LV kiosk and the point outside the existing LV switch room where the existing external feeders to each block commence, at which point the new cables shall be jointed to the existing cables serving each block.

All new-to-existing cable joints shall be fully compliant with current standards and manufacturer's recommendations, suitable for the cable type, size, installation method and environmental conditions, and shall maintain at least the same level of insulation, mechanical protection and ingress protection as the existing installation. Joint locations shall be accessible for inspection and maintenance and shall be clearly identified and labelled with circuit references.

Before any jointing works are undertaken, the existing outgoing feeders to Blocks B, C, D and E/S shall be positively identified and confirmed by testing and tracing, including verification of supply direction, phasing and load. No existing feeder shall be cut, jointed or made dead until the new cable from the external LV panel has been installed, tested and is ready for final connection.

Final jointing, testing, phasing checks and commissioning shall be carried out in a planned manner to minimise disruption to the school, with any required shutdowns agreed in advance. As-built records shall show the final route of the new cables, the position of all joints and the identification of each circuit supplying Blocks B, C, D and E/S

The Phase 2 cable schedule shall, for the current design stage, be based on the following existing cable sizes and protective devices:

- Cable-1 – Main Panel (Block C): 185 mm², 250 A
- Cable-2 – Hutment / Block D: 25 mm², 125 A
- Cable-3 – Block A Extension Assembly / SW-PANEL-A: 70 mm², 160 A
- Cable-4 – Block E & S main panel: 70 mm², 200 A
- Cable-5 – Block B main school distribution panel: 95 mm², 200 A
- Cable-6 – Temporary boiler electrical supply: 16 mm², 63 A



7.2.4 Meters

Contractor to include for an incoming supply (check) meter for the main LV panel board and sub-meters for each outgoing submain

Contractor to include for liaison with Client Energy Supplier and DNO for utility meter connection and installation.

7.2.5 Underground cable routes, ducts and drawpits

Existing trenches, ducts or external cable routes from the former electrical room may be reused where their location, capacity, condition and suitability are confirmed on site. However, they shall not be assumed to be fully reusable or continuous, particularly where the new temporary distribution board is not located in the same position as the existing switchroom. Where existing routes are unavailable, unsuitable, affected by demolition, or cannot be verified, new trench, duct or containment routes shall be provided as required to form complete and compliant routes from the new temporary distribution board to each retained building and to the temporary containerised boiler plant.

Any existing circuits and infrastructure serving only the demolished portions of Block A, including the former retained switch room and boiler room areas, shall be identified, isolated, disconnected and removed or terminated as redundant at the phase 1 stage of the works. No new supplies shall be provided to areas scheduled for demolition. Existing services serving retained areas shall remain live and operational until replacement arrangements, diversions or permanent new supplies have been installed, tested and brought fully into service.

- All new underground LV cable routes associated with the Phase 2 works, including the incoming supply diversion to the LV distribution panel and all new outgoing sub mains to retained buildings, shall be installed in underground ducts laid in trenches.
- As the proposed routes are predominantly within footpath and landscaped areas of the school site, ducts shall be installed with a minimum cover of 600 mm to the top of duct unless otherwise required by the DNO or where local site conditions dictate additional depth.
- Ducts shall be laid on a minimum 75 mm sand or fine fill bed and provided with a minimum 75 mm sand or fine fill surround above and below the ducts. Marker tape shall be installed 150 mm above the uppermost duct prior to final backfilling.
- All new underground ducts shall include draw ropes and temporary end caps until cable installation is complete.
- Provide individual ducts for each new LV feeder unless otherwise agreed by the Designer. Duct sizes shall be as follows:
 - Feeders up to and including 95 mm²: 100 mm internal diameter uPVC Class 1 duct.
 - Feeders greater than 95 mm², including the 185 mm² feeder: 150 mm internal diameter uPVC Class 1 duct.
- Where multiple ducts are installed in the same trench, maintain a minimum horizontal separation of 100 mm between ducts unless otherwise required for installation or coordination with other services.



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- Provide cable drawpits at significant changes in direction, at branch points and at intervals suitable for cable pulling and future maintenance.

7.2.6 Earthing, bonding and protection

- Provide earthing and bonding arrangements for the new containerised LV switch room and all associated electrical equipment in accordance with BS 7671 and the characteristics of the existing installation.
- Review protective device ratings, fault withstand, fault levels, earth fault loop impedance and discrimination for all modified or diverted circuits, and make any adjustments necessary to ensure the completed installation remains safe and coordinated.

7.2.7 Testing, commissioning and changeover

- All new and modified electrical works shall be inspected, tested and commissioned in accordance with BS 7671 prior to energisation.
- Testing shall include all inspections and dead and live tests necessary to confirm the suitability of the altered installation and the continued adequacy of the relevant protective devices. Existing test records shall be reviewed and supplemented as necessary for all affected circuits.
- The complete Phase 2 installation shall be fully operational and proven prior to decommissioning and demolition of the existing Block A switchroom.

7.2.8 Decommissioning of existing switch room

- Following successful completion of all transfers and confirmation that all retained buildings and services are supplied from the new containerised LV switch room, the existing Block A switch room shall be isolated, made safe, disconnected and prepared for demolition.
- No part of the existing switch room shall be demolished until written confirmation has been issued that all retained supplies have been transferred or made safe.



8 Mechanical Materials and Workmanship

8.1 Pipework

8.1.1 Protection during Construction

Adequate storage facilities shall be provided to ensure that tube does not suffer any deterioration from the 'as new' delivered condition.

During construction work, care shall be taken to prevent any foreign matter entering the pipework either in storage or during installation.

Open ends shall be capped with the appropriate pipework fitting. Wooden plugs and the like shall not be used.

Valves fitted on the ends of pipework shall not be accepted as a means of preventing the ingress of foreign materials.

8.1.2 Pipework Spacing

Pipe runs shall be spaced in relation to one another, other services and the building structure. Ensure adequate space for access to pipe joints, etc. and allowance for the specified thickness of thermal insulation.

Pipework supports and fixings shall be provided in line with manufacturer's recommendations with maximum support spacing as outlined in the individual sections below and shall be arranged to accommodate pipe movement caused by thermal changes.

Minimum spacing between insulation and structure / adjacent services shall be as follows:

- 25mm to wall
- 50mm to ceiling / soffit
- 150mm to floor
- 25mm to insulated pipe
- 50mm to uninsulated pipe

8.1.3 Copper Pipework

Copper tube shall be to BS EN 1057 R250/R290, be WRAS listed and drawn from the Yorkex range manufactured by Yorkshire Copper Tube Limited or equal and approved.

Provide a protective plastic coating to insulated copper pipework conveying cold services.

Push-fit system such as Maypress systems, are not allowed.

Press-fit fittings shall be of copper or copper alloy to the draft proposal Pr EN 1254 Part 7 and certified by WRAS and DVGW. Available in sizes from 15mm to 108mm they shall be capable of operating between -24°C and 110°C and rated 16 bar throughout the temperature range. They shall provide electrical continuity and be drawn from the XPress range from Yorkshire Fittings Limited. The System when constructed exclusively from XPress Copper and Yorkex components shall be suitable for use on hot and cold-water services, vented and unvented closed-circuit heating, chilled water and low



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8 Mechanical Materials and Workmanship

temperature hot water and have a guarantee of 30 years against all manufacturing defects, or equal and approved.

8.1.4 Polyethylene Pipe (Laid in Ground)

Installations shall be carried out using medium density polyethylene (MDPE) Protectaline pipe and fittings coloured blue (potable water services), black (non-potable water services) and yellow (gas services).

MDPE pipework for pressurised potable water systems shall be manufactured in compliance with Water Industry Specification (WIS) WIS 4-32-17 and BS EN 12201.

MDPE pipework for pressurised non-potable water systems (excluding reclaimed water) shall be manufactured in compliance with WIS 4-32-17 and BS EN 13244.

MDPE pipework for pressurised non-potable re-claimed water systems shall be black with longitudinal green stripes marked 'Reclaimed Water' and manufactured in compliance with WIS 4-32-17 and BS EN 13244. Installation of pipework associated with reclaimed water systems shall follow the guidance contained in the Water Regulations Advisory Service (WRAS) Guidance Note IGN 9-02-04.

MDPE pipe for natural gas systems shall be manufactured in compliance with British Gas/Transco Specifications GBE/PL2 Parts 1 & 6 (up to 5.5 bar) or Part 8 (up to 7 bar). MDPE fittings for gas systems shall be manufactured in compliance with Specifications BGE/PL2 Parts 2 & 3.

Pipework shall be jointed using approved proprietary electro-fusion or butt weld methods carried out by competent personnel suitably trained.

MDPE (PE80) pipe shall not be used where the temperature of the transported medium, be it gas or water shall rise above the maximum recommended by the manufacturer for the given installation method.

MDPE (PE80) pipe shall not be used downstream of any gas booster or compression set.

8.1.5 Mild Steel Pipework

Medium and heavy grade steel pipework shall conform to BS EN 10255.

Fittings on 150 mm and below shall be malleable cast iron fittings conforming to BS.143 with screwed joints to BS 21.

Fittings on pipework 175 mm and above shall be 45° and 90° long radius elbows, 180° return bends, caps, eccentric reducers and branch bends to BS EN 10253-1 to the same quality and thickness as the tube.

Care shall be exercised when threading the tube to ensure that threads are carefully cut to minimise the number of exposed threads.

Where steel pipework and screwed fittings are used on domestic hot and cold-water services, including cold water mains, joints shall be clean threaded, pulled up tightly using PTFE tape (Boss Permanite GT) and a suitable jointing compound as approved in the current "Fittings and Materials Directory" as published for the Water Research Centre. On cold water services, including cold water mains, 'Boss Blue' jointing compound is approved and recommended.

Stranded hemp and Boss white shall not be used under any circumstances



8.1.6 Copper Capillary Fittings

Excess flux and solder shall be removed and the joint cleaned to give a clean neat finish.

8.1.7 Expansion of Pipework

Anchors, guides, loops, expansion bellows shall be supplied and installed in locations determined by the contractor as part of their CDP

Adequate provision shall be made for expansion and Contraction of all pipework, and, where possible, advantage shall be taken of pipework changes in direction to accommodate movement in pipe systems.

Anchors and guides shall be positioned to contain all movement and resist the maximum loads imposed.

Anchors and guides are to be located at points which prevent excess stresses on pipework, joints and equipment connections.

Similar provisions shall be made for building movement or building settlement.

Where natural flexing of the pipework is not practicable, thermal and building movement shall be accommodated by the use of expansion joints.

Expansion joints may be of the restrained or unrestrained type and shall be provided with welded, screwed or flanged ends as appropriate and as indicated.

Expansion joint shall be capable of not less than 2000 complete reversals of movement at the given working conditions and the manufacturer shall be able to produce calculations to that effect.

Expansion joints shall be capable of withstanding a pressure test of twice their design pressure without loss of performance.

The manufacturer's guidelines for selection and installation shall be strictly adhered to. On completion of the installation, prior to heat being applied, the Contractor shall arrange for the manufacturer's representative to inspect and check that the installation of the expansion joints is in accordance with his instructions. This shall be agreed with the manufacturer prior to placing an order.

Axial unrestrained expansion joints shall only be used in positions where their pressure thrust can be contained by adequate anchor points. The Contractor shall arrange for the manufacturer to submit calculations for loadings on main anchors. Recommended guide spacing must be strictly adhered to.

Restrained expansion joints may be used for angular or lateral movement. Their restraints shall be capable of absorbing the full pressure thrust of the bellows, plus forces due to the connecting pipework.

Angular expansion joints shall be constructed using an ultra-low friction rocking hinge mechanism, which limits the movement to one plane. Angular expansion joints shall be used in pairs or in threes.

Lateral expansion joints shall be fitted with threaded tie bars and low friction self-lubricating hemispherical nuts allowing movement in two planes.



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Stainless steel convoluted hose with a stainless-steel wire braid may be used to absorb small lateral movements in pipework branches or for building movement in accordance with the manufacturer's recommendations.

Pipework subject to expansion and Contraction shall be supported via swivel type hangers.

The Contractor shall be responsible for arranging the manufacturer to approve the expansion joints provisions prior to ordering of materials and commencement of the works.

8.1.8 Expansion Loops

Prefabricated expansion loops shall be constructed in same pipework class and finish as the pipework system.

Where access is limited, prefabricated expansion loops shall be used and only on pipework up to 65 mm.

8.1.9 Anchors and Guides

Anchors, guides, loops, expansion bellows shall be supplied and installed in locations as required.

Anchors and guides shall be provided to control the direction and effects of movement of the pipework systems and to resist stresses and loading on pipework due to forces acting on the pipework system.

The anchor loads, anchor and guide locations, method of fixing to the structure and design details shall be submitted to the Project Manager for review prior to commencement of the works.

Ensure the structure is suitable for the transmitted stress.

Use similar or compatible materials with the pipework system.

Anchors shall be as follows:

8.1.9.1 Steel Pipe

On mild steel pipework, mild steel anchors capable of resisting the maximum stresses shall be provided and welded to the pipework.

Where it is impracticable to weld the anchors to the pipework, cast-iron chairs with at least two wrought-iron stirrup bolts shall use, the bolts being provided with sufficient thread to ensure an effective grip on the pipe.

8.1.9.2 Copper Pipe

The anchors shall be provided by wide copper straps secured to the pipework in such a manner that the pipe is not damaged.



8.1.10 Pipe Sleeves and Plates

All pipework passing through floors or walls shall be provided with sleeves of similar material and of such diameter as to allow free movement of pipework.

Sleeves shall be of sufficient length to finish flush with finished faces of wall or ceiling and 15mm. proud of the finished face of floors. All sleeves shall be retained in position before making good by lugs or plates welded on at sub-floor level.

The weight of pipework shall not be borne by sleeves.

Sleeves shall be manufactured from mild steel tube painted with two coats of zinc rich primer.

Copper sleeves shall be used in conjunction with uninsulated copper pipework.

Where pipework is insulated, the pipe sleeve shall be of sufficient size to allow the thermal insulation to pass between the pipe and the sleeve over its entire length.

In areas where floors are washed down, install with a 50mm protrusion above floor finish and shall have its edge rounded or bevelled. The protrusion length shall be agreed prior to installation.

Chromium plated plates shall be installed wherever pipes pass through walls, floors and ceilings exposed to view.

8.1.11 Pipe Sleeves Through Fire Barriers

Sleeves which are contained in walls, ceilings or floors which are fire barriers shall be additionally packed with a non-combustible material for the entire length to form a fire/smoke stop of the required fire rating.

The material shall be subject to approval and must comply with Building Control and the Building Regulations.

Petroleum based expanding foam products shall not be used.

The ends of sleeves packed with material shall have a suitable fire-resistant mastic applied to seal the fibres and present a neat appearance.

Sleeves for UPVC pipes shall contain an intumescent material to BS 476

8.1.12 Pipe Sleeves Through Acoustic Barriers, Enclosures and Plantrooms

Sleeves on pipes which are contained in walls, ceilings or floors which are acoustic barriers, or through acoustic enclosures, or plantroom walls, floors or ceilings, shall be packed with a 12 mm thick resilient neoprene inner sleeve around the pipe and filled with a non-setting mastic compound. The outer edges of the sleeve shall be made air-tight by sealing with a dense non-setting mastic compound. Where such barriers are also fire barriers, the material shall comply with Building Control and the Building Regulations.



8.1.13 Pipe Supports

Pipework supports are to be arranged so that no undue stress is imposed upon the pipes.

Ensure that all materials used for pipework supports are compatible with the pipeline materials.

Pipework supports shall not exceed the maximum intervals stated elsewhere.

Additional supports shall be provided for equipment such as valves, strainers and ancillaries so that minimum stress is imposed on the pipework and the weight is not taken by the pipework. The support arrangement shall allow safe operation and removal of the component.

All brackets and supports shall allow free movement of the pipes due to expansion and Contraction with special regard to prevention of damage to any thermal insulation and vapour barrier.

Where multiple pipe runs of differing bores are supported from a common point, use support spacing of pipe requiring the closest spacing with adequate provision for the unequal movement due to expansion and Contraction. Supports shall also be provided at bends where there is a run of pipework 1 metre or more both sides of the bend.

Cantilever type supports from walls shall not be allowed except for single pipes of diameters up to 50 mm.

Obtain approval for all fixings to structural concrete or structural steelwork and loads imposed on the structure. Shot fired fixings shall not be used or any reinforcement drilled through.

Static point loadings transferred to the structure which cannot be accommodated by the structural fixings shall be spread over a larger area by means of additional brackets and/or additional load spreading primary steelwork.

The Contractor shall be responsible for marking out the exact positions where pipe brackets are to be built in and for checking the accuracy, levels and alignment of supports after building in by others.

For 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 support when using non-end load capable flexible couplings

8.1.14 Steel Pipework Maximum Support Spacing

Pipe Bore Nominal (mm)	Maximum Support Spacing (m)		
	Horizontal		Vertical
	Bare	Insulated	Bare or Insulated
Up To 15	1.8	1.8	2.4
20	2.4	2.4	3.0
25	2.4	2.4	3.0
32	2.7	2.4	3.0
40	3.0	2.4	3.6
50	3.0	2.4	3.6
65	3.7	3.0	4.6
80	3.7	3.0	4.6
100	3.7	3.0	4.6
125	3.7	3.0	5.4



Pipe Bore Nominal (mm)	Maximum Support Spacing (m)		
	Horizontal		Vertical
	Bare	Insulated	Bare or Insulated
150	4.5	4.5	5.4
200	5.0	5.0	6.0
250	5.0	5.0	6.0
300	6.1	6.1	9.0
350	9.5	7.0	9.0
400	9.5	7.5	9.5
450	10.0	8.0	10.0
500	11.0	9.0	11.0

8.1.15 Copper Pipework Maximum Support Spacing

Pipe Bore Nominal (mm)	Maximum Support Spacing (m)		
	Horizontal		Vertical
	Bare	Insulated	Bare or Insulated
Up To 15	1.2	1.2	1.8
22	1.2	1.2	2.1
28	1.8	1.5	2.4
35	2.4	1.8	3.0
42	2.4	1.8	3.0
54	2.7	1.8	3.0
67	3.0	2.4	3.5
76	3.0	2.4	3.5
108	3.0	2.4	3.5
133	3.0	3.0	3.5
159	3.5	3.5	3.5

At least one fixing shall be provided for each unit length.

8.1.16 Pipework Brackets

Where expansion takes place in pipework, pipes shall be supported on cast iron roller chair assemblies with retaining strap or 'U' bolts to restrain transverse movement.

Where expansion is minimal, pipework shall be held in position by 'U' bolts, split bands or split pipe rings. Single pipe supports from walls shall be held in position by two-piece screw-on clips which shall be removable without disturbing the fixings. Calliper, single piece rings, or 'snap on' type brackets shall not be allowed.

Brackets shall be manufactured from the following materials:

- Steel and Cast-Iron Pipework



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- Mild steel or malleable iron, with cast iron rollers, mild steel nuts, bolts and washers and mild steel screws.
- Copper Pipework
- Brass or gun metal with cast iron rollers plastic coated, and brass screws, nuts, bolts and washers. Alternatively, mild steel plastic coated pipe brackets may be used on larger diameter pipework.
- Plastic Pipework
- PVC coated steel for 75 and 110 mm diameter plastic pipework and plastic or polypropylene for smaller diameter pipes. Fixing screws, nuts and bolts shall be steel with a galvanised or sherardised finish.

8.1.17 Venting and Draining

All pipework must be graded accordingly.

Equipment shall be provided with drains and vents which shall be accessible from outside casing.

Adequate drains and vents shall be provided to facilitate draining and venting the pipework system.

Drain points shall be located in accessible positions and shall include drain cocks with hose union and removable key.

Where pipework sections can be isolated, drain and vent points shall be provided to facilitate draining down and venting of that section of pipework.

In plantrooms, a 30m length of 25mm flexible rubber/armoured hose pipe shall be provided and fixed to a wall. The hose shall have a connection to match the drain valves.

The Contractor shall allow for the provision of fast fill and drain connections in accordance with the water treatment specialists' requirements and also in accordance with the current COP relating to water treatment and cleaning.

8.1.18 Overflows and Condensate Drains

Equipment which has a continuous or intermittent discharge of waste water shall have an overflow/drain connection and discharge pipe which shall fall continuously to the nearest gully.

Overflow/drains shall be the same diameter as the connection size to the equipment and increased as soon as possible to 25 mm.

A 150mm diameter by 150mm high tundish shall be provided adjacent to the equipment into which the overflow/drain shall discharge.

On connections to coils towers a waste trap shall be installed between the coil and the drain.

Where more than one overflow/drain runs into a common pipework drain the diameter of the pipework shall be sized, by the Contractor, to ensure that the system drains to the gully at all times.

An air break trap shall be provided to each drain to comply with CIBSE TM 13.

8.1.19 Positioning of Control Components

Pipeline control components shall be installed in accordance with the manufacturer's recommendations and in the positions indicated.



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For control components incorporated in insulated pipework submit for approval details of insulation methods proposed.

Supports shall be provided to ensure no strain is imposed on the components.

The components shall be installed so as to ensure adequate and safe access for operation and maintenance.

8.2 Accessories

Valves, cocks, air vents and pipework accessories shall be provided at all positions necessary for the proper working, regulation, control and maintenance of the installation.

Valves shall be as far as it is practicable of the same manufacture and style to provide conformity and to simplify maintenance. In addition, they shall comply with the requirements of the Local Water Board.

All valves required to comply with the Pressure Systems Safety Regulations shall carry the CE mark and have a declaration of conformity.

All valves, cocks, vents and accessories must be fitted in such a manner that they are accessible for operation and maintenance. Valve operating handles must be easily accessible and operation must not be impeded by structure or other services.

BSI kite marked and Water Research Council approved valves shall be used for potable mains, hot and cold-water services.

Institution of Gas Engineers (IGE) certified valves shall be used on gas service.

The pressure rating of valves must equal or exceed system working pressures at the relevant temperature and the system test pressure.

Valves shall be provided on all pipework wherever necessary to achieve proper isolation and regulation of the whole systems. They shall be installed to isolate and balance every section of the pipework network including but not limited to the following locations:

- To isolate each item of equipment including heat transfer terminal units
- To regulate and balance the flow through each item of equipment including heat transfer terminal units, and control valves
- To isolate every section of the pipework network including sub-branch mains, sub-circuits and to multi-connections to heat transfer terminal units
- To regulate and balance the flow through every section of the pipework network including sub-branch mains, sub-circuits, and to multi-connections to heat transfer terminal units
- To isolate, regulate and balance the flow to any item of equipment supplied by or, to be connected to the systems, by others. (Should the equipment or plant not be connected up prior to balancing, temporary by-pass connections and a regulating valve shall be installed to achieve balancing)
- To isolate, and allow the removal of all control valves, flow meters, strainers, and other similar pipeline ancillaries



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- To isolate, regulate and balance the whole, the sub-branch and the sub-circuit on hot water services flow and return systems
- To isolate each float operated valve
- To isolate water services to individual items of sanitary equipment, ranges of kitchen equipment, ranges of sanitary fittings and individual water draw-off fittings
- To isolate immediately inside the building incoming utility services

Stopcocks may be used for isolation within buildings on all mains or pressurised water services and in addition on tank fed services on pipework up to 22 mm diameter only. Above 22 mm diameter gate type isolating valves only shall be used.

Regulation and balancing of the systems shall be achieved by the installation of commissioning stations and isolating valves

A commissioning station shall be provided on the return branch or sub-circuit return main and an isolating valve shall be provided on the corresponding flow connection, flow branch or sub-circuit flow main. The commissioning station shall consist of a double regulating valve and orifice plate as detailed elsewhere.

The commissioning stations shall be installed to the manufacturer's recommendations, with special regard to straight pipe lengths required before and after the assembly.

A regulating valve shall be provided on the return pipe from each terminal unit and an isolating valve shall be provided on the corresponding flow connection to each terminal unit.

Access to double regulating valves must be such that scales and verniers are clearly visible.

At least 100 mm clearance from pressure test points must be allowed to enable manometer tubes to be connected without kinking. Ensure test points are located to enable safe, positive quick-coupling and uncoupling of the flexible connections.

Large valves shall not be supported by the pipework to which they are supported and additional supports positioned close to each side of the valve shall be provided. Removal of the valve shall not allow the adjacent pipework to sag.

Check valves shall be installed where plant operates on an automatic changeover basis or where flow reversal can occur. Check valves shall be installed in accordance with the manufacturer's recommendations.

Air vents shall consist of either open air pipes to atmosphere manually operated air cocks or automatic air release valves

Open air vent pipes shall not be less than 20mm diameter continued up beyond the highest point of the system and turned to discharge over the feed and expansion tank. All open vents shall run with a continuous rise from the point of connection to the system, to the point of discharge.

Where indicated, valves or cocks shall be lockable, with purpose-made locking devices which do not impede the fast closure of the valve where that is necessary. The locking device shall remain attached to the valve in both open and closed position

8.2.1 Provision of Lock Shields on Valves

Where valves are shown as lock shield pattern or where the accidental closure or opening of a valve from its normal functioning position could cause harm to equipment or persons, then the valve shall be



of the lock shield type with a bronze, chromium plated shield as indicated and complete with a loose key. In all other respects the valve shall be as specified for wheel type valves but of the lock shield type.

8.2.2 Pipeline Strainers

Strainers shall be provided on the inlet connections to all pumps, meters, pressure reducing valves and where stated elsewhere or shown on the drawings to safe guard against dirt and other foreign particles.

They shall be of the 'Y' type up to 150 mm and pot or "Y" type on 200 mm and above as indicated elsewhere and shall be located between isolating valves with a convenient drain adjacent and installed in such a way that the strainer element/basket can be readily removable below the level of the body.

Strainers shall be the same size as the pipeline immediately before any reduction in size of pipeline to suit a control valve or pump/plant connection.

Strainer elements shall be cleaned and free from dirt prior to Practical Completion.

Provide plugged connections for drain, air vent and differential pressure monitoring located in the adjacent pipework or within the strainer body. Threads shall be to BS 21 and BS EN 10226-1.

Provide pressure gauges on the inlet and outlet of each strainer on sizes 32 mm and above unless stated otherwise.

Strainers over 100 mm shall be complete with an adequate size of blow-down connection and drain cock and shall have a discharge pipe which shall run to the nearest gully.

Unless otherwise stated strainers shall have a stainless-steel element with perforation size as indicated below. Screen free flow area shall be not less than 250% of the pipe bore.

Screen perforations:

15 mm to 50mm	Within range 0.7 – 0.9 mm diameter
65 mm and over	Within range 1.5 – 1.8 mm diameter

Baskets shall be capable of withstanding the maximum pressures without distortion.

Strainers shall be complete with an asbestos free non-stick gasket.

Strainer bodies up to 50mm shall be bronze to with compression ends to BS EN 1254-2.

Strainer bodies above 50mm shall be cast iron with flanged ends to BS EN 1092-2.



8.2.3 Safety and Relief Valves

Safety and relief valves are to discharge with rapid opening action to prevent pre-determine safe pressure being exceeded.

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

Safety and relief valves shall meet the requirements of the appropriate British Standard for the equipment to which they are connected, and be suitable for the operating conditions of the system. Valves shall be sized for the rated output of the appliance.

Direct acting safety valves shall be in accordance with BS EN 4126-1.

Pipework connections shall be fitted, where indicated, to provide discharge connection to safety and relief valves. Discharge and waste pipes shall terminate at visible and safe positions to be agreed. Connections to drains shall be provided as indicated.

Safety and discharge pipework for hot water systems shall be laid with a continuous downward gradient.

Spring type safety valves

Valves shall be of the enclosed spring-loaded high lift type.

Valves up to 50mm nominal diameter shall be bronze or DZR copper alloy body as indicated and threaded to BS 21 and BS EN 10226-1.

Cast iron valves shall be flanged to BS EN 1092-2.

They shall have a screwed on or bolted on spring casing, carbon steel spring and a gun metal valve head, seat and adjustable screws and ferrule.

Valves shall be complete with a screwed on top cover, testing lever and padlock and shall have a discharge pipe of the same diameter as the valve which shall terminate 300 mm from the floor level.

The valve release pressure shall be set at a pressure above the system operating pressure. The spring range shall be selected to give equal adjustment either side of the operating pressure.

Valves shall be stamped with their set pressure and limiting temperature.

8.2.4 Isolating Valves (LTHW)

8.2.4.1 Ball Valves 15 mm up to 50mm

Type:	Ball valve
Body material:	Bronze or DZR brass (corrosion resistant)
Pressure rating:	PN25
End connections:	Threaded to BS EN 10226-1
Specification:	PTFE seat and packing

DZR brass ball

Mild steel (zinc plated) with PVC covered lever WRAS listed and BS kite mark approved.

Temperature range: -10°C to 100°C



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Operation: Lever operated, quarter turn, tight shut-off

Operation of the valve shall generally be by lever fitted with stop permitting a 90° movement of the ball between fully open and closed position. In areas where space is limited a T-handle shall be fitted. Valves on insulated pipework shall be provided with an extended stem in which the lever is held above the pipe insulation.

As indicated, valve spindles shall be suitable for operation by a screwdriver where the valve is liable to unauthorised use or lever operation.

8.2.4.2 Gate Valve 65mm And Above

Type: Gate valve to BS EN 1171

Body material: Cast iron

Pressure rating: PN6

End connections: Flanged to BS EN 1092-2

Specification: Wedge disk

Non-rising stem of manganese bronze

Inside screw

Bronze disc

Malleable iron hand-wheel

BSI kite mark approved

Operation: Hand-wheel

8.2.4.3 Butterfly Valve 65 Mm and Above

Type: Butterfly to EN 593

Body material: Cast iron

Pressure rating: PN16

Specification: Short wafer lugged type

WRAS approved EPDM liner

Stainless steel shaft and disc

WRAS approved

Operation: Lever operated up to 150 mm.

8.2.5 Valves for flow regulation

Valves shall be selected to produce the required pressure drop at between 50% and 75% of the fully open position.



8.2.5.1 Double Regulating Valve Up to And Including 50mm

Type:	Double regulating valve to BS 7350
Body material:	Bronze
Pressure rating:	PN20
Temperature range:	-10°C to 100°C
End connections:	Threaded to BS 21 and BS EN 10226-1
Specification:	Oblique or Y pattern

WRAS approved

Valves shall be of the screwed end pattern and shall be complete with position indicator and lockable adjustable setting position.

Where necessary, valves shall be selected for low flow conditions.

8.2.5.2 65mm And Above

Type:	Double regulating valve to BS 7350
Body material:	Cast iron
Pressure rating:	PN16
Temperature range:	-10°C to 120°C
End connections:	Flanged to BS EN 1092-2
Specification:	Oblique or Y pattern

Rising stem

Bolted on bonnet

Screwed boss into which an in-built drain cock/valve or air vent can be provided

Hand-wheel material: Cast iron

8.2.6 Check Valves

All valves shall have flow direction indicators and shall have a pressure rating to suit the maximum operating pressure of the system. Where used on systems with operating temperatures in excess of 65°C the disk and seating shall be suitable for the conditions.

Non-return valves shall be of the straight pattern, spring check type. Check valves shall be installed in horizontal pipework unless they are specifically selected for operation in vertical pipework. They shall be selected to present a low resistance to flow.

8.2.6.1 Up to And Including 50mm

Type:	Spring type check valve to BS 5154
Body material:	Bronze
Pressure rating:	PN25



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Temperature range: -10 to 100°C
End connections: BS21 taper
Specification: Metal disc; screwed in cap; BSI Kitemark

WRAS listed.

8.2.6.2 65mm and Above

Type: Swing pattern check valve to BS EN 12334
Body material: Cast iron
Pressure rating: PN16
Temperature range: -10 to 220°C
End connections: Flanged BS EN 1092-2
Specification: Cast iron disc; fibrous gasket.

8.2.7 Commissioning Sets

Commissioning sets shall comprise metering stations and double regulating valves installed in the positions indicated on the drawings or as stated elsewhere for the proportional balancing of heating and chilled water pipework systems.

The metering station shall be fitted to the upstream valve connection in accordance with the manufacturer's recommendations.

The Contractor shall submit, prior to ordering, a comprehensive schedule, prepared by the manufacturer, detailing the correct selection of each commissioning set in respect to signal pressure and valve position.

Flow measurement devices must always be sized using pressure differential – flow rate criteria and the general assumption that line size devices shall suffice shall not be acceptable.

Double regulating valves shall be selected to ensure that the required head absorption occurs at valve settings not less than 25% open.

Flow measurement devices should be selected and sized to meet the following requirements at the design flow rate:

The minimum pressure differential signal should not be less than 1kPa

The minimum head loss across the device should be consistent with the minimum pressure differential signal requirements

With water flow rates of 0.04 l/s or less, low flow measurement devices shall be used.

The accuracy of the flow rate derived from the pressure differential across the signal generating device shall be within $\pm 5\%$.

Where orifice valves are specified, these shall be used in their fully open position to ensure minimum pressure drop across the valve and the valve must provide positive shut-off.



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Commissioning sets shall be fitted in a straight length pipe run. The Contractor shall be responsible for obtaining from the flow measurement device manufacturer the appropriate number of pipe diameters to be allowed upstream and downstream of the device. Typical values are 10 pipe diameters downstream and 5 diameters upstream of any change in pipe direction to minimise the effect of turbulence on the pressure signals at the measuring device. Flow charts allowing the manometer readings to be converted into flow rates shall be provided for each size of measuring station.

The Contractor shall take due care throughout the installation and during the flushing and cleaning process to ensure that the flow measurement devices remain clean and undamaged.

Ensure that test points are not installed so as to become dirt traps. Where practical, high pressure test points shall point upwards to allow ease of venting.

8.2.7.1 Up to 50mm

Single unit commissioning valve with combined functions of regulation and flow measurement

Type:	Fixed orifice double regulating valve to BS 7350
Valve body material:	Bronze
Pressure rating:	PN25
Temperature range:	-10 to 100°C
End connections:	Threaded to BS 21
Specification:	Fitted with two insertion points allowing quick connection;
WRAS approved; integral orifice plate	

For water flow rates of 0.04 l/s or less, low flow measurement units shall be used

8.2.7.2 65mm and Above

Shall consist of a flanged oblique pattern double regulating valve complete with cast iron metering station installed on the return side of any circuit or sub-circuit

Type:	Fixed orifice double regulating valve and close coupled fixed orifice fitting manufactured to BS 7350
Valve body material:	Cast iron
Orifice plate:	Stainless steel orifice plate with two stainless steel extension tubes fitted with insertion test points
Pressure rating:	PN16
Temperature range:	-10 to 100°C
End connections:	Flanged BS EN 1092-2
Specification:	Cast iron disc; cast iron bonnet;
Hand-wheel material:	Cast iron



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Independent means shall be provided for positive isolation on pressure tapings.

8.2.7.3 Flow Measuring Device 15mm Up To 65mm

Type: Flow measuring device

Valve body material: Bronze

Pressure rating: PN25

Temperature range: -10 to 100°C

Specification: Fitted with two insertion points allowing quick connection; WRAS approved; integral orifice plate; flow measurement accuracy $\pm 3\%$

8.2.8 Isolating Valves (Potable Water, Hot and Cold-Water Services)

8.2.8.1 15 mm to 22 mm (Ball Valve Type)

Where stated elsewhere or on the drawings, isolating valves to appliances shall be of the ball valve type.

Type: Ball type valve

Body material: Bronze or DZR copper alloy body (chrome finish unless stated otherwise)

Pressure rating: Suitable for working pressures up to 16 bar

End connections: Threaded to BS 21 or compression to BS EN 1254 (BS 864) as applicable

Specification: Chrome or nickel plated DZR sphere with full bore aperture; PTFE seats and stem seals; shall be fitted with internal stop permitting a 90° movement of the ball between fully open and closed position; anti-blow out stem; WRAS approved;

Operation: Screw driver operated or key operated

8.2.8.2 15 mm to 50 mm (Ball Valve Type)

Type: Ball type valve

Body material: DZR copper alloy / DZR brass

Pressure rating: PN25

End connections: Threaded to BS21

Specification: Quarter turn; tight shut-off; chrome plated DZR copper alloy or brass sphere with full bore aperture; PTFE seats and stem seal; anti-blow out stem; WRAS approved;

Operation: Lever operated (in areas where space is limited a T- handle shall be fitted)



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Valves on insulated pipework shall be provided with an extended stem in which the lever is held above the pipeline insulation.

8.2.8.3 65 mm to 300 mm (Gate Valves)

Type:	Gate valve to BS EN 1171
Body material:	Cast iron
Pressure rating:	PN16
End connections:	Flanged to BS EN 1092-2
Specification:	Wedge disk; non-rising stem; inside screw; cast or malleable iron hand-wheel; BSI Kitemark
Operation:	Hand-wheel operated

8.2.8.4 65 mm and Above (Butterfly Valves)

Type:	Butterfly valve to BS EN 593
Body material:	Cast iron
Pressure rating:	PN16
Specification:	Lugged type; WRAS approved EPDM liner; stainless steel shaft; stainless steel disc; WRAS approved; lever and gear operated valves to be complete with long body neck for lagging clearance; good control characteristics.
Operation:	Lever operated up to 150 mm. Valves 200 mm and above shall be complete with gear unit.

8.2.9 Check Valves (Potable Hot and Cold-Water Services)

Check valves shall permit flow in one direction only and close automatically if flow reverses.

8.2.9.1 15 mm to 50 mm

Type:	Swing type check valve to BS 5154
Body material:	Gunmetal or bronze
Pressure rating:	PN 25 Series B
End connections:	Threaded to BS 21
Specification:	Metal disk; screwed in cap; metal to metal seat; WRAS approved; BSI Kite mark; flow direction indication.

Valves shall be suitable for mounting in horizontal and vertical pipe (with vertical flow upwards).



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Where specified elsewhere the disc material shall be nitrile rubber but restricted to 90 °C maximum temperature and WRAS approved.

8.2.9.2 Double Check Valves (Hot and Cold-Water Services)

Double check valves shall be used for the purpose of prevention of water contamination by back-siphonage, backflow or cross connection, shall be to BS 6282-1 and be WRAS approved.

The body material shall be bronze or DZR copper alloy with compression connections to BS EN 1254-2 or threaded to BS 21.

The valve shall be the in-line pattern type, be suitable for vertical or horizontal installation and provide positive closure.

8.2.10 Butterfly Valves

Valves shall be manufactured with cast iron bodies and comply with EN 593 with the pressure rating to suit the maximum operating pressure of the system

Valves shall be provided with lever operation up to 150mm diameter and gear operation on 200mm diameter and above.

The valve body liner shall be a WRAS approved EPDM liner with stainless steel disc and shaft. They shall be the short wafer lugged type and suitable for fitting between flanges complying with BS EN 1092, centrally located by the fixing bolts.

8.2.11 Float Operated Valves

All float operated valves and materials shall be WRAS approved.

When installed, float operated valves shall be capable of achieving the minimum air gap as required by the Water Supply Regulations.

Ball float valves shall be fitted with a servicing valve on the inlet.

Valves shall be manufactured from cast gunmetal or bronze of a dezincifiable grade.

To prevent back siphonage no connection of a dip tube or silencing pipe to the discharge port shall be permitted.

Float valves fitted to feed and expansion tanks shall be provided with an approved modified float arm such that it allows the float to move a sufficient distance to accept or allow the anticipated expansion/Contraction volume of water within the tank.

Float valves to WC cisterns shall be fitted with a collapsible silencing tube in compliance with BS 1212 - 3.

15 mm float operated valves shall be of the plastic body diaphragm type to BS 1212 unless stated otherwise. Plastic floats shall be to BS 2456.

22 mm and above float operated valves shall be the full-bore bronze or gunmetal body equilibrium pattern ball float type to BS 1212 with copper float to BS 1968.



8.2.12 Stop Valves 15mm – 50mm

Stop taps shall be manufactured in bronze or DZR copper alloy and the washer material shall be suitable for the service fluid and operating temperature. The valve shall be the straight pattern type with connections to suit the service pipeline.

Stop valves for potable water supplies shall be in accordance with BS EN 1213. The valves shall be the straight pattern type manufactured in copper alloy with connections to suit the service pipeline. Valves shall be easy clean polished finish where visible.

8.2.13 Draw-Off Cocks

15 mm – 50 mm draw-off cocks shall be the straight type, gland pattern, taper plug, with gunmetal or bronze body, threaded to BS 21 and complete with brass hose union outlet, screwed blank cap and strap. Plugs shall have a square head with a slot to indicate plug position. A loose malleable iron lever shall be provided with each plug valve. Each draw-off cock shall be hydraulically tested to 20 bar.

8.2.14 Flexible Pipe Connections (Up To 10 Bar And 100°C)

Flexible pipe compensators shall be installed on pipe connections to pumps, compressors, chillers, cooling towers, cooling and heating coils on air handling units supported on anti-vibration mounts.

Rubber bellows shall be a single convolution of multi-ply EPDM rubber with corrosion resistant steel wire mesh reinforced body.

The units shall be suitable for the working pressure and temperature.

The units shall have an indelible identification indicating manufacturer, date of manufacture, type, size, pressure rating and a batch number.

Ensure flexible connections have a design life of 10 years at 100 °C. Units shall be in accordance with DIN 4809 and after a service life of 10 years at 100 °C must have a burst pressure of not less than 30 bar.

Flanges shall be to BS EN 1092 and shall be able to swivel and be removable.

Threaded ends shall be to BS 21 with one union end.

Where untied bellows are used the manufacturers recommendations for anchors and guides shall be followed.

Tie bars shall be threaded and with adjustable length. Tie bars with rubber top hat washers shall be used where the working pressure exceeds 1.5 bar.

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

For working temperatures between 65°C and 90°C the bellows shall be steel wire mesh re enforced throughout and manufactured in accordance with DIN 4809.

For working temperatures up to 65°C the rubber bellows shall be high tensile synthetic fibre reinforced.

For hot water services the bellows liner shall be of a food grade butyl rubber.



8.3 Thermal Insulation

Thermal insulation shall be provided for the following functions:

- Inhibit freezing
- Prevent the formation of condensation on pipework, ductwork or equipment
- To protect personnel from exposure to extremes of temperature
- Conserve energy for both cooled and heated systems
- Control process temperatures

The Contractor shall ensure that all thermal insulation is made from materials with zero ozone depletion potential (CFC and HCFC free). The Thermal insulation level shall be at least 50% greater thermal efficiency than the minimum standard.

All insulation products shall maintain their thermal performance for a minimum of the plant design life.

All insulating material and associated products shall be applied in accordance with the manufacturer's recommendations and instructions. Definitions

Cold water:	Water delivered from the mains or natural supply
Warm air ducts:	Supply or return air ducts in which the air inside the duct is always above ambient.
Air conditioning ducts:	Supply or return air ductwork where the air may be cooled or dehumidified
Domestic hot water:	Hot water up to 60° C
LPHW:	Low pressure hot water for heating the building
Finishing materials:	Materials used to cover the insulation whether pre-applied or applied on site
Pre-applied covering:	Material applied to the insulation prior to delivery to the point of use
Vapour barrier :	Water vapour retarding layer
Surface temperature:	The temperature of the surface to be insulated is taken to be the temperature of the fluid inside the pipe, tank, duct, vessel or other piece of equipment unless otherwise stated

8.3.1 Workmanship

Thermal insulation work shall be undertaken by specialist firms who are members of the Thermal Insulation Contractors Association and employ skilled craftsman conversant with the class of work.

All thermal insulation materials shall be supplied by manufacturers assessed and registered in accordance with British Standard quality systems standards.



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All insulating material and associated products shall be applied in accordance with the manufacturer's recommendations and instructions.

Thermal insulation shall not be applied to pipework and ductwork services until:

The installation or sections of the installation have been fully pressure tested and all joints proved sound

The surface to be insulated has been cleaned, dried and is free of rust, scale and other foreign matter

All painting, where specified elsewhere, has been completed and is dry. Damage caused to pre-painted surfaces during installation shall be repaired at no additional cost

Copper pipework has been cleaned thoroughly to remove all traces of surplus jointing flux, building materials and debris, dust and moisture.

Protect all surrounding equipment during installation and leave the area clean and tidy.

Each pipe or duct shall be insulated separately and adjacent parallel pipes or ducts shall not be married together in one insulation covering. There shall be a minimum clearance of 25 mm between adjacent surfaces of insulation.

Where services pass through a fire compartment wall or floor the space between the pipework and the sleeve shall be completely filled with a certified fire resisting material having a performance equal to the fire rating of the structure. In this instance the thermal insulation shall not pass through the sleeve.

All materials delivered to site shall be new and kept dry, and maintained in this condition throughout the progress of the work. Materials shall be stored and adequately protected from damage or deterioration until installed. Protection shall also cover any adverse effects of environmental conditions prevalent in the stored and installed location.

All joints, surfaces, edges and overlaps shall be neatly finished. Where possible arrange overlaps to be on the 'blind' side and parallel to circumferential and longitudinal joints.

Where allowance for expansion and/or Contraction has to be accommodated, the insulation shall be finished in a neat and approved manner permitting easy access and disconnection of removable items without disturbing adjacent insulation.

All insulation work shall be to a good standard and the insulating materials, coverings and/or coatings shall be of a uniform thickness throughout.

All insulation shall be complete with a smooth and clean finished surface, no damaged ends or edges and with no irregularities in the thickness of the insulating material or in the material covering. Rigid sections shall be concentric and accurately matched.

Three sections of each type of insulation shall be cut out for inspection to ensure that the correct thickness has been. If the inspection reveals any defects the Contractor shall cut out a further three sections for inspection. If these also prove defective, then the insulation shall be rejected and all insulation shall be stripped off and reinstated at the Contractor's expense and with no delay to the programme.

All insulation joints shall be installed close butted together. Sections having damaged ends or edges shall not be accepted.



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Filling voids with adhesive, joint sealer or mastic shall not be accepted.

Pipework and ductwork supports are to be provided with inserts, to match the insulation thickness, to enable the insulation finishes to be continuous through the supports.

All support brackets for cold services pipework and ducting shall be provided with purpose designed load bearing high density phenolic foam inserts to facilitate installation of a continuous thickness of vapour sealed insulation and finish.

All connections and brackets for sensors, equipment labels and other pipe, duct or equipment mounted accessories shall be extended to project past the insulation thickness and enable items and accessories to be fitted or removed without disturbing the insulation or cladding.

Insulation applied to vessels and pipeline and ductwork ancillaries shall be neatly cut and finished around all manufacturers name and test plates, test points, and dampers to leave these visible.

Where an insulated duct or pipe penetrates the building, adequate precautions shall be taken to prevent the entry of water.

The Contractor shall ensure that all insulating materials, adhesives and finishes specified herein or added to this Contract conform with the requirements of the Local Authority. Installed insulation that is rejected by the Local Authority, shall be stripped out, replaced with acceptable materials at the Contractor's expense and with no delay to the programme.

8.3.2 Fire Performance

Insulation materials shall have a European Classification for reaction to fire performance of A1, A2, or B and should not have a potential to flashover.

All insulation materials installed inside buildings and building service ducts shall conform to Class O (unassisted by facing material) in accordance with the Building Regulations.

The complete assembly of materials, as installed, shall satisfy the 'spread of flame' requirements to Class 1 of BS 476-7.

The insulating material itself (i.e. without any facing) shall satisfy the 'spread of flame' requirements to Class 1 of BS 476-7.

All insulation materials, adhesives, sealants and facings installed shall have a smoke obscuration rating less than 5% when tested in accordance with BS EN ISO 5659-2.

Where fire and surface spread of flame certificates relate to factory made products, ensure that the certificates are valid where materials are incorporated in pre-insulated equipment.

If there is a potential hazard from contamination by oil or other flammable chemicals, a suitably resistant finish, e.g. a metal sheet or appropriate non-absorbent coating, shall be applied over the vulnerable areas. The lapped joints of sheet finishes shall be arranged to shed contaminating fluids away from the insulating material.



8.3.3 Vapour Barrier

On surfaces operating below ambient temperature a complete vapour barrier seal shall be provided.

The vapour barrier shall take the form of a coating or sheet material.

Vapour barriers shall be continuous and the integrity maintained. Where this is not possible, the vapour barrier shall be effectively sealed to the pipe to prevent any ingress of moisture or water vapour.

External vapour barriers shall be pre-applied or applied immediately after fitting the insulating material and before the fluid in the pipe, duct, or vessel is cooled.

The function of an external vapour barrier shall not be compromised by its additional use for other purposes e.g. as a form of weather protection or as mechanical protection for the thermal insulation. Separate layers, in the form of coatings or sheet material, shall be used for the individual purposes. Where such additional protection is required, the Contractor shall ensure that its application does not cause any damage to the vapour barrier during installation and is unlikely to cause damage in service.

The vapour barrier shall not reduce the fire performance of the system as installed below the limit specified as appropriate to the type of application.

The values for water vapour permeance of barriers shall be as BS 5422: 2001

8.3.4 Materials

All insulated services at all levels in the plantrooms are to be aluminium clad, with hammered finish.

All services in risers, services walkways and ceiling voids are to be aluminium foil faced.

The complete pipework and ductwork installation shall be insulated using Phenolic Foam.

All Phenolic foam shall be CFC and HCFC free.

Phenolic Foam pipe and duct insulation shall have a thermal conductivity of not more than 0.02W/mK at 10°C mean temperature.

All Phenolic Foam pipe insulation shall have a minimum density of 35kg/m³.

All duct insulation shall be a nominal density of 40kg/m³.

The perpendicular compressive strength shall not be less than 150kN/m² for pipe insulation and 100kN/m² for duct insulation.

Expanded Nitrile Rubber

Expanded Nitrile Rubber shall be used only on refrigeration plant and pipe work, subject to surface spread of flame restrictions.

All external refrigeration pipe work shall be provided with a painted finish as protection against U.V. degradation.



8.3.5 Insulation Thickness

Thickness of insulation shall be in accordance with BS 5422: 2001.

Pipe nominal diameters stated in insulation thickness tables are based upon steel pipework. Where copper or plastic pipework is used the equivalent outside diameter of the pipe shall be used. Reference should be made to BS EN 10255 and BS EN 10220.

If the thickness given in, or interpolated from, the tables in the British Standard or the Specification do not correspond with available thickness, the nearest higher available thickness shall be used.

In multi-layer applications, where material thickness is rounded up to suit available commercial thickness, the Contractor shall ensure by calculation (in accordance with the appropriate British Standard) that each interface temperature is below the maximum continuous operating temperature of the materials involved.

Minimum insulation thickness for chilled and cold-water supplies to prevent condensation (BS 5422: 2001 Table 8)

8.3.6 Heating and Hot Water Pipework

8.3.6.1 Internal Pipework (Concealed)

Pipework shall be insulated with approved rigid preformed pipe sections having a factory applied bright Class 'O' foil facing.

Sections shall be close butted and all longitudinal and circumferential joints sealed with 'Class 'O' aluminium foil self-adhesive tape applied over a clean surface and firmly pressed down. The minimum width of aluminium foil tape shall be 50mm. Where provided, the longitudinal joint overlap shall be sealed with a suitable adhesive to the manufacturer's recommendations.

Sections shall be firmly secured by additional bands of aluminium foil tape applied circumferentially at not greater than 300 mm centres, ensuring a minimum of three self-adhesive bands per metre run.

The insulation shall be further retained in position by light gauge aluminium bands at a maximum of 450 mm spacing and not nearer than 50 mm to the end of the section.

All bends, sets, tees and elbows are to be correctly mitred and segmented with insulation to the necessary thickness to match the adjoining. All joints to be securely sealed with 50 mm wide Class 'O' aluminium foil self-adhesive tape.

The insulation shall not be left exposed at termination points. Insulation edges shall be over taped and returned and adhered to the exposed insulation face. Ensure the aluminium foil does not come into contact with the insulated metal face.

Bends, fittings, flanges and pipe clips shall also be insulated with preformed sections of foil faced insulation, cut to suit on site with joints sealed with adhesive and matching self-adhesive tape. Bends shall be insulated with mitred segments.

If cold and damp conditions are anticipated during installation, consideration shall be given to utilising a Class 'O' aluminium foil tape with an acrylic adhesive.



8.3.7 Cold Water Pipework.

8.3.7.1 Internal Pipework (Concealed)

Pipework shall be insulated with approved rigid preformed pipe sections having a factory applied bright Class 'O' foil facing to form a continuous vapour barrier.

Sections shall be close butted and all longitudinal and circumferential joints sealed with 'Class 'O' aluminium foil self-adhesive tape applied over a clean surface and firmly pressed down. The minimum width of aluminium foil tape shall be 50mm. Where provided, the longitudinal joint overlap shall be sealed with a suitable adhesive to the manufacturer's recommendations.

Sections shall be firmly secured by additional bands of aluminium foil tape applied circumferentially at not greater than 300 mm centres, ensuring a minimum of three self-adhesive bands per cut section.

All bends, sets, tees and elbows are to be correctly mitred and segmented with insulation to the necessary thickness to match the adjoining. All joints to be securely sealed with 50 mm wide Class 'O' aluminium foil self-adhesive tape.

The insulation shall not be left exposed at termination points. Insulation edges shall be over taped and returned and adhered to the exposed insulation face. Ensure the aluminium foil does not come into contact with the insulated metal face.

Bends, fittings, flanges and pipe clips shall also be insulated with preformed sections of foil faced insulation, cut to suit on site with joints sealed with adhesive and matching self-adhesive tape. Bends shall be insulated with mitred segments.

If cold and damp conditions are anticipated during installation, consideration shall be given to utilising a Class 'O' aluminium foil tape with an acrylic adhesive.

All ends of the insulation and points where the covering is penetrated shall be sealed so that the continuity of the vapour barrier is maintained.

Particular care shall be taken to vapour seal insulation termination points on pipework, valves and equipment operating below ambient temperature. A suitable vapour barrier sealant shall be applied to moisture proof the interface between the insulation and the underneath metal face at all termination points and the vapour barrier shall be returned affectively and sealed to the butt end of the insulation section as not to allow any ingress of moisture or water vapour.

All metal parts of valves, strainer caps, etc., projecting beyond the insulation shall be painted with an approved anti-condensation compound. All mild steel pipework prior to being insulated shall be painted two coats of red oxide paint. Particular care shall be taken to ensure neither water nor water vapour enter the insulation system via valve spindles etc.

8.3.8 External Pipework

Pipework shall be insulated with approved rigid preformed pipe sections having a factory applied bright Class 'O' aluminium foil facing as for internal pipework and finally protected with aluminium cladding or polyisobutylene (PIB) sheeting



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Workmanship and installation requirements for preformed pipe sections shall be as stated elsewhere for internal pipework except aluminium bands are not required.

All joints and protrusions through the cladding shall be sealed with an approved sealant to provide a water and weatherproof finish. The cladding shall be additionally secured with metal banding at 450mm centres. The banding shall be selected to complement the sheet cladding and not contribute to bi-metal corrosion.

Particular care shall be taken to vapour seal insulation termination points on pipework, valves and equipment operating below ambient temperature.

External Pipework and Pipework in purpose built external trenches

All pipework shall be insulated with rigid preformed Class 'O' aluminium foil faced pipe sections and finally protected with polyisobutylene (PIB) sheeting.

Workmanship and installation requirements for preformed pipe sections shall be as stated elsewhere for internal pipework except aluminium bands are not required.

Particular care shall be taken to vapour seal insulation termination points on pipework, valves and equipment operating below ambient temperature.

8.3.9 Tanks and Cisterns

Cold water storage tanks and cisterns shall be insulated with either:

Phenolic foam insulation having a factory applied bright Class 'O' reinforced aluminium facing complying with BS 5422: 2023 and BS 5970 water vapour permeance

Thickness of insulation shall be in accordance with BS 5422: 2023.

Insulation shall be bonded to tank sides by means of suitable adhesive, applied in accordance with the manufacturer's requirements.

All insulation slabs shall be closely butted together and joints sealed by means of matching self-adhesive tape 100mm. wide. Any exposed edges of the insulation and any points where the covering is penetrated shall be sealed, using a suitable sealant.

Tanks shall be insulated on the sides and top only - not on their undersides.

Insulation for loose covers and access manholes shall be made in separate sections completely removable.

The insulation shall be protected on the four vertical corners with 75mm. x 75mm. aluminium angles.

The insulation surfaces by means aluminium sheeting, all overlaps being secured with sheridised self-tapping PK. screws or pop rivets.

Ensure the vapour barrier is not damaged when applying the sheet metal cladding.



8.3.10 Insulated Support Blocks

At the points of support where insulation bears the weight of pipework and contents, purpose designed load bearing, high density blocks of an approved material shall be installed at all support positions to facilitate installation of a continuous thickness of vapour sealed insulation and finish.

The pipe insulation shall be butted up to the block and the joints sealed with a suitable adhesive tape to provide a continuous vapour seal through the support.

Sharp edges on metal support brackets/clips shall be ground smooth to ensure that the brackets/clips do not perforate the foil facing, thus destroying the vapour seal.

Where pipework is supported on steel bearers/rollers, purpose designed high density blocks of an approved material fitted with galvanised metal wearing plates shall be used. The support blocks shall be butt jointed, wrapped with adhesive tape and vapour sealed.

8.3.11 Flexible Thermal Insulation Jackets

Heating and hot water valves up to 50 mm shall be provided with flexible thermal insulation jackets as specified.

Flexible thermal insulation jackets shall be secured by way of draw string collars and Velcro fasteners. The outer layer of the valve cover shall be aluminised polyester film coated glass fabric. The inner layer shall be a woven glass fibre fabric, capable of withstanding a continuous hot face temperature of 260 °C. Flexible thermal insulation jackets shall be removable and reusable.

8.3.12 Polyisobutylene (PIB) Sheeting

Polyisobutylene (PIB) sheeting shall have a minimum thickness of 0.8mm and of tensile strength not less than 3.4 MN/m² lapped on all circumferential and longitudinal joints and sealed using a solvent/cold welding agent. Points where the PIB sheeting is penetrated due to protrusions shall be sealed with a suitable sealant to the manufacturer's recommendations.

Adhesives and welding agents used shall as recommended by the Polyisobutylene (PIB) sheeting manufacturer. Under no circumstances shall an alternative adhesive or welding agent be permitted.

PIB shall be applied in accordance with the manufacturer's instructions.

8.4 Flue Installation

Twin wall stainless steel flues shall be installed in line with manufacturers requirements and in accordance with the Approved Document Part J.

Flue systems shall be installed by a Specialist Contractor who is to be Gas Safe Registered and to be a Quality Assured 9002 registered company. All work is to comply with the Clean Air Act Memorandum. The Clean Air Act and the updated Institute of Gas Engineers UP 10.

All joints to have proprietary seals, cover/ locking bands, as applicable

The installation shall comply fully with BS5854 Code of Practice for Flues and Flue



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All penetrations through the fabric shall be fully flashed and weather proofed. The installation shall comply fully with the boiler manufactures requirements.

The flue system shall be independently supported from the structure via purpose made brackets with drop rods/floor supports/wall brackets as necessary.

Prior to manufacture of the flue system, fully detailed working drawings shall be issued to all relevant parties for approval.

Test points shall be provided. The mechanical Services contractor shall be responsible for the balancing and commissioning of the flue system once the flue system is put into operation.

The Contractor shall include for a complete installation to suit the programme including all necessary scaffolding. Builders work, breaking into chimneys and reinstatement of any fire stopping to form a complete installation including making good of the openings.

8.5 Identification of Services

All methods of identification shall be compatible with the pipe and operating conditions.

Identification of services shall comply with BS1710 and BS 4800.

When it is required to supplement the warning colour with warning sign to comply with statutory requirements reference should be made to BS 5499: Part 5.

Identification bands shall be applied in a logical and tidy manner with lettering and flow arrows clearly visible. Where several pipelines are installed in parallel to each other the identification bands shall be applied at the same location on each pipe.

8.5.1 Valve Labels and Charts

Each valve in plantrooms shall be provided with a label indicating the service being controlled, together with a reference number corresponding with that shown on the valve chart(s) and record drawings. The labels shall be made from 3 ply (black/white/black) traffolyte material showing white letters and figures on a black background. Labels shall be tied to each valve with chromium plated linked chain.

A wall mounted, glass covered plan shall be provided and displayed in each plantroom showing the plant layout with pipework, valve diagram and valve schedule indicating size, service, duty, etc.

8.5.2 Identification of Services

Pipework and ductwork shall be identified by colour bands 150mm. wide or colour triangles of at least 150mm/side. The bands or triangles shall be applied at termination points, junctions, entries and exits of plantrooms, walls and ducts, and control points to readily identify the service, but spacing shall not exceed 4.0 metres.

8.5.3 Pipework Services

Basic Colours for Pipeline Identification:

Water	12 D 45	Green
Steam	10 A 03	Silver-grey



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Oils	06 C 39	Brown
Gas	08 C 35	Yellow/Brown
Air	20 E 51	Blue
Drainage	00 E 53	Black
Electrical	06 E 51	Orange

Colour code indicator bands shall be applied as colour bands over the basic identification colour in the various combinations as listed below:

Water Services:	
Cooling	00 E 55
Fresh/drinking	18 E 53
Condensate	04 D 45/14 E 53/04 D 45
Central Heating Services (below 100 degC)	18 E 53/04 D 45/18 E 53
Cold water storage tanks:	00 E 55/18 E 53/00 E 55
Hot water supply	00 E 55/04 D 45/00 E 55
Oils: Diesel	00 E 55
Drainage and other fluids:	Basic colour only
Electrical Services:	Basic colour only

In addition to the colour bands specified above all pipework shall be legibly marked with black or white letters to indicate the type of service and the direction of flow, identified as follows:

Low temperature hot water	LTHW
Condensate	Condensate
Domestic hot water service	HWS
Potable water	MWS
Cold water down service	CWDS
Harvested rainwater	RW

Pipes shall have the letters 'F' and 'R' added to indicate flow and return respectively as well as directional arrows.

The size of the symbol shall depend on the size of the duct and the viewing distance but the minimum size should not be less than 150mm. length per side. One apex of the triangle shall point in the direction of airflow.

Conditioned Air	Red and Blue	04 E 53/18 E 53
Warm Air	Yellow	10 E 53



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Fresh Air	Green	14 E 53
Exhaust / Extract Air	Grey	AA 0 09
Foul Air	Brown	06 C 39
Dual duct system		
hot supply air	Red	04 E 53
cold supply air	Blue	18 E 53

In addition to the colour triangles specified above all ductwork shall be legibly marked with black or white letters to indicate the type of service, identified as follows:

Supply air	S
Return air	R
Fresh air	F
Exhaust air	E

The colour banding and triangles shall be manufactured from self-adhesive cellulose tape, laminated with a layer of transparent ethyl cellulose tape.

8.5.4 Identification of Plant

Each item of plant and equipment shall be labelled with a traffolyte or metal label indicating its unique reference code as used in the operating and maintenance documentation, together with a barcode label, see controls Specification.

The plant numbering system shall be agreed with the Project Manager prior to the commencement of the Works.

All items of plant and equipment shall be provided with a manufacturer's nameplate indicating the plant type, reference, serial number, year of manufacturer, performance and electrical data.

Pressure vessels which have been hydraulically tested at the manufacturer's works shall indicate the test pressure, working pressure and date of test.

8.6 Pipe Cleaning and Water Treatment

This section covers the water treatment of heating, hot and cold-water pipework systems.

Use a water treatment specialist, for the analysis, design, supply, installation and operation of any system cleaning and chemical treatment process.

The Contractor shall:



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- Ensure the water treatment and pipe cleaning processes comply with statutory authority, COSHH Regulations and health and safety requirements.
- Pre-commission cleaning of heating and cooling pipework systems shall be carried out in accordance with BSRIA Application Guide AG 1/2001.1 Pre-commission cleaning of pipework systems.

The recommendations of BSRIA Application Guide AG 2/93 shall be consulted in the selection of chemicals for corrosion control.

The Contractor shall before commencement of the works:

- Provide a detailed method statement within the operating and maintenance manual for the chemical cleaning and ongoing water quality treatment for the water systems provided under the Contract. The method statement shall include the maximum agreed Pseudomonas (cfu/l) and TVC (cfu/l) levels.
- Determine the potential for partial or phased cleaning of a system and locate suitable isolating valves to prevent cross contamination
- Provide details of the method by which flushing velocities are to be achieved, i.e. pumping requirements and motor power requirement for temporary pumping facilities
- Agree witnessing and reporting stages for confirmation that system cleaning is being conducted in accordance with the agreed procedure, and that the results are acceptable
- Obtain approval from the local Water Authority for the disposal of contaminated flushing water, and in particular, for the disposal of cleaning chemicals. If approval cannot be obtained, make preparations for removal of the waste by other means.
- Ensure that the flushing and chemical cleaning procedures are planned so that the whole operation is carried out as a continuous process, i.e. there are no delays during the flushing stage, or between the flushing and chemical cleaning stages. Chemical cleaning must be carried out immediately after the pre-flush.

During the fabrication and installation of pipework systems, the Contractor shall comply with the recommended Codes of Practice and take sufficient care to prevent the ingress of extraneous matter.

Chemical cleaning shall not be undertaken unless the system has been thoroughly clean-water flushed to the satisfaction of the cleaning specialist. Notify manufacturers and suppliers of equipment of proposed system cleaning and chemical treatment processes. Establish for all equipment requirements of any particular cleaning and chemical treatment process due to size of waterways or materials used.

All chemicals for system cleaning, corrosion inhibition and bacteria control must be selected by a water treatment and chemical cleaning specialist and agreed prior to commencement of the works.

Maintain progressive records of a staged cleaning process.

It is the responsibility of the Contractor to advise the water treatment specialist of the materials used in the construction of the plant and systems.

Comply with the Water Supply Regulations in undertaking cleaning and flushing activities.

8.6.1 Inspection and Witnessing

The Contractor shall ensure that inspection and witnessing of the cleaning process shall be conducted as the work is in progress and shall be carried out in accordance with BSRIA Application Guide AG 1/2001.1.



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The Contractor shall advise the Clerk of Work, at least five working days in advance of flushing and cleaning activities so procedures can be witnessed.

8.6.2 Water Samples

The Contractor shall carry out all necessary tests to ensure that cleaning and chemical treatments are operating as required.

All water samples taken for chemical and microbiological analysis shall be submitted to an independent laboratory. The laboratory used shall have NAMAS accreditation or equivalent for the tests to be undertaken.

Results shall be submitted to the Project Manager for review, if poor results are obtained, then remedial action shall be taken at no additional cost to the Contract. Under this condition tests shall continue until stability of the system(s) is proved.

Water samples from agreed locations shall be taken throughout the cleaning process to prove the quality and chemical and microbiological stability of the systems. Water samples shall be taken from representative system extremities and low points.

Prior to commencement of the Works on site obtain an analysis of mains water taken from the site supply point and ensure the results are typical for the site location with the local water authority. Submit a sample of water to the water treatment specialist.

8.6.3 Mains Water

An adequate supply of mains water should be made available for flushing.

Back-flow protection in compliance with the Water Supply Regulations must be provided between the incoming mains connection and systems fill point.

All temporary mains shall be cleaned and chlorinated in accordance with BS 6700 and BS BS EN 806 before being used for system filling.

Where the quality of the mains water is not satisfactory, a biocide dosed, temporary supply of fill water to reduce risk of bacterial contamination shall be provided.

8.6.4 Pseudomonas and Closed Systems

Water samples shall be taken from the proposed source of water for testing, flushing and final filling before the Works commence and shall be tested for Pseudomonas bacteria. The laboratory used shall have NAMAS accreditation or equivalent for the tests to be undertaken. The test results shall be submitted to the Project Manager before commencement of the Works.

On Pseudomonas being detected, a method statement detailing testing, sourcing and treatment regimens shall be agreed with the Project Manager in time for the procedures to be incorporated within the construction programme.

The Tenderer shall include two sums within the Tender for:

- Undertaking the necessary treatment to overcome a Pseudomonas contamination
- Providing and maintaining a temporary water treatment plant on site for initial filling and hydraulic testing. The plant shall be maintained until Practical Completion.

If no contamination is found at the time of Practical Completion the sums shall be removed by instruction.



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Before Practical Completion, the Contractor shall commission a final water analysis report based on samples taken. The report shall demonstrate that the systems do not contain any microbiological activity and are in accordance with the water treatment specialist's recommendations. If microbiological activity is still present, the systems shall be retreated and tested until clear.

8.6.5 Preliminary Checks

Prior to the cleaning and chemical treatment process, the Contractor shall ensure that:

No damage can occur to any item of plant or equipment due to the cleaning and/or chemical treatment process or blockage due to cleaning. Equipment or fittings that shall restrict the cleaning procedures or shall be subject to damage must be either by-passed or removed, and the flow and return connections cross connected unless otherwise stated. The extent of these measures and any others that could restrict effective circulation shall be discussed and agreed prior to carrying out the cleaning process.

All foreign matter is removed.

Certified pressure tests have been undertaken.

Chemicals to be used are compatible with system materials and equipment and approved.

All necessary temporary by-passes are provided.

All drains provided have been tested and approved together with any associated pumping equipment.

Adequately sized drains are fitted at all low points that cannot be emptied via the main drains.

Temporary strainers and filters are installed as required for removal of solids during the cleaning and/or chemical treatment process.

Dirt pockets are installed at low points to facilitate removal of solids and are complete with drain valve to pipework size.

All automatic/manual air vents are fully commissioned.

All necessary electrical supplies are available to undertake the works.

Dead legs more than 3 pipe diameters in length are looped to allow effective cleaning. Connections shall be of a similar bore to the pipework.

Adequate and safe means of access is provided to the pipework system during the cleaning and chemical treatment process.

Circulation has been demonstrated and approval obtained on all parts of the system.

All necessary approved precautions are undertaken where there is a risk of freezing.

8.6.6 Disposal of Chemicals

The Contractor shall obtain all necessary permissions from the local Water Authority before any chemical is discharged into public foul or surface water drains and comply with the requirements of all necessary legislation.

The Contractor shall make applications to all necessary authorities and provide details of the chemicals to be discharged, the maximum quantity, the maximum rate of discharge, the temperature, and the proposed date on which the discharge shall take place.



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Where required by the local water authority, provide effluent tanks for storage of all waste products of cleaning and chemical cleaning processes.

Upon local water authority approval, either dispose to drain of all waste products after neutralizing to the required standard or ensure authorised disposal at registered sites.

8.6.7 Treatment Prior To System Handover

Prior to handover the Contractor shall be responsible for regular monitoring of water quality and ensuring the system water is circulated and if necessary, further dosed until the system is handed over and put into normal use. This may also necessitate the provision of all necessary precautions to prevent freezing.

Prior to handover the water in each system shall be analysed to confirm that the correct condition and chemical concentration has been achieved, before a completion certificate is issued.

Water sampling procedures shall be as stated elsewhere.

8.6.8 Initial Flushing of Pipework

The Contractor shall be responsible for thoroughly flushing with mains cold water to a satisfactory quality, via a break tank, all pipework to remove traces of loose dirt, scale and extraneous matter, prior to pre-commission cleaning and placing into operation the various pipework systems.

Flushing of water systems shall be carried out in accordance with BSRIA Application Guide AG 1/2001.1.

8.6.9 Pre-Commission Flushing and Chemical Cleaning

The Contractor after completing the initial flushing of the heating and chilled water pipework services the Contractor shall arrange for the water treatment specialist to carry out the pre-commission flushing and chemical cleaning of the pipework systems.

Pre-commission flushing and chemical cleaning procedures shall be in accordance with BSRIA Application Guide AG 1/2001.1.

8.6.10 Sterilization of Domestic Water Pipework Systems

All cold-water mains, rising mains, storage tanks, cold water down services and hot water services pipework systems used for domestic purposes shall be sterilized by a water treatment specialist in accordance with BS. 6700 and the requirements of the local water authority.

Prior to sterilization ensure each system is flushed, cleaned and drained.

Following sterilization submit samples for microbiological analysis to an independent laboratory. The laboratory used shall have NAMAS accreditation or equivalent for the tests to be undertaken. Results shall be submitted to the Project Manager for review, if poor results are obtained, then remedial action shall be taken at no additional cost to the Contract.

Immediately prior to handover, retake samples and submit for analysis and report. Where necessary repeat the sterilisation of potable water system(s) immediately prior to handover.

The following basic information shall be provided to the water treatment specialist by the Contractor to enable the extent of the sterilization process to be fully assessed:



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- Building description, gross area and number of stories
- Total capacity of each of the system to be treated
- Location, type, size and number of draw-off points served by:
- Incoming cold water main
- Storage tank(s)

Systems to be treated in one visit to site.

The following facilities shall be provided to enable the water treatment specialist to carry out the sterilisation process:

- Should the local water authority not permit the opening of the town main isolating valve until the incoming main and rising main have been sterilised (to avoid the possibility of contaminating the town main) an adequate supply of water must be arranged from an independent source. The cost for any such arrangement shall be included in the Contract price.
- For chlorination of tanks and down services the town main supply may be used subject to the approval of the local water authority.
- Provide a suitable electrical supply for the operation of associated equipment.

It is the responsibility of the Contractor to ensure all components of the system(s) are completely sterilized.

Provide a 22 mm valved drain connection on the incoming main immediately downstream of the mains isolating valve.

Ensure unrestricted access to all draw-off points during the whole of the process.

It is the responsibility of the Contractor to ensure that all tanks are cleaned, the systems have been flushed with clean water to remove all debris, refilled and pressure tested before the water treatment specialist attends site.

The Contractor's attention is drawn to the importance of carrying out a thorough initial cleaning of all systems using mains cold water from an independent source to avoid the possibility of re-chlorination.

The Contractor shall ensure:

- Deposits of iron oxide or other foreign materials such as brick dust, cement, etc., all of which allows the "hide-out" of bacteria in pipework systems have been thoroughly flushed out.
- Tanks are cleaned of extraneous matter and left in a thoroughly clean condition.

8.6.11 Cold Water Installations

The Contractor shall comply with the latest Water Regulations and ensure that:

- Water storage tanks are situated in cool locations, shaded from sunlight.
- Water storage tank rooms are adequately ventilated either by natural or mechanical means, dependent on location.
- Cisterns and tanks are insulated to ensure water in storage is held below 20°C.



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- Equal flow occurs through each tank on a multi tank coupled installation.
- Ball valves are installed on the opposite side of the tank to the outlet pipe to minimise the risk of static water.
- All distribution pipework is insulated.
- Dead legs to drinking water points, low water consuming fixtures, showers and spray taps do not exist.
- Pipes are installed to falls to avoid air locks.

8.6.12 Hot Water Installations

Construction of calorifiers and cylinders include the following features:

- Bolted access doors for cleaning purposes
- Sparge pipe on cold feed inlets to avoid stagnation
- Drain valves sized to drain the contents of water within 30 minutes in order to remove sludge and debris. On large calorifiers longer periods may be permitted.
- Bottoms to be convex - concave bottoms should be avoided.
- Where duplicate vessels are employed, equal flow rates must be achieved through each calorifier or cylinder.
- Minimise the lengths of dead legs, especially to showers, spray taps and low water consuming fixtures.
- Secondary pumped return connections to extend beyond the last draw-off connection on branches.
- Install pipes to falls to avoid air locks.
- Control the storage of water at 60°C and maintain return water at not less than 50°C.
- Avoid temperatures of storage water exceeding 60°C in order to prevent excessive corrosion and scale formation.

Should the Contractor have any queries relating to the above provisions, these must be discussed and approved prior to commencement of the works.

8.6.13 Dosing Pots

Dosing pots shall be a fabricated welded steel container manufactured with welded end caps and complete with:

- air cock
- conical filling funnel
- non-return valve at the base
- flow and return valves including connections
- drain valve

The dosing pot shall be suitable for the system operating pressures.

Dosing pot shall be installed between the flow and return lines in accordance with the manufacturer's recommendations to ensure satisfactory mixing of the concentrated chemical solution with the total



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water capacities of the systems. The unit shall be located in a convenient, fully accessible position, either fixed by wall brackets or suitably supported on a mild steel angle iron stand from plantroom floor

The dosage pots shall be of the following sizes unless stated otherwise:

- System volume up to 2000 litres 2.5 litre dosing pot
- System volume more than 2000 litres 10.5 litre dosing pot

8.7 Inspection, Testing and Commissioning

8.7.1 Definitions

Where used in the Specification the following definitions shall apply:

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. This 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 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. This may include the re-assessment of design values and control set points to achieve the required system performance.

Pre-commissioning checks: Systematic checking of a completed installation to establish its suitability for commissioning.

8.7.2 General Requirements

The entire commissioning and performance testing of the Works shall be undertaken by an approved commissioning specialist employed by the Contractor. The Contractor shall be responsible at all times for the supervision of the commissioning specialist and providing all necessary attendances.

The Contractor shall ensure satisfactory completion of the testing and commissioning together with the recording of results.



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The Contractor shall appoint a “competent person” to supervise the whole of the testing, commissioning, system proving, system demonstration and instruction of the employer’s staff.

Co-ordinate the activities of all specialised personnel, including manufacturer’s representatives, together with providing any attendance required.

The Contractor shall undertake the following:

- Testing, pre-commissioning checks, commissioning, regulation and setting to work of the Works
- Prepare comprehensive programmes, commissioning plans, schedules and method statements and procedures supported by risk assessments for the pre-commissioning checks, setting to work, commissioning, system proving and environmental testing of the complete Works
- Monitor progress against the program of works and provide weekly reports detailing progress of testing and commissioning activities
- Maintain a diary/log of all significant activities and document any faults, snags or queries and how these were resolved. The diary/log shall be fully noted and available for inspection at any time.
- Measure and reconcile noise levels at agreed locations to verify compliance with design criteria
- Ensure all certification is attained and witnessed as necessary for inclusion in the record documentation
- Provide and submit a report for every test, demonstration, balance or commissioning activity witnessed, together with an engineering appraisal on the performance, either on or off-site
- As necessary co-ordinate and liaise with the Employer’s representative
- Co-ordinate, give notice and obtain all approvals from the necessary authorities

Performance testing, system demonstration, system proving or environmental and capacity testing, commissioning of the system must be completed.

All works shall be verified in accordance with Building Regulations Approved Document Part L (specific section(s) appropriate to the project).

If the Works include extensions, modifications or alterations to existing systems the Contractor shall allow for the balancing and commissioning of the new works in conjunction with the re-balancing of the existing works.

The object of the witnessing stage shall establish a level of confidence in the commissioning results being presented.

If the tests fail to demonstrate that the plant and equipment are properly installed and functioning correctly, the cause of the failure shall be investigated. Should the failure be due to incorrect or faulty work then without delay, carry out such remedial measures and adjustments as may be necessary and repeat the commissioning and testing procedure.

Where it is not possible at the particular time of commissioning and testing for full load conditions to be obtained or simulated, undertake to repeat such operations of full load or a simulation thereof at a time when this can be achieved as agreed.

The Works shall be fully tested, commissioned and be fully operational prior to witnessing and inspection.



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Where portions of the work are required to be commissioned and tested separately, then upon final completion, demonstrate that all the several portions are capable of proper simultaneous operation in accordance with the requirements of the Specification.

In cases where the construction programme is such that the commissioning, testing, balancing, adjustment, requires to be undertaken in an area of the building taken over and occupied by the Employer, then take all necessary precautions against and be responsible for any damage caused whilst working in such areas for that purpose.

All certification documents shall be submitted to the Project Manager for examination before any system is offered for final acceptance.

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

The Contractor shall ensure that all testing and commissioning undertaken on specialist equipment by a manufacturer is completed to the satisfaction of the commissioning specialist.

Any special equipment not covered by clauses in this section of the Specification shall be tested in accordance with the manufacturer's recommendations and with any particular clauses stated elsewhere.

Include for carrying out the tests as stated, together with such additional inspections and tests during the process of manufacturing, erection or otherwise, to prove the physical characteristics of all materials and manufactured parts incorporated in the works to ensure the overall suitability of all equipment, and to satisfy the requirements of the Local Authority.

All costs, apparatus, measuring equipment, instruments, and meters required for inspection, testing, balancing, regulation, setting up, etc., of the systems shall be deemed to be included for by the Contractor.

It shall be necessary for the building to be in an acceptable condition prior to commissioning and that all building works, including finishing trades such as painting and decorating are complete prior to commissioning of any air systems.

Indicate on drawings where access is required into ceiling voids, service risers etc. and ensure these points are not closed up until the commissioning and testing is complete.

8.7.3 Testing and Commissioning Programme

Within one month of appointment, unless stated otherwise, submit a preliminary commissioning programme. The programme shall be of the itemised bar chart format and shall clearly indicate the proposed approach and all key activities including a 2-week fault free period.

The Contractor and commissioning specialist shall together produce the detailed and final commissioning programme. This document shall amplify and expand upon the preliminary commissioning programme and include all necessary detailed method statements and procedures.

The programme shall be fully integrated with all other site activities envisaged to be occurring during the period of commissioning and shall also indicate all necessary witnessing and acceptance dates.



8.7.4 Reports

The Contractor shall submit written reports signed by a qualified person to confirm that:

- Prior installation - all system designs can be commissioned
- Post installation - installations complete and ready for commissioning
- System cleanliness - specified cleanliness has been achieved
- Pre-commissioning checks – completion of pre-commissioning checks
- Commissioning and testing – to demonstrate compliance with specified requirements and confirm that each installation has been correctly tested and commissioned and achieving the specified performance.

The final documentation of reports and completed record sheets shall be compiled into a Systems Commissioning Manual for inclusion in the Operating and Maintenance documentation.

8.7.5 Instruments for Testing and Commissioning

All instruments shall be provided by the Contractor or the commissioning specialist.

Submit a schedule detailing the equipment and instruments to be used in the testing and commissioning of the complete works.

Ensure all instruments are correctly calibrated and are marked with a unique reference for identification.

Submit evidence of correct calibration of all instruments used in connection with commissioning and testing prior to commencement of the works. Test methods shall be demonstrated where required.

Instrument calibration data and identification shall be included on the respective test record sheets.

8.7.6 Inspection by Employer's Insurance Company

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.

The Contractor shall provide a programme for the inspection and certification and inform when the installation or equipment is ready for examination.

The Contractor shall ensure all necessary information is provided to enable the insurers to approve the design before manufacture.

The Contractor shall arrange for the attendance of the insurance company's representative at agreed stages of manufacturer and installation and provide all necessary attendance, access and facilities for inspecting and testing as is required.

No equipment or installations subject to inspection and certification shall be accepted on behalf of the employer unless a satisfactory certificate has been received from the insurers.



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All costs associated with such inspections shall be included in the Contract price unless stated otherwise.

8.7.7 Manufacturer's Off-Site Testing

Equipment shall be tested for duty and performance at works prior to dispatch. Test to the appropriate British Standard or the requirements stated elsewhere if these exceed the British Standard.

Testing shall be to the satisfaction of the Employer's insurance representative.

Duplicate certificates of all such tests shall be provided within 3 days of testing and copies included in the operating and maintenance documentation. All certificates shall be signed by a competent person and witnessed.

For certain equipment, manufacturer's tests shall be required to be repeated on site to prove the operating performance.

Each item of equipment tested at works shall be stamped or fitted with a plate to provide the following minimum data:

- Normal working conditions
- Test conditions
- Individual equipment reference
- British Standards applicable
- Date of test
- Manufacturer's details

The above information shall be included on the test certificate for each item of equipment together with details of the test location.

8.7.8 System Demonstration

Subsequent to the completion of all testing and commissioning, operate the plant and demonstrate that the overall systems function correctly in accordance with the requirements of the Specification.

Full running and operation for a period of at least one week shall be considered reasonable for this demonstration and this period shall be allowed in the programme.

During this period, be responsible for the recording of results and the operation and maintenance of the plant. If appropriate, use this time to instruct the Employer's staff in the operation and maintenance of the systems.

Provide an operational report of the demonstration and print out of the conditions maintained within the space for a period of 48 hours.



8.7.9 Pipework Pressure Testing

The Contractor shall comply with the procedures given in HVCA Guide to good practice for site pressure testing of pipework and ensure all safety precautions detailed in the necessary HSE guidance notes are adopted.

When a section of any installation is completed and ready for testing the Contractor shall advise, giving seven working days' notice, to allow witness of such tests.

The Contractor shall provide a blanked connection to accommodate a check gauge in addition to the gauge used for test purposes.

All buried or concealed pipework shall be tested before any permanent covering is applied.

Pipework installations shall be hydraulically tested after erection and before thermal insulation is applied. For welded mains, every weld shall be hammered while under pressure and the test period may be extended to allow this activity to be undertaken.

Test section by section as the work proceeds.

The term 'pipework installation' shall include valves, heat exchangers and controls etc., subject to the system pressure when in operation.

The Contractor shall be responsible for ensuring that all valves, ancillaries and equipment are suitable for the test gauge pressure.

Pressure testing of water pipework systems shall be carried out generally in accordance with BS 6880-3 and BS 6700 and BS EN 806.

Test pressures generally shall be twice the working pressure up to and including working pressures of 280 kPa and thereafter 1.5 times the working pressure plus 140 kPa.

Tests pressure shall be maintained for a minimum of two hours without loss of pressure or visible evidence of leakage.

The cleaning and testing of domestic water services shall be in accordance with the recommendations in BS 6700 and BS EN 806

8.7.9.1 Water Mains

Water mains shall be tested to Water Authority requirements and the recommendations of the HVCA Guide to good practice for site pressure testing of pipework for testing underground CWS mains.

8.7.9.2 Gravity Drainage Systems Inside Buildings

Test section by section as work proceeds and subsequently on completion with all appliances installed and working.

All soil, waste, ventilation and rainwater installations shall be tested in accordance with BS EN 12056.

Systems shall be subject to a separate air and hydraulic test.



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On completion of the work, performance tests shall be carried out to simulate the probable worse conditions in practice.

The Contractor shall undertake all testing required for local authority approval and the Building Control officer shall be given due notice of all tests.

8.7.10 Pre-Commissioning Checks

The Contractor shall undertake all necessary pre-commissioning works and checks as detailed in the CIBSE Commissioning Codes and the BSRIA Application Guides stated elsewhere.

The Contractor shall submit a written report, including record sheets, for each system indicating completion of the pre-commissioning works and checks.

System commissioning shall not commence until the pre-commissioning works and checks have been completed and accepted as satisfactory.

8.7.11 Commissioning

8.7.11.1 General

Commissioning provisions and procedures shall follow the guidance and recommendations contained within the following documentation unless stated otherwise:

Current CIBSE Commissioning Codes

- Series A: Air Distribution Systems - High and Low Velocity
- Series C: Automatic Control Systems
- Series R: Refrigeration Systems
- Series W: Water Distribution Systems

BSRIA Application Guides

- AG 1/2001: Pre-commission cleaning of pipework services
- AG 2/89.2: The Commissioning of Water Systems in Buildings
- AG 3/89.3: Commissioning of Air Systems

Particular attention shall be given to the permitted tolerances in the above documentation.

In addition to the requirements stated elsewhere, the Contractor shall perform and record the following:

- Test all equipment in accordance with manufacturers' recommendations, checking rotation, revs, running current on each phase of electrical motors, etc., and recording.
- The ventilation and air conditioning systems shall be run without air filters to disperse all dust, etc., and commission the system before the introduction of the Client's filters.
- Check air volumes, sound levels, speeds, running currents and pressures generated of fans.
- Check hydraulic pressure drops across all items of equipment.
- Check air on/off, water on/off temperatures to all heater batteries, cooler batteries, circuits, boilers and other relevant plant.



8.7.11.2 Automatic Controls

Automatic control systems shall be tested and commissioned in accordance with CIBSE Commissioning Code C.

The Contractor shall be required to demonstrate every function and interlock relating to the automatic controls. This demonstration shall be conducted under simulated occupancy and shall include but not be limited to:

All automatic temperature control functions including high limit and safety cut-outs.

All safety devices and 'position under failure settings' such as normally closed damper positions; normally open valves; gas cut off valves; isolation of ventilation plant etc., shall be demonstrated.

- All automatic smoke detectors mounted within ductwork and their associated interlocks shall be demonstrated including the 'plant available for use' facility offered to the Fire Officer in emergency situations.
- All optimiser and time clock energising of plant shall be demonstrated. Demonstration of any optimiser shall include the switching of all required plant during 'non-occupation periods' under simulated frost and internal condensation conditions.
- All controls associated with the fan coil terminal units. Spot checks shall be made to ensure correct operation of the fan coil units including temperature, volume and pressure checks.

At the completion of the Contractor's commissioning and prior to any final approval, simultaneous internal and external dry and wet bulb temperatures shall be taken, witnessed and recorded. Should the Contract programme determine that such temperature recording tests occur during partial load conditions then the Contractor shall be required to return to site and repeat the tests. This rechecking shall occur during the months of January/February and July/August.

8.7.12 Authority Witnessing and Testing

As part of the commissioning procedure the Contractor shall arrange for all necessary checks and witnessing by the Local Authority, Government Offices, Statutory Authorities, etc.

Such witnessed tests and signed certificates of acceptance shall be obtained from, but not limited to, the following:

- Local Environmental Health Officer
- Drainage Inspector or Building Control Officer
- Fire Officer
- Water Board Inspector
- Gas Board Inspector
- Building Control Officer

The Contractor shall be prepared to carry out similar tests at the end of the defect liability period if deemed necessary to prove that the plant and installation are still functioning in accordance with the requirements of the Specification. The Contractor shall allow for this item at the time of Tender.



8.7.13 Testing and Commissioning Record Sheets

Maintain a systematic record of commissioning results.

The Contractor and commissioning specialist shall record results of inspections, checking, testing and commissioning on record sheets approved prior to the commencement of the works.

Where proforma record sheets are not issued, use record sheets as described in BSRIA Application Guide 3/89.3 for air systems and record sheets as detailed in BSRIA Application Guide 2/89.2 for water systems.

The Contractor shall issue the completed sheets in a logical sequence as the Works proceed.

Any witnessing or independent checking shall be carried out as considered necessary.

Two sets of the checking and testing record sheets shall be issued for use during the progress of the Works and the Contractor shall provide any further or supplementary test record sheets as required to provide a comprehensive record of all tests.

8.7.14 Performance Testing

Demonstrate the performance of installations including single, standby, multi-duty plants and systems, and plants specified for future use.

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 of the systems.

The Contractor shall provide portable seven-day space temperature and relative recorders together with adequate charts.

Demonstrate by measured tests that noise criteria indicated have been achieved.

The outflow from all cold and hot draw off points shall be demonstrated with full bore delivery from taps. In the case of hot water service installations storage recovery shall be demonstrated with heat exchanger plant working at rated output.

The performance of sanitary systems shall be in accordance with BS EN 12056.

Air circulation and distribution shall be demonstrated after the systems have been balanced to provide the correct air quantities. Smoke tests may be required to prove distribution.

8.7.15 Practical Completion

Practical completion requires but not limited to the following:

1. All installation works are complete other than agreed minor 'snags', omissions or defects, by contract administrator.
2. All tests and demonstrations have been undertaken in the presence of the Contract Administrator as required in the specification(s).



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3. All final copies of the Record Drawings, schedules, operating and maintenance instruction manuals have been supplied to the Contract Administrator in an agreed format.
4. All spares, keys, tools, and other materials required by the specification for the running and maintenance of the building engineering services systems as specified, have been supplied
5. All instruction of the Employer's staff has been satisfactorily completed.
6. All necessary certification by the Employer's insurers has been completed.
7. All documentation required for the completion of the Health & Safety File under the CDM Regulations has been issued to the satisfaction of the Principal Designer and/or Principal Contractor as appropriate and that the complete file is passed to the Client.

8.7.16 Post Practical Completion

During the 12 months after Practical Completion:

- The Contractor/ Contractor shall undertake testing and fine tuning of the installations at each season of the year i.e. full heating load test in mid-winter, full cooling load test in midsummer, autumn and spring to assess part load conditions.
- The Contractor /Contractor shall ensure the requirements for fine tuning are incorporated in the commissioning Specification
- The Contractor/ Contractor shall ensure that fine tuning activities are programmed, planned in advance and agreed with the employer prior to commencement.
- The Contractor/Contractor shall arrange that the relevant parties are retained and appointed to provide input to fine tuning activities
- The Contractor/ Contractor shall ensure that fine tuning activities are planned with regard to the health and safety of occupants and such that any disturbance to them is minimised
- The Contractor/ Contractor shall provide a mechanism by which the employer can provide feedback on the performance of the building both before and after fine tuning

8.8 Noise and Vibration

Attenuators and other noise control equipment shall be installed to achieve the stated noise levels with minimum resistance to air flow.

The Contractor shall take due consideration of the planning restrictions relating to the acoustic requirements of the project and ensure compliance with the plant operating at all design configurations.

All dynamic machinery shall be isolated from the building structure by vibration isolators and/or vibration isolation materials which shall be selected to suit the machinery.

Noise level data for all items of plant, based on octave band analysis data, shall be submitted to the Project Manager prior to ordering.

Where sound power levels have been indicated for specific plant items these shall be the maximum sound power levels.

The Contractor shall undertake the final selection of sound attenuation equipment to satisfy the particular performance requirements of the Specification and the spatial allowances based on final plant/equipment selection and final co-ordinated installation drawings



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The Contractor shall undertake the redesign of the final acoustic requirements associated with approved alternative equipment or materials which subsequently varies the Works in any way whatsoever.

All attenuating materials shall be inherently non-combustible and limit the surface spread of flame to Class 1 when tested in accordance with BS 476: Part 7 and shall not emit toxic or hazardous fumes if ignited. Non-flammable adhesives shall not be used.

All acoustic components shall be made from materials with zero ozone depletion potential (CFC and HCFC free). Submit, prior to ordering, written confirmation from the manufacturer(s) that the products to be installed are CFC and HCFC free.

For all acoustic infill material, test evidence must be available and submitted to the Project Manager showing that the fibres from which the products are made are not classified as a possible carcinogen as detailed by European Directive 97/69/EC. Fibres shall also comply with the requirements as stated elsewhere and with HSE guidelines.

Ensure that isolation mounts are not bridged by rigid connections such as electrical conduits or obstructions underneath the floating equipment.

Provide acoustic seals around all pipework and ductwork penetrations through plantroom enclosures and other enclosures where acoustic separation is required and indicated.

8.8.1 Vibration Isolation

Supply and install plant and equipment isolators as stated elsewhere to ensure that vibration from plant is not transmitted to the building, other supporting structure, pipework or ductwork. All anti-vibration mountings shall be supplied and fixed by the Contractor.

Isolators must be selected for the operating weight of equipment and shall be positioned for equal deflection.

Mountings shall be clearly and permanently marked with their load capacity and colour coded to BS1726 to enable easy identification during installation.

Mountings shall be constructed of materials that are passive or have low levels of electrolytic action

The Contractor shall be responsible to ensure that all mountings are appropriate for the design loads, operating and environmental conditions that shall prevail. Particular attention shall be paid to mountings exposed to atmospheric conditions to prevent corrosion.

The Contractor shall provide all necessary information, including but not limited to actual plant loads and running speeds, to the vibration isolation specialist/supplier to enable final isolator selections to be made. Selection shall allow for uneven load distributions such that the minimum deflection is achieved on all vibration isolators under normal operating conditions.

The Contractor shall confirm the final vibration control equipment selections and their compliance with the Specification prior to commencement of the Works.

Pipework and ductwork connections to equipment mounted on anti-vibration mounts shall not be rigid; flexible couplings or connections shall be installed.



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Helical steel spring mounts shall comprise single or multiple spring elements fitted to a plated steel base plate. A rubber/neoprene pad shall be bonded beneath the bottom plate.

All mountings shall incorporate a lockable levelling device. There shall be provision for bolting through the base plate in at least two places.

The springs shall have an outside diameter of not less than 75% of the operating height and be selected to have at least 50% overload capacity.

Vertically restrained spring mounts shall be as described under the clause for helical steel spring mounts but include a mechanism that provided an adjustable vertical limit stop to prevent spring extension when load is decreased.

Turret compression mountings shall comprise a synthetic formulated rubber compound turret in compression between two steel plates with complete lateral freedom for deformation. All metal surfaces must be covered to avoid corrosion and have friction pads to and bottom. Bolt holes shall be provided in the top and bottom plates to facilitate fixing.

The rubber turret shall be resistant to oil, sunlight, corrosion and ozone.

Turret compression mountings shall not be employed where ambient or equipment temperatures exceed the manufactures recommendations.

Helical spring compression hangers shall comprise a helical steel spring fitted with acoustic rubber end caps fitted incorporated within a steel hanger box.

The lower box hole diameter shall be adequately sized to provide free drop rod movement up to 15° from vertical in any direction in order to compensate lateral movement.

The hanger bracket shall be designed to carry five times overload without failure.

Where hangers incorporate a positioning device, the adjustment system shall incorporate a locking mechanism to prevent the hanger going out of adjustment as a result of vibration or unauthorised tampering.

Spring hangers shall be installed to support all pipework and ductwork connected to rotating and reciprocating machinery within plantroom areas or within 30m of the plant, whichever is the lesser.

The hanger bracket shall be designed to carry five times overload without failure.

Hangers shall be colour coded for identification.

Neoprene element hangers shall be essentially as described under the clause helical spring compression hangers except it shall incorporate a neoprene in shear element. The element moulded in special formulated rubber compound shall be resistant to oil, sunlight, corrosion and ozone.

Hangers shall be colour coded for identification

8.8.2 Pipework Flexible Connections

Flexible pipe compensators shall be installed on pipe connections to all rotating or reciprocating plant isolated by vibration control equipment.



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Construction:

Type: Single convolution rubber bellows

Liner: EDPM rubber

Reinforcement: Steel wire mesh reinforced throughout and manufactured in accordance with DIN 4809

Cover: EDPM rubber

Flanges: Carbon steel to BS EN 1092 and shall be able to swivel and be removable

Threaded ends: BS 21 with one union end

Tie bars: Carbon steel zinc plated adjustable tie bar assembly

The Contractor shall ensure that the flexible pipe connections proposed are capable of withstanding the system operating temperatures and pressures.

All units shall have an indelible identification indicating manufacturer, date of manufacture, type, size, pressure rating and be colour coded.

The units shall have a design life of 10 years at 100 °C. Units shall be in accordance with DIN 4809 and after a service life of 10 years at 100 °C must have a burst pressure of not less than 30 bar.

Where untied bellows are used the manufacturer's recommendations for anchors and guides shall be followed.

Tie bars shall be threaded and with adjustable length. Tie bars with rubber top hat washers shall be used where the working pressure exceeds 1.5 bar.

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

8.8.3 Acoustic Testing

Unless otherwise stated, sound pressure levels shall be measured in all spaces containing supply or extract terminals, all plantrooms, all rooms immediately adjacent to plantrooms and all rooms located above or below plantrooms.

The results shall incorporate a spectrum band analysis made at octave band centre frequencies from 63 Hz to 8k Hz. Results shall be both tabulated and plotted on NR curves.

All plant such as fans, chillers, pumps, boilers etc. shall be tested to ensure their acoustic performance is within the respective manufacturer's stated data at the time of order.

Noise readings shall be taken at the site boundaries and adjacent facades to demonstrate the acoustic performance of the systems complies with the noise levels stated elsewhere.

Locations for noise readings shall be agreed prior to measurements being undertaken.

Measuring of environmental noise shall be in accordance with BS 4142 and the local authority guidelines.



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All measurements undertaken to demonstrate compliance with the Specification shall be performed using sound measuring equipment conforming to BS EN 61672 and other relevant standards. Calibration certification for all measuring equipment shall be submitted to the Project Manager prior to measurements being undertaken.

Duplicate records of all such shall be provided within 3 days of testing and copies included in the operating and maintenance documentation. All records shall be signed by a competent person and witnessed. Results shall be submitted to the Project Manager for examination before any system is offered for final acceptance.

All necessary apparatus, measuring equipment, instruments, and meters required for acoustic testing of the Works shall be provided by the Contractor at no additional cost.

Diffusers shall be selected to provide adequate air distribution and mixing with room air. Baffle plates shall be provided as necessary or as indicated to avoid local obstruction.

Unless otherwise indicated, each diffuser shall be provided with an air flow rate controller and a means of altering the discharge air flow pattern. All controllers shall be adjustable from the front of the diffuser.

Diffusers with ducted connections shall be provided with plenum boxes selected and fabricated by the diffuser manufacturer to match the output of the diffuser. Construction shall be as stated elsewhere. Each plenum shall be sealed to the back of the diffusers.

Where a diffuser is directly connected to a stub duct which has a straight length of less than two equivalent diameters, an equalising deflector shall be used.

Grilles shall be constructed from extruded aluminium or other materials as indicated and shall be complete with matching surrounds.

Extract air grilles shall have a single set of fixed blades with 15° deflection for aesthetics, or a lattice or egg crate front as indicated. The air flow rate controller for extract air grilles shall be a damper of the opposed blade multi-leaf type.

The air flow rate controller of all grilles shall be adjustable from the front.

Grilles with ducted connections shall be provided with plenum boxes selected and fabricated by the grille manufacturer to match the output of the grille. Construction shall be as stated elsewhere. Each plenum shall be sealed to the back of the grille.

Air valves shall be constructed from white polypropylene and shall be provided with sub frames formed to provide a seating ring for the face section. Flanges shall be provided with sealing gaskets.

Air valves shall be used in WCs, cleaner's rooms etc. where the air flow rates are low and the air can be moisture laden.

The air volume shall be adjusted by rotating the central disc to alter the space between the disc and valve ring. The adjustment shall be capable of being locked.

Plenum boxes shall be provided as to all grilles and diffusers with duct connections and shall be to the same ductwork Specification as the connecting ductwork and fitted with round inlets with flexible connections and butterfly type balancing dampers, unless otherwise stated.



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Where connected to insulated ductwork the plenum box shall be insulated to the same standard as the connecting ductwork.

Outlets from plenum boxes shall be either circular or rectangular to suit the diffuser/grille neck connection.

The dimensions of the plenum box shall be as recommended by the diffuser/grille manufacturers and shall be of adequate dimensions to ensure correct diffuser/grille performance in terms of noise level, throw and pressure drop.

Where appropriate plenum boxes shall be provided with galvanised steel perforated plates to achieve equal air distribution and pressure drop across the whole face of connecting grilles or diffusers. The details of all plenum boxes shall be submitted to the Project Manager for approval prior to ordering

Where plenum boxes are fitted with an opposed blade damper, dampers shall not be required on the neck of the diffuser being served.

8.8.4 External Louvres

All air intake and exhaust points shall be protected with louvres designed to prevent ingress of rain. Louvres shall be designed to prevent water carry over through the louvres for the stated size and air volume.

The louvre system shall achieve minimum resistance to airflow, with louvre blades aerodynamically shaped with no sharp edges or protrusions.

Louvres shall be mounted in large section angle frame having intermediate uprights as necessary for rigid support of the louvres. An effective weather and acoustic seal shall be achieved using approved packing and filling materials as necessary.

Frames and blades shall be fabricated from galvanised mild steel sections and sheet, or from aluminium alloy of adequate stiffness to prevent vibration and/or damage as indicated.

Louvres shall be fully protected against corrosion.

Louvre blades shall be roll formed to an aerodynamically efficient profile and clipped to concealed structural supporting mullions with efficient water drainage on to sill.

The louvre system shall achieve the minimum aerodynamic performance coefficients (CV) and weathering classification against as indicated when tested in accordance with BS EN 13030.

Vermin/insect screens shall be fitted to all external louvres and shall be removable for cleaning. The design should allow for additional resistance to airflow and reduced air flow rate performance.



9. General Requirements for Electrical Services

The electrical installation shall be inspected and tested as required by BS 7671 and shall then be fully commissioned and left working.

The Installer shall issue an electrical installation certificate as required by BS 7671 at the completion of the works

The testing of elements under the various sections of the specification may be required to be carried out in parts, or as a whole.

All tests shall be made in the presence of the Project Manager who shall have been duly notified of the installer's intentions. Provide triplicate copies of test certificates covering all tests carried out on the completed installation.

Following the satisfactory conclusion of final inspections and tests on completed sections of the works, the installer shall duly commission each section of the electrical installation and leave it in full working order.

For the purpose of this specification, the term 'commissioning' shall be deemed to include:

The energising of electrical distribution circuits and equipment that have previously been inspected, tested, and found satisfactory and capable of being energised with complete safety.

The setting of electrical protective devices and systems, where relevant, in accordance with the directions of the Project Manager or, failing such directions, in accordance with sound engineering practice.

The starting up of all electrically powered plant and equipment, including that supplied and installed under other contracts, as detailed in the annexed schedules.

The verification of the performance of all such plant and equipment by the carrying out, where required, of further tests and the making of all necessary adjustments so as to obtain optimum performance.

The Project Manager may request tests, at the installers or suppliers premises, all or any of the materials and equipment used in the Contract Works in any manner he may deem necessary to ensure conformity with the specification. The results of such tests shall in no way relieve the Installer of his responsibilities to ensure that all materials and equipment installed in the works are entirely suitable for the applications and conditions of operations.

Mere compliance with the requirements of this section of the specification shall not by itself in any way relieve the installer of any of their obligations under the contract.

No approval given by the Project Manager in connection with the commissioning process, whether by way of approval of procedures carried out or proposed, or approval of results obtained shall in any way relieve the installer of the contractual and statutory obligation to ensure that all connections and adjustments are made correctly and that the installations and equipment are handed over in a complete safe and satisfactory condition. Where required commissioning shall be carried out by the equipment manufacturer's commissioning engineers.

No connections or adjustments shall be made to plant or equipment that has already been commissioned and set to work, except with the prior consent of the CA.

The Project Manager shall have power to require that the whole of the plant, equipment and installations, or selected parts thereof, be re-inspected and, if necessary, re-test immediately before the end of the contractual maintenance period, and the installer shall be responsible for making all necessary arrangements with the Employer.



9.1 Periodic inspection and testing

Include recommendations within the operating and maintenance manuals that the installation be inspected and tested in accordance with BS 7671 and include a recommended maximum period before re test based on the advice given in BS 7671 guidance notes.

9.2 Rubber matting

Black rubber strip floor matting shall be installed in front of switch panels and control panels. The matting shall be manufactured in accordance with BS 921 and neatly cut to the dimensions required and laid in an approved manner.

9.3 Containment systems

9.3.1 General requirements

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules. Cable ladder rack

Cable ladder rack shall be installed where required for the support and accommodation of larger cable systems.

The rack shall be of proprietary manufacture, from a recognised company and shall be a complete system, with all fittings etc. The material and finish shall be galvanised steel.

Site manufactured fittings will not be accepted.

The rack shall be sized to accommodate all necessary cables, allowing space between cables and having due regard for grouping and cable current ratings.

The rack shall be installed as a complete system and supported as detailed on drawings using steel channel and fixing clips, brackets, etc. The channel and fixings shall be of the same finish as the rack. Where the finish has been damaged during erection, it shall be repaired or touched up with a paint system to match the original finish.

Supports are to be designed to take the full weight of the rack and cables, along with any imposed loads such as wind etc and imposed loads produced during installation and cable pulling. When the rack is finally installed and loaded, deflection between supports shall not exceed the manufacturers' recommendation. And all drop rods for the support to be cut back and capped.

9.3.2 Perforated cable tray

Perforated cable tray shall be formed from plain steel sheet which has been hot dip galvanised after fabrication to BS EN ISO 1461, unless otherwise specified. Tray shall have a minimum coating weight of 275 g/m².

Cable tray shall have the dimensions and finish as specified on drawings or in associated particular information.

Standard Dimensions of Cable Tray



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Nominal Width	Minimum Height of Upstand	Nominal Thickness of Steel Sheet	Application
100mm	12mm	1mm	Internal
150mm	12mm	1mm	Internal
225mm	12mm	1.5mm	Internal
300mm	20mm	1.5mm	Internal
450mm	20mm	1.5mm	Internal
600mm	20mm	1.5mm	Internal
100mm	12mm	2.5mm	External
150mm	12mm	2.5mm	External
300mm	20mm	2.5mm	External

9.3.3 Bends and Tees

Bends shall be of the same material, thickness and finish as the cable tray and shall have an inner radius of 50mm and a straight length of 100mm at each end.

No perforations shall be made in the circular portion of the 100mm and 150mm bends. On 225mm and 300mm bends perforations shall be made only a line set at 45°. On 450 and 600mm bends perforations shall be made only along lines set at 30° and 60°.

Tees shall be of the same material, thickness and finish as the cable tray. The distance measured between a point of intersection and at the end of the fitting shall be 100mm.

9.3.4 Fixing Screws

Mushroom-head steel roofing bolts and nuts complying with BS 1494 Part 1 shall be used to fix together adjacent sections of cable tray and/or accessories. The head of any fixing screw shall be presented to the surface of the tray on which the cables are to be fixed.

9.3.5 Installation

Cable tray shall only be cut along a line of plain metal, ie not through the perforations. All cut edges of galvanised cable tray shall be prepared and treated with 2 coats of a zinc rich paint.

Site fabrication of accessories shall be kept to a minimum and manufacturers' standard items shall be used. Where special sections are required, the material, thickness and finish shall be as specified for standard items.

Where welding has been employed in the fabrication of cable tray and/or accessories the area around the joint shall be mechanically prepared and thereafter treated with zinc chromate primer or zinc rich paint according to the original finish of the metal.

Holes cut in cable tray for the passage of cables shall be provided with securely fixed bushes.

A minimum clear space of 20mm shall be left behind all cable tray.



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Fixings for cable tray shall be disposed at regular intervals not exceeding 1200mm and at 225mm from bends, tees and intersections. The maximum deflection between supports on a fully loaded cable tray shall not exceed 1/110 of the span between supports.

Fixings shall be fabricated from mild steel flat bar. When used with galvanised cable tray, fixings shall be hot-dip galvanised, unless only bending and drilling is required in the manufacture when galvanised mild steel flat bar may be used. Hot-dip galvanising shall comply with BS EN ISO 1461.

9.3.6 Cable basket

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

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

Where bends in cable basket are formed on site, the radius of those bends or tees shall be sized to accommodate twice the largest installed cable.

Where cable basket is used to carry cables such as Cat 5e, Cat 6, Cat 6a, or any other gigabit speed IT cabling, the basket shall be lined with a suitable barrier to prevent cable compression.

Cable basket shall not be used in external environments or where extremes of temperature and moisture may be present.

Only proprietary fixings designed specifically for use on cable basket shall be used.

A minimum clear space of 20mm shall be left behind all cable basket.

Support system fixings for cable basket shall be at distance no greater than 1200mm apart and at 225mm from bends, tees and intersections. The maximum deflection between supports on a fully loaded cable tray shall not exceed 1/110 of the span between supports.

The support system shall be fabricated from mild steel flat bar or channel.

9.3.7 Steel trunking

Steel trunking shall mean general service trunking, multi compartment trunking, lighting trunking, dado and skirting trunking and floor trunking. Where necessary, specific requirements are given in associated particular requirements.

Unless otherwise specified the whole of the various installations specified herein shall be carried out in galvanised steel trunking complying BS EN 50085.

Underfloor and flush floor trunking shall comply with BS 4678-2

General trunking shall be the return flange type.

All trunking shall be supplied with appropriate screw fixed lid. Where security fixings are required, they shall be identified elsewhere in this specification. Verify type of security screws before procurement.

Lighting trunking shall only be used for its intended purpose and shall be supported in accordance with it's manufacturers recommendations. Galvanised lid shall be installed unless the Project Manager accepts the use of plastic lid.

The trunking installation shall be suitable for the environment and be protected against corrosive or polluting substances, extremes of temperature and excessive solar radiation.



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Only manufactured bends, tees, intersections, stop ends, hangers, joints and all other fittings shall be used. No site or workshop fabricated fittings or accessories shall be permitted. Ensure fittings are the same class and finish as associated trunking system

Heavy Gauge shall be used throughout.

Inverted trunking, including lighting trunking shall be supplied with cable restrainers.

Where but joints are made in trunking runs, these shall be fully supported so that the joint is not subjected to strain.

Where conduits terminate into trunking, this shall be via a brass bush and coupling.

As soon as galvanised trunking is fixed in position all exposed cuts and scratches shall be painted with one coat of zinc rich paint.

All trunkings shall be checked for debris before wiring is commenced and cables shall not be drawn into any section of the system until the system is complete.

All joints shall be fitted with copper bonding links.

All bolts shall be installed so that no cables can snag on them.

Where cables leave the trunking system, a suitable edge protection shall be provided to stop cuts and abrasion of cables.

Trunking shall be supported at regular intervals not exceeding 1.2m on horizontal runs and 1.5m on vertical runs. Where the trunking manufacturers recommendations are more onerous, they shall be applied instead of the distances given above.

Accessories such as switch boxes and adaptable boxes shall be connected to the trunking system via couplings and bushes.

9.3.8 PVC and uPVC Trunking

PVC trunking shall mean general service trunking, "mini" trunking, multi compartment trunking, dado and skirting trunking as well as PVC floor trunking. Where necessary, specific requirements are given in associated particular requirements.

Trunking shall be supplied from one source so that variations in colour are avoided.

Lighting trunking shall only be used for its intended purpose and shall be supported in accordance with the manufacturers recommendations.

The trunking installation shall be suitable for the environment and be protected against corrosive or polluting substances, extremes of temperature and excessive solar radiation.

Only manufactured bends, tees, intersections, stop ends, hangers, joints and all other fittings shall be used. No site or workshop fabricated fittings or accessories shall be permitted. Ensure fittings are the same class and finish as associated trunking system. No joints cut with hacksaws shall be permitted.

Inverted trunking, including lighting trunking shall be supplied with cable restrainers.

Where but joints are made in trunking runs, these shall be fully supported so that the joint is not subjected to strain.

Where conduits terminate into trunking, this shall be via a uPVC bush and coupling.

Any sections with scratches or abrasions in the trunking shall be replaced by the contractor.



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Conduit which has manufacturers or distributors codes marks or other information either stamped or printed on it shall not be used.

All trunkings shall be checked for debris before wiring is commenced and cables shall not be drawn into any section of the system until the system is complete.

Where cables leave the trunking system, a suitable edge protection shall be provided to stop cuts and abrasion of cables.

Trunking shall be supported at regular intervals not exceeding manufacturer's recommendations

9.3.9 Steel conduit

Unless otherwise specified the whole of the various installations specified herein shall be carried out in heavy gauge galvanised screwed conduit complying the BS 4568 Parts 1, and BS EN 61386.

Resistance to ingress of water and against ingress of solid foreign bodies shall be to the stated rating to BS EN 60529

The conduit installation shall be suitable for the environment and be protected against corrosive or polluting substances and excessive solar radiation.

Ensure fittings are the same class and finish as associated conduit system

No conduit less than 20mm diameter or larger than 32mm diameter will be permitted.

The end of conduits shall be cut square and the length of screw threads shall be sufficient only to allow the ends of the conduit to butt solidly in all couplings and against the shoulders provided in conduit boxes.

The ends of all conduits shall be carefully reamed to remove all burrs or sharp edges after the screw threads have been cut. All dirt, paint or oil on the screwed threads of the conduit and accessories shall be carefully removed immediately prior to erection.

The number of running joints in conduit shall be kept to a minimum and where installed locknuts shall be used to secure the sockets.

Where conduits terminate in switch-fuses, fuse-boards, adaptable boxes, etc., they shall be connected thereto by means of smooth bore male brass bushes, compression washers and sockets. Where a conduit terminates on a sheet steel enclosure a flanged coupler shall be used.

All bends are to be made on site to suit conditions and not more than two right angle bends or runs exceeding 15 metres will be permitted without the interposition of a draw box. No tees, elbows, sleeves, either of solid or inspection type will be permitted.

Immediately conduits are fixed in position all exposed threads, scratches and bends shall be painted with one coat of zinc rich paint.

All conduits shall be swabbed through before wiring is commenced and cables shall not be drawn into any section of the system until all conduits and draw boxes for that particular section are fixed in position.

All conduits shall be concealed unless specifically indicated otherwise, i.e. in roof spaces, above suspended ceilings, under floors, in flooring screeds, cast insitu, and in chases cut or cast into walls and/or concrete ceilings.

Where a concealed installation is called for, all conduits shall be chased into walls and concealed in the ceilings and floor screeds as far as the structure of the building will permit. Conduits installed in chases shall be fixed by means of crampets and painted 2 coats bitumastic paint prior to the chases being filled in.



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Deep boxes or extension rings on standard circular conduit boxes shall be used where necessary in order to bring the front face of each box flush with the surface of the ceilings and walls.

Conduit runs shall be determined by the installer and approved before any work is started. Conduit shall be run at least 150mm clear of plumbing and mechanical services.

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

Conduit run on the surface shall be run vertical, horizontal or parallel with the features of the building.

Conduit buried in concrete shall have at least 35mm depth of cover over its entire length. Conduit buried in plaster shall have at least 5mm depth of cover over its entire length.

Where conduit is buried in the carcass of a building or in the ground, all open ends shall be temporarily plugged or wrapped in 'Denso' tape to prevent ingress of foreign matter, moisture or water.

Where conduit buried in concrete crosses an expansion joint in the concrete, it shall be wrapped with 'Denso' tape for a distance of 300mm on each side of the joint. The coupling method for protecting the conduit against stresses due to expansion shall be approved by the CA.

Conduit shall be supported at regular intervals not exceeding 1.2m on horizontal runs and 1.5m on vertical runs. On surface runs, any section of conduit run shall be supported by at least two saddles and shall not rely on the integrity of any conduit box or connection to any other containment or accessory for support.

At each distribution board and multi-gang switchbox the conduit provided must be of the capacity to accept all cables, which could be connected to outgoing ways, whether they are installed at this stage or in the future.

Conduit systems shall be sized in accordance with the details given in Appendix A of Guidance Note No. 1 published by the IET. The cable capacities given in this document shall not be exceeded (note that protective conductors can be ignored in capacity calculations, so long as cables can be easily installed and removed).

Wire pulling lubricant shall not be used. The Project Manager reserves the right to require all cables pulled in with any lubricant to be removed and replaced and conduits cleaned out.

Where surface conduit is specified, it shall be fixed by means of distance saddles and shall terminate in deep pattern conduit boxes. Surface conduits shall not be bent or cut to enter accessories. If a suitable accessory is not obtainable, the accessory shall be mounted on an approved backing piece of sufficient thickness to align the conduit entry with the surface conduit

The cable shall be continued in a short length of flexible metallic conduit or composite PVC/metal foil conduit that shall be fixed to the motor terminal box.

An independent stranded copper cable protective conductor shall be run through all such flexible conduit and shall be connected to the motor earth terminal at one end and to a M 3.5 screw tapped into the side of the connected box at the other. The cable is to be sized in accordance with the requirements of BS 7671.

9.3.10 Condensation management in steel conduit installations

Install conduit systems to ensure internal condensation does not affect the 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.



9.3.11 PVC Conduits and Accessories

All PVC conduits shall be high impact PVC complying with BS 4607, BS EN 50086 and BS EN 61386. The minimum size of conduit shall be 20mm external diameter.

PVC conduit which has manufacturers or distributors codes, marks or other information either stamped or printed on it shall not be used.

Light gauge conduit may be used for protected pre-cast and in-situ concrete work where builders' traffic is minimal.

Heavy gauge conduit shall be used for surface installation and where it is laid in floor screeds.

Conduits shall be jointed and terminated utilising the appropriate rigid PVC components detailed below or standard conduit entry electrical equipment. Jointing will conform to one of the following techniques:

9.3.12 Permanent Adhesive

The solvent cement supplied by the conduit manufacturer shall be used to produce a rigid sealed connection.

9.3.13 Flexible Adhesive

A non-hardening adhesive supplied by the conduit manufacturer shall be used to produce a flexible sealed joint where allowance is necessary for longitudinal movement (e.g. expansion couplers).

Bends and sets in conduit will be made in accordance with the manufacturers' instructions. The radius of the bend shall not be less than 2.5 times the outside diameter of the conduit or such greater radius that will facilitate easy drawing-in of cables.

PVC conduits shall not be used in situations where ambient temperatures are likely to exceed 70°C or where the normal working temperature of conduits and fittings will exceed 60°C. Conduits shall not be installed adjacent to steam or hot water pipes. Adequate allowance shall be made for longitudinal expansion and contraction of the conduits under normal working temperature variations as follows:

Expansion couplers should be used on straight runs exceeding 6.0m with a loose or flexible type joint (b above) at the long spout end of the coupler. Special consideration shall be given to the fixing of accessories where this may prevent natural conduit movements. Oversize or slotted fixing holes may be necessary or the introduction of expansion couplers.

Conduits shall be saddled at not more than one metre intervals.

9.3.14 PVC Conduit Boxes

PVC adaptable boxes shall be of moulded or fabricated PVC of square or oblong shape complete with PVC lids secured by two M4 round or pan headed screws. All adaptable boxes and lids of the same size shall be interchangeable. No adaptable box smaller than 75 x 50mm or larger than 300 x 300mm shall be employed. Boxes shall be of adequate depth in relation to the size of conduit entering them.

Conduit shall be terminated at adaptable boxes, fuseboards, switches, socket-outlet or other equipment not possessing push-in or threaded spouts by means of the appropriate size adaptors. All cemented joints are to be made to a depth not less than the diameter of the conduit being used.

9.3.15 Protective conductors in PVC trunking and conduit

A separate circuit protective conductor shall be provided within non-metallic conduits and trunking. The conductor shall have green/yellow LSF insulation and shall be sized in accordance with the



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requirements of BS 7671. A protective conductor may be common to more than one final circuit providing it is sized for the worst circuit conditions.

An earthing terminal shall be provided at every switch and outlet position for connection of a circuit protective conductor as required.

Excavation and laying of cables, external

Underground cables shall be laid direct in trenches unless otherwise indicated.

When cable trenches are opened all cables shall be laid and the trenches shall be backfilled within 24 hours. At all times adequate safety precautions shall be taken around open trenches and arrangements made to prevent damage to cables.

Trenches shall be excavated to provide the minimum cover specified elsewhere. Turf and topsoil and any reusable paving/sets etc shall be removed carefully and preserved for reinstatement in their original positions.

Minimum cover for cables

Cables shall be covered to a minimum depth as given in the NJUG standard Volume 1.

Where damage is caused during excavation to drainage and other services, this shall be reported immediately to the CA. Approval shall be obtained from the Project Manager before backfilling the trench.

The excavation shall be kept free of water and properly shored up in a manner pre-approved by the CA. Other services uncovered shall be adequately supported by slings or other means and protected.

Before cables are laid, the bottom of the trench shall be evenly graded, cleared of loose stones and then covered with a 75mm layer of sand.

Power cables shall be pulled in over adequately spaced cable rollers and the resulting surplus cable shall be snaked across the width of the trench. In straight run trenches cable crossing is not permitted except where cables branch from the main run. At each draw-in point, joint or junction box the cable shall be left slack. Cables shall not be pulled taught to straighten them after laying.

Cables stockings shall be used for cable hauling. In order to ensure that the strain is taken on the cores as well as the sheath when cables are laid with a cable stocking, a solid plumbed hauling end shall be made. The only permissible exceptions to this requirement are the lengths of up to 9 metres not pulled into a thrust boxing.

Where more than one cable is laid in a trench the cables shall be spaced apart in accordance with their current rating but subject to the minimum spacing specified elsewhere. The minimum distance between cables and segregation from other services shall be as specified elsewhere. When this is not possible 50mm thick concrete or stone tiles shall be used as separators.



9.3.16 Minimum spacing of cables

Cable type	HV	LV	Telephone & Data	Co-axial	Gas, Water and other piped services
	mm	mm	mm	mm	mm
HV	50	300	300	300	300
LV	300	25	150	150	300
Telephone & Data	300	150	50	50	250

After laying, the cables shall be covered with sand to ensure a 50mm cover after tamping. Warning covers as specified shall be laid over the cables and the trench filled in and compacted. Cable warning marker tape shall be laid across the full width of the trench at 100mm below finished ground level (see clause 2.3.14 and table 3E for colour details.)

Reinstatement shall be effected by backfilling in 100mm layers and hand ramming the first two layers. Power compactors may be used for the remaining layers. The turf, slabs, etc shall be replaced and the level of the finished reinstatement shall not protrude more than 25mm above the normal ground level. All soils shall be properly compacted and where required by the CA, a compaction test shall be carried out in accordance with the method set out in BS 1377: Part 9, 1990.

All cable ends shall be sealed in a manner recommended by the cable manufacturer.

9.3.17 Cable warning covers

Interlocking cable warning covers shall be provided for cables laid direct in the ground. The material and dimensions of the covers shall be as specified on drawings.

The location of all directly buried cables shall be marked by concrete slab markers, 600mm square and 100mm thick.

Each HV and LV cable run shall be marked at the point where it leaves the plinth, sub-station, feeder pillar or other current controlling device, and shall be marked at approximately every 60 metres along the cable run with an additional marker at each change of direction of the cable run.

Cable markers shall be installed flat in the ground immediately above the cable with approximately 25mm projecting above the surface. When site fabricated, impress the words 'HV CABLE' or 'LV CABLE' together with a cable reference number as required on each cable marking slab. The letters shall be approximately 100mm high and 75mm wide overall with strokes 12.5mm wide and 6mm deep.



9.3.18 Cable Warning Covers

Service	Material for Cover	Number and Diameter of Cables	Dimensions of cover (length & width)
LV	Earthenware	One not exceeding 50mm One exceeding 50mm or two not exceeding 37.5mm	225 x 150mm 300 x 225mm
HV	Reinforced concrete	One not exceeding 50mm One exceeding 50mm	1m x 150mm 1m x 175mm

The location of each underground cable joint shall be marked by a concrete slab placed over the joint with approximately 25mm of slab projecting above the ground. When site fabricated the word 'JOINT' shall be impressed by the installer on each slab in letters approximately 100mm high and 75mm wide overall with strokes 12.5mm wide and 6mm deep. Joint locations shall also be precisely located on as build drawings, dimensioned from some easily identifiable fixed point on the building.

9.3.19 Cable ducts and draw pits

All cable ducts shall be formed from 100 or 150 diameter uPVC piping, as detailed elsewhere. Ducts shall be laid in continuous lengths with integral joints and shall form a watertight system to prevent the entry of ground water into the duct system (this watertight requirement is not applicable to short ducts for road crossings).

Ducts shall be uPVC to BS EN 1401, complete with vehicle loads, encasement, concrete and draw pits, fittings, etc to make a composite system. All duct routes shall be shown on the installers drawings and agreed on site with the Project Manager prior to installation.

Cable ducts shall only each contain one distribution cable (with any associated pilot or control cables), but for systems such as street lighting etc, multiple cables may be drawn into a duct, so long as the cables do not take up more than 30% of the duct section, the cables can easily be withdrawn and the effect of grouping is allowed for in the current rating of the cables.

All duct and tape colours and identification shall comply with the proposals set out by the National Joint Utilities Group (NJUG). Table 1 in NJUG publication "Guidelines on the positioning and colour coding of underground utilities' apparatus" details the specific requirements

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

Cables installed on private property may not follow the guidelines in this document. The owner concerned should be contacted for information on the colour code applying in these cases.



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

Ducts shall be laid to be self-draining to the cable pits and a drainage connection shall be made to the surface water drainage system.

Ducts shall be kept clear of gas and water pipes, drains, sewers and electrical plant. In order to allow the use of 'tapping' machines on gas and water mains that may be adjacent wherever possible at least 150mm clearance shall be given to these and any other services. No clearance shall be less than 25mm where services cross, the minimum clearance shall be 50mm.

Ducts shall be laid to provide the minimum cover and spacing specified.

Where it is necessary to deflect from a straight line or to vary the depth, as in passing from footway to carriageway or in entering an underground chamber, a lateral set not exceeding 25mm in a length of 750mm or a vertical set not exceeding 25mm in a length of 1.5 metres shall be given to the joints.

Ducts shall be plugged or capped before and after each test. uPVC plugs or caps shall be inserted at the ends of each section of duct to prevent entry of soil or stones.

Ducts shall be cleared in the presence of the Project Manager with a mandrel not smaller than the internal diameter of the duct minus 12.5mm followed by a circular wire brush 12.5mm greater in diameter than the duct just before any cables are drawn in.

Sealing of duct entries to buildings (including service pipes)

After all cables have been installed, both duct ends shall be sealed using mastic or expanding foam to form a vermin, gas, water and fire barrier. The fire rating of the seal shall be as necessary to match the fire rating of the local building structure.

Spare ducts shall be sealed with end caps and mastic to form a vermin, gas, water and fire barrier.

Cables shall be identified where they come into and out of ducts and all labels shall be legible and visible after duct sealing is complete.

9.4 Cabling systems

9.4.1 General requirements

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

All cables shall be colour coded in accordance with the requirements of BS 7671 (taking account of the latest revisions regarding colour compliance. If the contractor is in any doubt as to the colour coding required, particularly with the installation of new cabling within an existing building, then the installer shall seek written confirmation from the CA).

Low-voltage cables shall have a voltage designation as shown below:

Cable type	Standard designation	Voltage rating
PVC insulated and unsheathed	6491X	450/750V
PVC insulated and sheathed	6241Y	300/500V
PVC insulated and sheathed	6242Y	300/500V



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PVC insulated and sheathed	6243Y	300/500V
PVC insulated and sheathed	6181Y	300/500V
LSOH insulated and unsheathed	6491B	450/750V
LSOH insulated and sheathed	6242B	300/500V
LSOH insulated and sheathed	6243B	300/500V
PVC insulated and sheathed	3182Y	300/500V
PVC insulated and sheathed	3183Y	300/500V
PVC insulated and sheathed	3184Y	300/500V
LSOH insulated and sheathed	3182B	300/500V
LSOH insulated and sheathed	3183B	300/500V
LSOH insulated and sheathed	3184B	300/500V
PVC insulated, single wired armoured, PVC sheathed	6942X (PVC/SWA/PVC)	600/1000V
PVC insulated, single wired armoured, PVC sheathed	6943X (PVC/SWA/PVC)	600/1000V
PVC insulated, single wired armoured, PVC sheathed	6944X (PVC/SWA/PVC)	600/1000V
XLPE insulated, single wired armoured, PVC sheathed	(XLPE/SWA/PVC)	600/1000V
XLPE insulated, single wired armoured, PVC sheathed	(XLPE/SWA/PVC)	600/1000V
XLPE insulated, single wired armoured, PVC sheathed	(XLPE/SWA/PVC)	600/1000V
XLPE insulated, single wired armoured, LSF sheathed	6942B (XLPE/SWA/LSF)	600/1000V
XLPE insulated, single wired armoured, LSF sheathed	6943B (XLPE/SWA/LSF)	600/1000V
XLPE insulated, single wired armoured, LSF sheathed	6944B (XLPE/SWA/LSF)	600/1000V

Abbreviations:

PVC – Polyvinylchloride



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LSOH –Low smoke and zero halogen

LSF – Low smoke and fume

XLPE – Cross linked polyethylene

Notes:

PVC insulated as well as PVC insulated and sheathed cables shall not generally be used.

PVC insulated, single wire armoured, PVC sheathed cables shall only be used where cables are either buried in the ground or contained in ducts likely to be saturated with water.

LSOH shall mean low smoke cables which burn with zero halogen content and shall not limit the contractor to using Prysmian cables.

Reduced neutral conductors in multicore cables are not acceptable. Conductors shall be copper unless otherwise specified.

CY, SY and YY type cables shall only be allowed where verifiable cable data stating current (A) rating in appropriate scenarios, thermal constraints applying to that rating, volt drop in mV/A/m and conductor resistance in ohms/km is available before installation.

Comply with the requirements of BS7671 with regard to cables concealed in walls or partitions. In addition to requirements elsewhere in this specification, unskilled labour shall not be permitted for cable installations.

The contractor shall not make any assumptions as to whether or not a buildings electrical installation will be under the control of a skilled or instructed person once in use.

All cables shall be of one manufacture only and shall be delivered to site with appropriate seals if the cable is likely to suffer from water or frost damage. Where cables are supplied on drums, stored for long periods and subject to extremes of temperature, the cables shall be uncoiled and stored in a manner which eliminates the risk of thermal damage to the insulation.

Labels on cable drums shall indicate the manufacturers name, size, description, BS number, classification, length, grade and date of manufacture.

All cable types shall be certified and marked in accordance with the British Approvals Service for Electric Cables (BASEC)

Records shall be kept of all high-voltage cable drum numbers and supporting information. This information shall be indicated on the record drawings indicating the precise location of each length of cable.

Copies of the manufacturer's cable test certificates shall be included in the operating and maintenance manual.

Where conductor sizes are not indicated in the specification and/or the associated drawing(s) they shall be selected in accordance with BS 7671 for the current rating required by the circuit loading, the type of cable, the ambient temperature, the conditions of installation and the maximum voltage drop permissible.

9.4.2 Unarmoured cables

PVC and LSOH insulated and unsheathed cables drawn into conduit and trunking

LSOH insulated cables shall be manufactured to BS 7211. PVC insulated cables shall be manufactured to BS 6004.



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Cables shall only be drawn into a conduit system when it is complete, permanently fixed and thoroughly swabbed out.

The cables shall be looped progressively from point to point and joints will not be permitted. Cables for different voltage bands shall not be installed in the same conduit and trunking systems unless specifically stated in project particular information.

The installation of cables in any conduit shall be in accordance with manufacturers' instructions and BS 7671. Cables shall be installed in conduit and trunking in accordance with IET guidance; however cables in conduit shall occupy no more than 65% of the available space and in trunking, no more than 55%.

Cables shall be drawn in such a manner that it is possible to withdraw any number from the conduit without disturbing the remainder. Wire pulling lubricant shall not be used.

The Project Manager reserves the right to require all cables pulled in with any lubricant to be removed and replaced and conduits cleaned internally.

PVC and LSOH insulated and sheathed cables

Insulated and sheathed cables shall be installed on either cable tray, cable basket or trunking. Cables may also be clipped direct to building fabric as well as concealed within the building fabric in accordance with BS 7671.

Please note that where concealed in the building fabric, the depth of cables and method of mechanical protection may introduce the need to protect the circuit by either RCD or RCBO.

The installation of cables shall be in accordance with manufacturer's instructions and BS 7671.

9.4.3 Armoured cables

XLPE/SWA/PVC cables shall be manufactured to BS 5467.

PVC/SWA/PVC cables shall be manufactured to BS 6346.

XLPE/SWA/LSF cables shall be manufactured to BS 6724

The armouring for multi-core cables shall consist of a single layer of galvanised steel wires complying with BS EN 10257-1. Single core cables shall have non-magnetic armour, such as aluminium wire or strip.

Where cables are buried direct in the ground or laid in ducts, they shall be installed and covered in accordance with the National Joint Utilities Group (NJUG) Standard Volume 1.

Where cables are installed on cable ladder, tray, basket or fixed directly to the building fabric, they shall be securely fixed in accordance with BS 7671. Where cables are exposed to direct sunlight or extremes of temperature, they shall be provided with suitable containment or solar shading as appropriate.

9.4.4 Flexible cables and cords

All flexible cables shall comply with BS 6500 and shall be 450/750V grade PVC insulated and sheathed in normal temperature situations, with various other insulation and sheath properties in 300/600V grade to BS 6141 for higher operating temperatures. The minimum conductor size shall be 1.0mm².

In addition to those flexible cable types listed under general requirements, the following flexible cables and cords may be used in the appropriate situation and subject to authorisation by the CA.

60°C rubber insulated braided twin and three core.



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60°C rubber insulated and sheathed.

60°C rubber insulated oil-resisting and flame retardant sheath.

85°C rubber insulated HOFR sheathed.

85°C heat resisting PVC insulated and sheathed.

150°C rubber insulated and braided.

185°C glass fibre insulated single core twisted twin and three core

The application of the above temperature and constructional features of cables shall be to suit the relevant item of electrical equipment and its operational temperature.

Where an earthing conductor is required for the earthing of metalwork in apparatus and luminaires, it shall be contained within the flexible cord.

Flexible cords for use with lighting pendants and electric lighting fittings

All flexible cables and cords shall comply with BS 6500 and BS 6004. Cables shall be 300/500V grade PVC, rubber or LSF insulated and sheathed as appropriate.

Flexible cords for use with luminaires employing tubular fluorescent lamps or apparatus operating at normal room temperature shall be PVC insulated and sheathed and shall comply with BS6500.

The application of the temperature and constructional features of cables shall be to suit the relevant item of electrical equipment and its operational temperature.

Where an earthing conductor is required for the earthing of metalwork in apparatus, it shall be contained within the flexible cable or cord.

Flexible cables and cords shall be secured at each end with proprietary retaining clamps.

9.4.5 Mineral insulated cables (MICS)

MICS cables shall comply with BS EN 60702 and be either LSF sheathed or bare copper as specified elsewhere in this document.

All persons employed to make terminations on MICS cables shall have attended a course of instruction and they shall demonstrate, if so requested, to the Project Manager their ability to make a satisfactory seal prior to commencing work on the site.

Where terminations are made to flush accessory boxes within a plaster finish cable clamps fixed to the accessory box and firmly gripping the cable seal may be used in lieu of the brass gland.

Where glands are terminated in equipment without screwed entries, a lock washer and back nut shall be used.

Where cables are exposed, shrouds shall be fitted over the glands. These shrouds shall be the same colour as the sheath.

All circuits with inductive loads supplied by MICS/LSF cabling shall be fitted with voltage surge suppressors in accordance with the manufacturer's recommendations.

9.4.6 Jointing

If a run of MICS cable is of a length that exceeds the maximum to which the cable can be manufactured, a through joint will be permitted. Such a joint shall be made with an adaptable box into which shall be fitted a fixed base mechanical clamp type connector of approved design.



9.4.7 Installation

Where MICS cables are not installed on cable tray they shall be fixed by either bare or LSF coated copper clips (as appropriate to the type of cable) of an approved design at a maximum of 375mm centres on vertical runs and a maximum of 200mm centres on horizontal runs.

Where MICS cables pass through floor slabs or other structural work, they shall be protected by short pieces of heavy gauge galvanised steel conduit. The conduit shall be plugged with non-setting cold mastic compound after the MICS cables have been installed.

Where MICS cables without LSF outer sheath run across or pass in close proximity to steel or other conducting building material, water pipes etc the cable shall be bonded to the said materials at intervals to ensure that no difference in potential can exist. Spacing saddles shall be installed to prevent the cables from contact with dissimilar metals.

All cables shall be installed in a neat and workmanlike manner, being dressed into shape and free from corrugations and damage to the sheaths. All cables shall run vertically on walls and at right angles or parallel to floors of the room or areas served. On no account shall diagonal or arbitrary routes be permitted.

Minor runs of not more than two MICS cables may be fixed direct to non-fireproofed structures, masonry and concrete. In all other situations, they shall be run on cable tray.

Multiple runs of MICS shall be laid neatly on perforated cable tray of an approved type, spaced from the tray by multiple fixing cleats recommended by the manufacturer.

All cable routes shall be agreed by the Project Manager before work is started. Cables shall be run at least 150mm clear of all plumbing and mechanical services. The use of conduit and/or cable trunking to enclose conductors shall be kept to the minimum.

Where an MICS cable is connected to a motor or other appliance liable to vibration, the cable shall be taken direct to the terminal box. A coil of one turn to a radius of not less than 100mm shall be formed in the cable to take up their relative movement between the machine and the solid base.

9.4.8 Soft skin fire performance cables

Soft skin fire performance cables are those types capable of continuing to operate when exposed to fire. All soft skin cables used on the project shall comply with BS 7629 and BS EN 50200. All cables shall have insulation complying with BS 7655 to standard EI5.

Where cables using solid inner cores are used, these cables shall be installed without kinks. Any kinked cables shall be replaced throughout their length.

Each termination shall be complete with suitable gland and shroud.

Where cables are used for fire alarm installations, the colour shall be agreed with the Project Manager prior to commencing any installation. Do not assume that red sheathed cables will be accepted.

Cables shall be supplied by the same manufacturer throughout the project when used on a common system.

Care shall be taken when terminating soft skin cables to ensure cores are not compressed together

9.4.9 ELV cables for data and communication use

Cables for data and communications use shall be in accordance with the operational requirements of the system to which they are installed. Where cables run in the proximity of LV cables, they shall have insulation to the same standard.



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Where ELV cables are installed in areas of high moisture, extremes of temperature or exposed to direct sunlight, they shall be protected by suitable containment.

All cables shall be installed in accordance with BS 7671.

9.5 Cable installation & support

9.5.1 Cable support intervals

All distribution and final circuit cabling shall be supported on a cable support system complying with the manufacturers recommendations. Where no recommendations are available, support at the following maximum intervals (dimensions in millimetres) may be acceptable as agreed with the CA.

Cables conforming to BS EN ISO 6346:1995+A3:2012, BS 5467 and BS 6724:

Overall cable diameter not greater than	Non-armoured Vertical	Horizontal	Armoured Vertical	Horizontal
9	400	250	400	250
9 to 15	400	300	450	350
15 to 20	450	350	550	400
20 to 40	550	400	600	450
40 to 60	900	700	900	700
60 upwards	1100	1100	1300	1100

Cables conforming to BS EN 60702:

Overall cable diameter not greater than	Horizontal	Vertical
9	600	800
9 to 15	900	1200
15 to 20	1500	2000



9.5.2 Cable Bending Radii

Cables conforming to BS 6346, BS 5467, BS 6724 and BS EN 60702 shall have the following minimum internal bending radii, unless the manufacturer specifies some greater radius.

Insulation	Finish	Overall Diameter	Multiplying Factor for Minimum Bending Radii
Rubber, PVC or XLPE circular or circular stranded copper or aluminium conductors	Non armoured	up to 10	3
		10 to 25	4
		25 and above	6
	Armoured	all	6
PVC or XLPE solid aluminium or shaped copper conductors lifts 2000V	Armoured or non-armoured	all	8
XLPE insulated above 2000V	Armoured	all	12
Mineral	Copper with or without PVC or LSOH sheath	all	6

9.5.3 Cable glands

All cable glands and terminations shall maintain the IP rating and integrity of the enclosure they terminate into. Unless otherwise specified elsewhere, mechanical cable glands shall be brass to BS 6121. Where proprietary forms of gland made of nylon or similar plastics material are available, they may be used with unarmoured cables.

Indoor glands shall be BS 6121 type CW and outdoor glands type E1W minimum. All glands shall be fitted with close fitting shrouds of the same colour as the cable sheath.

All cables shall be identified at each gland and termination as specified elsewhere.

Cable jointing and terminations



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All joints and terminations shall be made by qualified cable jointers, using jointing materials, components and workmanship recommended by the cable manufacturer and jointing accessory manufacturer. The manufacturers, instructions shall be followed at all times.

Cable ends shall be cut immediately prior to jointing or terminating. Cables left unconnected for more than 24 hours shall be sealed to permanently prevent the ingress of moisture. All XLPE and LSF sheathed cables shall be sealed using proprietary shrink on end caps.

All necessary precautions shall be taken to ensure that strands are not damaged when stripping cable cores. Strands shall be twisted together and mechanically secured at terminations. Under no circumstances shall the number of strands be reduced at any termination.

Prior to jointing or terminating, the armour of all armoured cables shall be cleaned.

Where connections are made to equipment and switchgear without integral cable clamping terminals, insulated compression lugs shall be used for bolted terminal connections.

For core sizes 10mm² and above, all compression connections to components shall be made using tools that cannot be released unless the correct degree of compression has been achieved.

Core terminations shall be securely bolted via lugs to equipment using washers and proprietary shake-proof devices.

The bunching of more than two cores at clamping terminals or bolted connections shall not be permitted.

All cables shall be marked at each end at both sides of penetrations or transits and at any joints to provide adequate identification.

At all joints and terminations all cores, including multi-core spare cores shall be connected. Any unused core of multi-core cables shall be bonded at both ends to earth.

All compression joints for copper conductors shall comply with relevant standards.

9.5.4 Cable installation

Cables shall be run neatly on the surface by means of cleats or on cable ladder rack or tray, or laid in floor trenches or drawn into ducts or buried in the ground, as indicated by the CA.

Cable routes shall be agreed with the Project Manager prior to commencement of work.

Cables shall be run at least 150mm clear of plumbing and mechanical services and below heating and hot water pipework.

Cables passing through structural floors or walls shall have galvanised sleeves, wrapped with a non-combustible tape and grouted in position.

Cables and cable containment systems installed in escape routes shall be in accordance with BS7671

Cables shall be installed in accordance with good installation practice.

Cables shall not be installed or removed from the drum unless the ambient temperature and the temperature of the cable are above 0°C and have been so for the previous 24 hours. Where cables have been subjected to temperatures below 0°C, care shall be taken to ensure that they are above that temperature before they are removed from the drum.

Take all necessary precautions to prevent damage to cables during installation.

Where cables are installed in situations where works by others are incomplete, take all reasonable precautions to protect the cables against damage arising from the execution of such other works.



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In the event of damage to the sheath or armouring of a cable, the cable shall be replaced throughout its entire length.

All cables shall run directly from point to point without joints.

Where a cable changes direction, whether in a horizontal or a vertical plane, the radius of the bend in the cable shall not be less than the minimum laid down in BS 7671 and/or the relevant British Standard and shall comply with the manufacturers guidance, however the bending radius of cables during installation shall be kept as large as possible.

Three-phase groups of single-core cables carrying alternating current shall be laid, in trefoil formation and touching each other. Where this is not possible, the disposition to be adopted shall be agreed with the Project Manager before installation is commenced.

All cables shall be pulled into position in such a manner as to avoid any damage whatsoever to the cable or its sheath. Cables shall wherever possible, be pulled directly from the top of the drum, which shall be supported throughout the operation in such a manner that it is completely free to rotate.

Where circumstances make removal of the cable from the drum before pulling into position unavoidable, the cable shall be laid out neatly on a smooth clean area of ground completely free of debris or anything likely to cause damage to the cable. In such cases, 'figure-eights' shall be avoided wherever possible, and care shall be taken to avoid subjecting the cable to twisting.

An adequate number of cable rollers, each of which shall be undamaged and completely free to rotate, shall be used to support the cable during pulling, in such a manner that no part of the cable can touch the ground, the trench bottom or sides, or the walls of buildings. Cables shall not be dragged over concrete or other surfaces.

The number and positioning of rollers at bends in the route shall be such as to ensure that the minimum bending radius for the cable is not approached.

Cables shall, wherever possible, be pulled into position by hand, using an adequate number of operatives suitably positioned along the length of the cable.

Winches whether power driven or hand operated, and other mechanical aids shall only be used with the prior authorisation of the CA.

Wherever possible, cables which are intended to be winched into position shall be fitted by the manufacturer with a suitable pulling eye, firmly attached to all of the conductors, before being dispatched to site.

Whenever a winch or similar appliance is used, an approved tension gauge shall be fitted into the haulage line between the winch and the cable. The pulling tension must at all times be within the limit advised by the cable manufacturer, which shall be communicated in writing to the Project Manager before the operation is commenced.

Cable stockings, when used, shall be of an approved pattern and the correct size, with swivel eye, in perfect condition, and shall be fitted with care to avoid damage to the cable sheath.

When a cable stocking has been used on a XLPE or LSF sheathed cable and the sheath, after removal of the stocking, shows signs of having been stretched, the cable shall be left for 30 minutes to recover. At the end of this period, if the sheath has not completely returned to its original position, the cable end shall be cut back by an amount equal to the length of the stocking plus 300mm, then immediately resealed.

During the course of pulling operations, the cable shall not be allowed, under any circumstances, to twist or rotate about its longitudinal axis because of excessive pulling tension or for any other reason.



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Whenever the length and arrangement of a cable run is such that excessive tension would be likely to be needed to nose-pull the cable into position, the continuous bond method shall be employed. A wire pulling bond equal in length to twice the cable length, to which the cable shall be securely attached at intervals not greater than 1.8 metres. Snatch blocks shall be used at bends in the run to ensure that the pulling tension is taken by the bond and not by the cable.

Whenever a cable is cut, for whatever reason, the cut ends of both portions shall be immediately re-sealed. LSF and XLPE cables shall be sealed by means of an approved plastic cap embracing the armour wires and outer sheath.

All cable drums shall be handled with care to ensure that they are not damaged. All handling shall be carried out using sufficient and adequate plant and equipment.

All empty cable drums shall be stacked neatly in such a manner as not to obstruct access to, or about, the site or the operations of other trades.

Empty cable drums shall be removed promptly from the site and, in any case, not more than seven days after the cable has been removed from them. At no time shall more than three empty drums be stored on the site unless the Project Manager has agreed otherwise.

Any cable joints shall be enclosed in a permanent joint chamber with removable cover in accordance with the requirements for draw-in pits.

Any work carried out requiring the use of split ducts shall be carried out in such a manner as to permit future cable withdrawal.

In rising ducts open to access, all non-armoured cables shall be protected against mechanical damage by the installation of a 300mm high mild steel 'kick-shield' suitably fixed at floor level. The 'kick-shield' to be of a suitable robust nature and treated against corrosion.

9.5.5 Inspection and testing

After installation and connection, all cables shall be inspected and tested for continuity and insulation resistance in accordance with the requirements of BS 7671. All results shall be recorded by the installer and approved by the CA.

9.5.6 Identification of cables

Except in the case where it is terminated in full view on to a clearly labelled switch, starter, distribution board or similar piece of apparatus, or on to a motor or other item of equipment the function of which is evident, each and every cable end shall be provided with an approved means of identification. In particular, this requirement shall apply to all cables terminating on the back, or in the base, of a cubicle type or similar switchboard or control panel and in any case where the function of the cable is not immediately obvious.

The means of identification shall be one or other of the following, or an approved alternative:

An engraved plastic label securely fixed to the cable sealing box (the cable sealing box must not be drilled or damaged however).

An engraved trafolyte label fixed to the cable with plastic cable ties.

A proprietary cable identification method with numbered/lettered ferrules on a label fixed to the cable.

Self-adhesive embossed plastic labels will not be accepted as permanent.

The cores of all control cables shall be individually identified at terminations, by means of approved plastic ferrules bearing indelible characters, in accordance with the numbering on the relevant wiring diagrams.



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All cables run above ground shall be identified by means of engraved or stamped plastic label at intervals not exceeding 30 metres. The labels shall bear details of the cable size, number of cores, function, and reference number (if any) and shall be securely attached to the cables with cable ties

All cables run underground shall be identified at joint positions, in draw pits, and elsewhere at intervals not exceeding 30 metres. The labels shall bear details of the cable size, number of cores, function, and reference number (if any) and shall be securely attached to the cables with cable ties

All identification numbering shall be agreed with the Project Manager before use and shall be clearly recorded on the 'as built' drawings and in the cable schedules.

9.6 Testing and certification – general

9.6.1 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

The electrical installation shall be inspected and tested as required by BS 7671 and shall then be fully commissioned and left working.

Provide all labour (including specialist), special instruments, materials, fuel, lubricants, coolants, tools, plant and equipment required to carry out the pre-commissioning, commissioning and the performance testing of all elements.

The Project Manager may request tests, at the installers or suppliers premises, of all or any of the materials and equipment used in the Contract Works in any manner he may deem necessary to ensure conformity with the specification. The results of such tests shall in no way relieve the Installer of his responsibilities to ensure that all materials and equipment installed in the works are entirely suitable for the applications and conditions of operations.

The testing of elements under the various sections of the specification may be required to be carried out in parts, or as a whole.

All tests shall be carried out to the complete satisfaction of the CA.

All instruments shall be calibrated immediately prior to commencement of the testing and shall be re-calibrated in accordance with the manufacturer's recommendation during the course of testing, as necessary. Copies of the calibration certificates shall be provided with the test results.

Test instruments used to measure the external impedance (Z_e) of the installation shall be capable of reading as low as 0.001 ohms.

The installer shall demonstrate the installation or any portion thereof, which has been set to work, complies with the requirements of the specification.

Any defects of workmanship, materials, performance, maladjustment, non-compliance with the specification, or other irregularities which become apparent during the tests shall be rectified by the installer, at no additional cost to the contract and the tests repeated at the installers expense until the whole is proved free from defects and in complete working order. All systems shall be left sound and correct.

Publish a programme of the proposed inspections and testing works and detail requirements for the Project Manager to witness such inspections and tests at least fourteen days prior to the beginning of such works.



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The Installer shall provide to the CA, full settings, data and works of all equipment and systems at least fourteen days before beginning such works. The Project Manager shall have the right to comment on such proposals.

9.6.2 Approval and acceptance

After receipt of the results of satisfactory tests, the Project Manager shall authorise the Installer to proceed with the commissioning and system performance tests.

The Installer shall give the Project Manager fourteen days written notice to his intention to demonstrate and seek 'approval' for any item or system.

The Installer shall allow for giving such notice and making adjustments, setting up and other preparations for testing and for witnessing such tests.

9.6.3 Protective device certification

All protective devices except fuses shall be tested to ensure operation within their design parameters and compliance certificates issued accordingly. This test may be carried out off site at the discretion of the Project Manager for devices over 63A provided that each individual protective device can be clearly identified with its certified performance data.

9.6.4 Personnel

Carry out testing work using experienced electrical operatives who are fully trained in the use of the equipment and the requirements of the test. The Project Manager may request evidence of competence for those carrying out testing.

Testing and commissioning of major items of proprietary plant shall be carried out by manufacturer's personnel. The Installer shall be responsible for arranging their programme of works to allow the Project Manager to witness tests as required.

The Project Manager shall ensure that all testing work carried out by such specialist manufacturers is carried out to his, and the CA's satisfaction and in such a way that it does not prevent him proceeding with the overall commissioning of the installation.

9.6.5 Inspection, test and electrical installation certificates

Inspection and test certificates shall be dated, numbered and clearly referenced to the item tested by means of serial, chassis or other manufacturer's reference number permanently marked in a conspicuous position on the item concerned.

The Installer shall issue an electrical installation certificate as required in BS 7671 at the practical completion of the works.

9.6.6 Works tests

The Project Manager shall have the power to inspect at the makers' works, during manufacture and after completion, all or any manufactured material, apparatus or equipment ordered by the installer for incorporation in the Works and to require tests to be carried out in the presence of his representative in order to prove that the said material, apparatus or equipment meets the requirements of this Specification. All costs incurred in carrying out such tests and inspections shall be included in the contract and shall be borne in full by the installer.

The installer shall be responsible for ensuring that the Project Manager is advised in writing whenever material, apparatus or equipment is ready for inspection and/or test at his own or his suppliers'



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premises. At least five days notice shall be given and due allowance shall be made for this period of notice in drawing up the programme of works.

The Project Manager shall have the right to reject any material, apparatus or equipment which, as the result of inspections and/or tests may be found to be defective or unsatisfactory in any respect, or not in accordance with the requirements of the specification, and to require the installer to repair, adjust, modify or replace the defective items before dispatch to site. If the defective item be adjudged by the Project Manager to be unsuitable for repair, adjustment or modification, then it shall be replaced by a completely new item at the expense of the installer.

No inspection or testing by the Project Manager or his authorised representative nor the witnessing of satisfactory tests nor the authorising of dispatch to site shall in any way relieve the installer of any of his obligations under the contract, nor shall it in any way limit the right of the Project Manager to reject such items after delivery to site if they subsequently prove to be defective or unsatisfactory or unsuitable for their intended purpose.

The installer shall be responsible for ensuring that all materials, apparatus and equipment required for the execution of the works are ordered sufficiently early to ensure delivery to site at the correct time as required by the construction programme. It shall be the responsibility of the installer to ensure that adequate time is available for inspection and/or testing by the CA, including the giving of required due notice. No materials, apparatus or equipment subject to inspection and/or test will be recognised as complete and ready for dispatch until after such inspections and tests have been satisfactorily carried out and no claim for delay will be allowed unless the Project Manager has failed to carry out inspection or to waive inspection after being given the specified period of notice.

9.6.7 Site tests

The Project Manager shall have power to inspect all work in progress and upon completion or substantial completion and to require the installer to carry out tests in his presence or in the presence of his authorised representative in order to prove that all work carried out and all material, apparatus and equipment installed are wholly satisfactory and fully meet the requirements of this Specification. All costs and charges associated with or arising from such inspections and tests, including costs incurred by the installer in carrying out the prescribed tests and in attending upon the Project Manager whilst tests and inspections are in progress shall be deemed to have been included in the contract price and shall be borne in full by the installer.

Upon completion of the electrical installation, or any substantial section thereof, the installation or that section and all of the associated electrical equipment shall be subjected to the tests specified in the relevant British Standards together with such other tests as may be required by the Project Manager in order to prove compliance with this Specification. When no relevant British Standard exists, or the appropriate British Standard fails to specify tests, tests shall be carried out to the requirements of the CA.

The installer shall record all the details, measurements and data as required in the relevant standards. All test results shall be written at the time of test in blue ink and signed by the tester and any witness. Alterations or corrections shall be made by crossing out not by over-writing the previous data. No test results shall be corrected with correction fluids or similar correction media. Where the installer is unable to provide the original test certificates as described above, the tests shall be repeated at the installers cost.

The installer shall provide the original and a copy of the inspection and test sheets, together with any supportive documentation required by the relevant standards, to the Project Manager within two days of the tests being carried out.

The inspection and test documentation shall indicate all of the test instrument details including the manufacturer, type, date of calibration, scale used and the recorded results/tolerances.



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The result of each and every inspection and test carried out in accordance with the provisions of this Specification, whether or not witnessed by the Project Manager shall be accurately recorded on an approved form of test certificate signed by the person in charge of the testing procedure. Test results shall be written at the time of test in blue ink and signed by the tester and any witness. Alterations or corrections shall be made by crossing out not by overwriting the previous data. No test results shall be corrected with correction fluids or similar correction media. Where the installer is unable to produce test results as described above the test shall be repeated at the installers cost.

An additional copy of every test certificate relating to site tests of the completed installation or parts thereof shall be included in the operation and maintenance manual.

The installer shall give at least fourteen days notice to the Project Manager when the works or substantial sections thereof, will be completed and ready for inspection and test and before covering such works.

The Project Manager shall have the right to reject any material, apparatus or equipment which, as the result of inspections and/or tests may be found to be defective or unsatisfactory in any respect, or not in accordance with the requirements of the Specification, and to require the installer to repair, adjust, modify, or replace the defective item. If the defective item be adjudged by the Project Manager to be unsuitable for repair, adjustment or modification, then it shall be replaced by a completely new item at the expense of the installer.

No material, apparatus, equipment or installation shall be covered or otherwise permanently concealed from view until the Project Manager has had the opportunity to inspect it and either has formally waived his right to inspect it or has given written authorisation for covering to proceed following satisfactory tests and/or inspection.

9.6.8 Commissioning

Following the satisfactory conclusion of final inspections and tests on completed sections of the works, the installer shall duly commission each section of the electrical installation and leave it in full working order. For the purpose of this specification, the term 'commissioning' shall be deemed to include:

The energising of electrical distribution circuits and equipment that have previously been inspected, tested, and found satisfactory and capable of being energised with complete safety.

The setting of electrical protective devices and systems, where relevant, in accordance with the directions of the Project Manager or, failing such directions, in accordance with sound engineering practice.

The starting up of all electrically powered plant and equipment, including that supplied and installed under other contracts, as detailed in the annexed schedules.

The verification of the performance of all such plant and equipment by the carrying out, where required, of further tests and the making of all necessary adjustments so as to obtain optimum performance.

Mere compliance with the requirements of this section of the Specification shall not by itself in any way relieve the installer of any of his obligations under the contract.

No approval given by the Project Manager in connection with the commissioning process, whether by way of approval of procedures carried out or proposed, or approval of results obtained shall in any way relieve the installer of the contractual and statutory obligation to ensure that all connections and adjustments are made correctly and that the installations and equipment are handed over in a complete safe and satisfactory condition. Where required commissioning shall be carried out by the equipment manufacturer's commissioning engineers.

No connections or adjustments shall be made to plant or equipment that has already been commissioned and set to work, except with the prior consent of the CA.



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All commissioning procedures shall be carried out in a safe and satisfactory manner and in accordance with the provisions of the Electricity at Work Regulations, the Health and Safety at Work Act, and the Electricity Safety, Quality and Continuity Regulations (where appropriate), to the complete satisfaction of the CA.

The Project Manager shall have power to require that the whole of the plant, equipment and installations, or selected parts thereof, be re-inspected and, if necessary, re-test immediately before the end of the contractual maintenance period, and the installer shall be responsible for making all necessary arrangements with the Employer.

All commissioning documentation and certificates shall be included in the operation and maintenance documentation.

9.6.9 Periodic inspection and testing

Include recommendations within the operating and maintenance manuals that the installation be inspected and tested in accordance with BS 7671 and include a recommended maximum period before re test based on the advice given in BS 7671 guidance notes.

9.7 Panel boards

9.7.1 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

The panel board assembly shall be suitable for connection to the supply system as stated in the design criteria.

Panel boards for the purposes of this specification are defined as wall mounted MCCB or fuse boards intended to provide re-distribution and circuit protection of distribution cables between switchboards and distribution boards.

In smaller installations, panel boards may be used as switchboards if stated on drawings or in particular elements of this specification.

9.7.2 Rated voltage

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

9.7.3 Panel board assembly

The assembly shall be designed and constructed to withstand the thermal and mechanical stresses set up by short-circuit conditions from a source fault level as stated elsewhere.

The numbers, sizes and ratings of units incorporated within the panel board shall be as indicated on the drawings and schedules.

The assembly shall be a CE marked, ASTA certified, multi-cubicle, type-tested assembly (TTA) to BS EN 61439-1 with Form 4 segregation in accordance with BEAMA Installation recommendations. The type of Form 4 segregation is stated elsewhere. A copy of the specific certification shall be provided to the Project Manager and included in the operational and maintenance manuals.

The assembly shall be manufactured from high grade, machine folded/welded, zinc coated, sheet steel of not less than 1.5mm thickness.



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The assembly shall have characteristics appropriate to the conditions upon which the design is based. Equipment shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection.

Doors shall be provided with neoprene gaskets. Door handles shall have an integral cylinder lock and two keys shall be provided for each lock. Keys shall be fully labelled and handed to the Project Manager at practical completion.

Removable un-drilled gland plates not less than 2 mm thick shall be provided. Gland plates for single core cables shall be non-magnetic.

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

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

Removal of any covers for cabling outgoing circuits shall not expose any live parts.

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

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

Where a source of generation is to be installed and connected to the installation, the source shall be provided with overcurrent protection on the a.c. side.

Generation systems shall only be connected into the system on the live side of the main switchboard and not panel boards.

All feeder equipment shall be ASTA certified, independently operated, capable of being locked in the OFF position and suitable for uninterrupted duty in the closed position at rated loads.

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

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

Life safety equipment circuit to be identified by highlighted in red with DO NOT SWITCH OFF labelled.

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

9.7.4 Busbars

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

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



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9 General Requirements for Electrical Services

Busbars shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin as noted above.

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

Means shall be provided to prevent arcs or arc products occurring on one busbar from affecting the other busbars.

Access to busbars and connections shall only be possible by the use of tools.

9.7.5 Earthing

The earth bar shall be drilled to accommodate all protective conductors and the incoming supply cable earth as well as a connection to an external earth bar.

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

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

All equipment and metalwork, including gland plates, shall be connected to the panel board earth bar. All hinged doors and removable covers shall be bonded by separate flexible earth conductors.

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

The earth bar shall be manufactured from HDC Copper.

9.7.6 Identification of switch panels

Identification and warning labels shall be in accordance with BS 5499:Part 1.

Switch panels shall be permanently identified. Labels shall be of a laminated plastic material attached to the apparatus by screws. Lettering shall be black on white labels and the wording shall be agreed with the CA.

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

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

A warning label shall be fixed to the front of the switch panel.

9.7.7 Labels and diagrams

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

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

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



9.8 Distribution boards

9.8.1 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

All distribution boards shall be type-tested and comply with BS EN 61439-1 and BS EN 60439-3. They shall be suitable for surface mounting, have lockable doors (supplied with two keys) and be controlled by an on-load integral disconnecter. Keys shall be labelled and handed to the Project Manager at practical completion.

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

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

The earth bar shall have the capacity to connect to an external earth bar.

Where specified elsewhere a separate isolated secondary earth bar shall be provided within the enclosure. This earth bar shall be of similar size to the protective earth bar but shall be insulated from the remainder of the assembly.

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

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

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

- Internally IP32
- Externally IP65

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

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

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

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

9.9 Identification of distribution boards

Identification and warning labels shall be in accordance with BS 5499:Part 1.

Distribution boards shall be permanently identified. Labels shall be of a laminated plastic material attached to the apparatus by screws. Lettering shall be black on white labels and the wording shall be agreed with the CA. The characters shall be at least 10mm high and 1.5mm thick.

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



A warning label shall be fixed to the front of the switch board

9.10 Circuit breakers and RCD's

9.10.1 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

9.10.2 Moulded case circuit-breakers (MCCB)

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

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

MCCB's shall be full load rated for continuous use under normal operating conditions. They shall be capable of operating at their maximum setting 24 hours a day continuously.

For switchboard mounting MCCB's shall be the cubicle mounting type with door mounted padlocked rotary type operating handle. They shall be of the fixed pattern with fully shrouded fixed contacts. Interlocks shall be provided to prevent the opening of the front cover with the operating handle in the 'ON' position.

MCCB's shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection.

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

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

Ensure that demonstrable discrimination is achieved between the up and down stream devices. Selection of MCCB's on the cascade principle will not be accepted.

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

All MCCB's shall be clearly labelled.

9.11 Fire alarm systems

9.11.1 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

The fire alarm systems shall be provided as shown on the drawings and as specified elsewhere and shall conform to the requirements of BS 5839 and BS EN 54 (all current parts as applicable)



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9 General Requirements for Electrical Services

The design is provided at scheme level and detail design along with supply, installation and commissioning shall be carried out by the contractor. This will allow the design to be optimised to the contractors preferred fire alarm manufacturer.

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

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

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

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

Category P : Automatically activated systems designed to protect property

- P1 - Systems installed throughout the protected building.
- P2 - Systems installed only in defined parts of the protected building.

A similar categorization system for dwellings is described in BS 5839 – Part 6.

The category designation for the fire detection and alarm system to be installed will be stated in the particular requirements of this specification.

9.11.2 System types

The table below gives an overview of system types



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9 General Requirements for Electrical Services

Type	Description
Manual system	A system which relies on persons detecting a fire and using the fire alarm system to raise awareness to all in the building.
Conventional monitored	A system where detectors, manual call points and sounders are wired as radial circuits with an end of line device. The fire alarm system monitors output states “normal” or “fire” as well as “fault”.
Analogue or digital addressable	A multi-state system in which signals from devices are individually identified at the control and indicating panel(s). The system is wired as a loop or series of loops, dependent on the complexity of the installation.
Radio based system	A system where some or all of the interconnections between components are made by radio links.
Aspirating System	A system which monitors the particulates within the air and raises an alarm if the level of smoke particulates goes above a pre-determined level.

The system type (or types depending on the complexity of the design) for the fire detection and alarm system to be installed will be stated in the particular requirements of this specification.

9.11.3 Manual call points

Manual call points shall comply with BS EN 54-11 for “Type A” operation i.e. Direct Operation.

Manual call points shall be coloured “Red” with a frangible element covering the push button. Manual call points shall be clearly labelled with the text “FIRE”.

Manual call points shall be mounted no higher than 1200mm AFFL and in compliance with the Disability Discrimination Act. The contractor shall obtain final written approval from the Building Control Officer (BCO) prior to installation.

Manual call points shall be flush or surface mounted to suit adjacent accessories.

9.11.4 Fault Monitoring

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

- Short circuit in any circuit serving manual call points or detectors.
- Open circuit in any circuit serving manual call points or detectors.
- Removal of any manual call point or detector that is designed to be detachable.
- Short circuit of any circuits serving fire alarm devices.



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9 General Requirements for Electrical Services

- Open circuit of any circuits serving fire alarm devices.
- Short circuit / open circuit of any wiring between power supplies and fire alarm devices.
- Any earth fault condition.
- Any operation of circuit protective device serving any fire alarm device.

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

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

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

9.11.5 Power Supplies

Power supply units shall comply with BS EN 54-4

The power supplies shall normally be 24 volts DC derived from the mains via bridge rectifier / transformer equipment, but in the event of a mains failure the system shall operate from a battery system for a minimum of 24 hours, after which there should be sufficient capacity to operate the sounders for 30 minutes.

9.11.6 Remote Signalling

Remote signalling to alarm monitoring centres, such as RedCare shall be provided in accordance with BS 5979 if stated as a particular requirement elsewhere in this specification.

9.11.7 Fire alarm interfaces

The fire alarm system shall be interfaced with specialist systems and equipment as identified in the scope of works section to ensure the operation as described.

9.11.8 Wiring

The fire alarm system will be wired using either MICS or “enhanced” grade fire resistant “soft skin” cable in accordance with BS 5839-1. Where there are particular requirements to use a specific cable type, this is identified in the particular requirements of this specification or on drawings.

Mixture of cable types will not be permitted. Cables shall only be supplied from one manufacturer for the entire system to avoid known impedance problems caused by mixing different manufacturers cables.



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9 General Requirements for Electrical Services

Where used, the enhanced fire resistant cable will meet the PH120 classification when tested in accordance with EN 50200.

Cable used for power supplies to fire alarm panels, repeater panels or auxiliary power supplies shall have a minimum PH120 rating and be in accordance with BS 8519 Category 3.

The minimum cross sectional area of the fire alarm cables shall not be less than 1.5mm².

The fire alarm cable shall have a LSZH outer sheath, preferably coloured red. Other colours may only be used if specified in the particular requirements of this specification or identified on associated drawings.

9.11.9 Installation and test

The fire alarm system shall be installed and tested in accordance with the requirements stated in BS5839-1.

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

9.11.10 Commissioning and handover

The fire alarm system shall be commissioned in accordance with the requirements stated in BS5839-1. The commissioning engineer shall measure and record sound level readings.

9.11.11 Documentation

In accordance with BS5839-1 the fire alarm installer shall provide the following documentation on completion of system commissioning: -

Certificates for Design, Installation and Commissioning.

Operation and Maintenance Manual.

“As fitted” drawings.

Log Book.

Record of agreed variations from the original design specification.

BS7671 – Electrical Installation test certificates.

9.11.12 Logbook

The fire alarm installer shall provide at handover a fire alarm system log book in accordance with Annex F of BS5839-1.



10. Completion and Handover

10.1 Handover requirements

As a pre-requisite to Practical Completion in respect of the contract works or part thereof, demonstrate to the satisfaction of the Project Manager that:

All the contract works are complete. With the exception of minor snags or limited defects as agreed with the Project Manager 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 reports signed by an approved competent person

A complete demonstration of the contract works including fully functional operational controls tests undertaken in the presence and to the satisfaction of the CA.

All necessary certification by the Employer's insurers has been completed.

All approved record documentation including record drawings, operation and maintenance manuals, etc is approved and issued

All information required for the health and safety file is issued to the satisfaction of the Planning Supervisor.

All necessary Statutory Authority approvals have been undertaken and written confirmation established

Completion and issue of building log book information in accordance with Building Regulations.

Should adequate record documentation not be available Practical Completion will not be granted.

10.2 Reading of meters

On completion of the Works record readings of all water, gas and electricity meters and forward to the CA.

10.3 Recommended spares

Before practical completion submit to the Project Manager 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 Works.

Submit the schedule of spare parts six weeks before practical completion

The schedule shall be priced in detail and include the following information for each item:

- Manufacturer's current price (including packaging and delivery to site)
- Quantity to be provided



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10 Completion and Handover

- Manufacturer's reference for the item
- Referencing to the plant and equipment installed
- Purpose
- Identify the items that are additional to those specified and included in the contract price.

Submit to the Project Manager a quotation, priced in detail, for the additional items.

10.4 Supply of spare parts

Two weeks prior to practical completion provide all specified spare parts and the additional items if so instructed by the CA.

For each spare part provided include for and undertake to:

- Check that each spare part is suitable for the replacement of the corresponding part supplied with the plant and equipment installed
- Reference to the plant and equipment information in the operating and maintenance manual so purpose is clear
- Label and reference in accordance with the schedule of spare parts
- Paint, grease and pack as necessary to prevent deterioration during storage

All spares shall be contained where practicable in protective containers.

10.5 Recommended tools

Prior to practical completion submit to the Project Manager 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 Works.

Submit the schedule of tools and portable instruments six weeks before practical completion

The schedule shall be priced in detail and include the following information for each item:

- Manufacturer's current price (including packaging and delivery to site)
- Quantity to be provided
- Manufacturer's reference for the item
- Referencing to the plant and equipment installed
- Purpose

Identify the items that are additional to those specified and included in the contract price. Submit to the Project Manager a quotation, priced in detail, for the additional items.

10.6 Supply of tools

Two weeks prior to practical completion provide all specified tools, keys and portable instruments and the additional items if so instructed by the CA.

Include for and undertake to:



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- Check that each item is suitable for the intended application
- Label and reference each item identifying purpose and the plant or equipment
- Paint, grease and pack as necessary to prevent deterioration during storage

All tools, keys and portable instruments shall be secured and contained in lockable cabinets that will be located as agreed with the CA.

10.7 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.

Provide a programme for the inspection and certification and inform the Project Manager when the installation or equipment is ready for examination.

Ensure all necessary information is 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 and provide all necessary attendance, access and facilities for inspecting and testing as is required.

No equipment or installations subject to inspection and certification will be accepted on behalf of the Employer unless a satisfactory certificate has been received from the insurers.

The Employer will place an order with the insurance company and all insurance company charges will be paid for by the employer.

All other costs associated with such inspections shall be included in the contract price.

10.8 Instruction of employer's staff

At a time to be agreed with the Project Manager and prior to practical completion instruct the Employer's staff in the use, correct operation and general maintenance of the Works and be satisfied that such staff is competent to take over the installation on completion. Include adequate periods to instruct the Employer's staff in the operating and maintenance of the Works.

Submit to the Project Manager for approval a detailed training programme and method statement for the training of the Employer's staff two weeks before commencement of training.

During such periods of instruction undertake and be responsible for the correct operation and maintenance of the installations.

Employ the services of relevant specialists and suppliers necessary for this purpose and provide each person with a comprehensive set of teaching notes and diagrams.

All the associated training equipment required by the trainer(s) to enable the training to be demonstrated effectively shall be provided.

For all instruction periods maintain training records which shall be submitted to the Project Manager on completion. All attendee names shall be recorded and signatures obtained from all attendees confirming they have understood the training given. A schedule of names shall be provided within the operating and maintenance documentation.



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All health and safety issues relating to the Works shall be brought to the attention of all attendees.

All attendees shall be provided with the appropriate Personal Protective Equipment (PPE).

Provide each person with a comprehensive set of teaching notes and diagrams.

'Formal' presentations shall be carried out over 'half day' periods.

As an indication, the training for operating staff should include, but not be limited to:

Building services system scope (demonstrated with the aid of schematics and/or other drawings/visual aids). To include an overview of the purpose and normal operating functions of the Works and explaining the philosophy and method of control used.

Demonstration and training (by controls Specialist) of the building control system.

An electronic projector style 'walk through' of the operation and maintenance manuals, highlighting important areas of health and safety together with all other items of importance.

Highlighting, demonstrating and providing delegate experience in all maintenance procedures identified in the O&M Manuals.

Physical tour(s) of inspection of the Works illustrating aspects covered in the 'classroom' and the location of essential isolating points of all incoming services.

Explaining and illustrating all operator alarms, their possible causes and actions required.

Explaining all known and typical fault scenarios which are capable of being recognised and/ or rectified by the operators.

Identifying and demonstrating all safety equipment and interlocks including all interlocks with other suppliers' systems /equipment.

Identifying the noise levels in the various areas and highlighting the need for any protection required.

Specifying and illustrating any hazards associated with the Works and the methods employed to deal with them.

Providing instruction on the correct operation of plant items and the safe limits of their operation.

Explaining the mode of operation and sequence of events resulting from both power failure and fire alarm conditions.

Demonstrating any alarms and explaining they're meaning and possible causes.

Highlighting any associated hazardous maintenance materials which may require special disposal considerations.

Highlighting the signs, cause and effect of known/ possible breakdown or fault conditions.

Indicate and demonstrate (where practicable) arrangements made for access and removal of specific items of equipment or key large or heavy subassemblies / components.

Demonstration of the safe day to day running and maintenance of all systems, plant and equipment.

Providing sufficient expertise to address delegate questions.

The training for the operation of the controls, monitoring or BMS installations shall include as a minimum:

- Initial training at the works of the controls supplier including hands on experience of equipment and software similar to the installation.



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- 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.
- The provision of all appropriate reference and training manuals.
- Complete initial instruction prior to commissioning of the installed system.
- Site instruction on the installed system.

Together with the controls and commissioning specialists, be available for an agreed period as agreed with the Project Manager to assist the Employer's personnel in the operation of the various systems following practical completion and occupation of the buildings.

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

10.9 Operation of systems prior production of record documentation

Provide attendance, at no expense to the Employer, to put into service, operate 24 hours a day and maintain the systems to the Tender Deliverables, including the provision of suitable competent labour, in the event that the record drawings and/or maintenance manuals are not available when the Works would, in the opinion of the CA, otherwise qualify for practical completion.

Failure to provide this service satisfactorily the Employer shall be entitled to make his own arrangements and recover the full cost through

10.10 System demonstration

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

Full running and operation for a period of at least 1 day (24 hours) shall be considered reasonable for this demonstration and this period shall be allowed in the programme.

During this period be responsible for the recording of results and the operation and maintenance of the plant. If appropriate, use this time to instruct the Employer's staff in the operation and maintenance of the systems.

Provide an operational report of the demonstration and print out of the conditions maintained within the space for the required demonstration period.





Appendix A

Tender Forms



Appendix A Tender Forms

A.1 Form 1 – Tender Price Schedule

Table 2. Tender Price Schedule

Item	Description	Unit Price (£)
1	Consumer mains	£
2	Distribution boards	£
3	Submains	£
6	General power and equipment wiring	£
7	Cable rerouting and diversions	£
8	Power cable	£
9	Fire detection and alarm system	£
10	Strip out	£
11	Domestic Cold Water	£
12	Domestic Hot Water	£
13	Low Temperature Hot Water	£
14	BMS and Controls	£
15	Commissioning & Testing	£
16	Operation & Maintenance Manuals	£
17	As built Drawings	£
18	Maintenance, Defects & Liability Period	£
Total		£



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