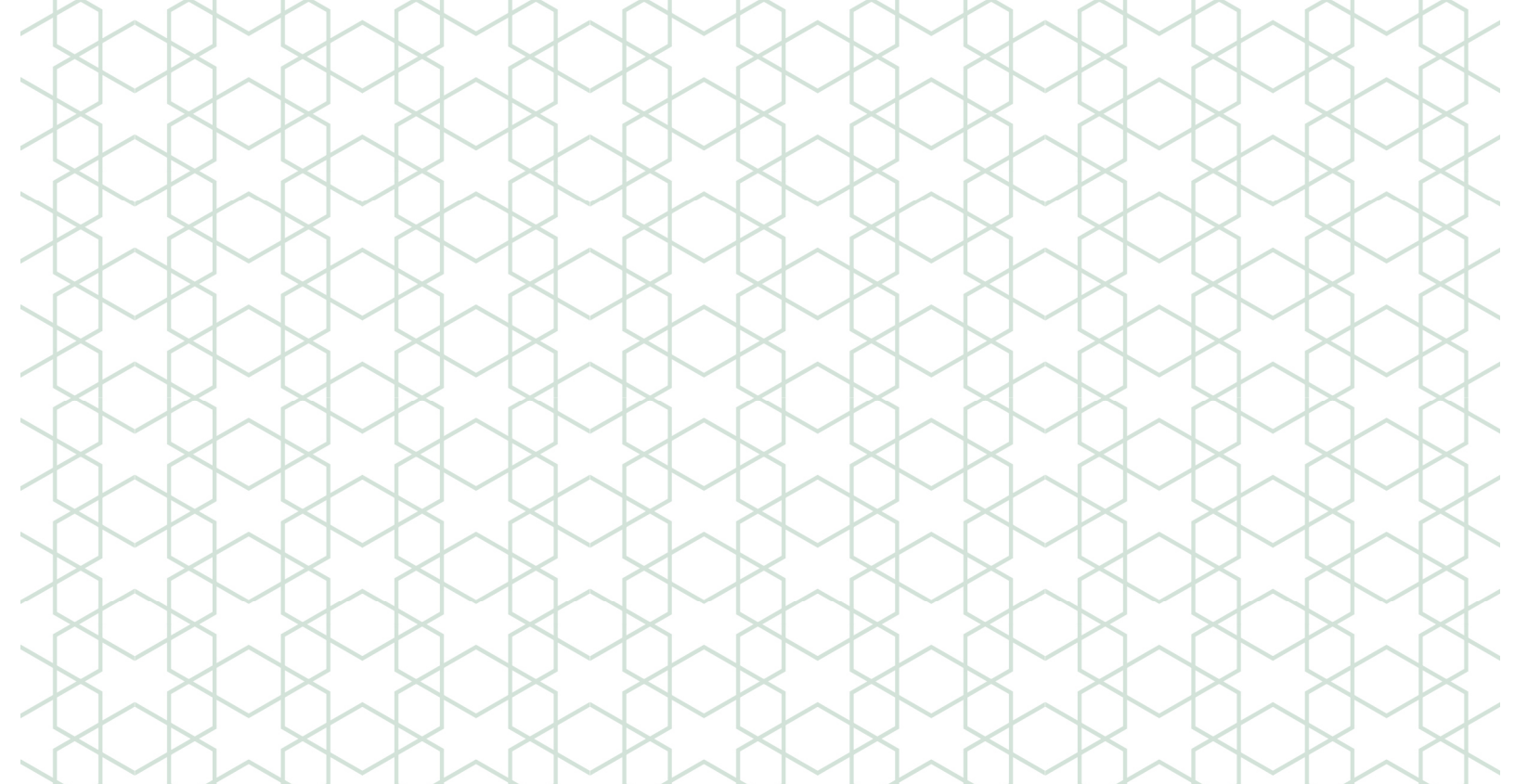




HOARE LEA 

**Computer Science & ITS
Project.
Eddie Newcombe.**
University of Manchester.

PART B - PROJECT DETAILS AND SYSTEM SPECIFICATIONS
REVISION T01 - 22/08/25

Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
P01	05/08/25	Stage 4i Issue	EJG/EY	RCM/CW	EJG
T01	22/08/25	Tender Issue	CW	EJG	EJG

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B Complete buildings/structures/units.

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B1 Introduction.

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1. Title and nature of project.

- 1.1 ITS & Computer Science – Eddie Newcombe Building at the University of Manchester
- This project aims to refurbish areas of the Eddie Newcombe building and redesign the corresponding MEP services to accommodate members of the ITS Faculty.
- 1.2 As-fitted information available is limited and the accuracy of which is unknown. The Contractor is required to carry out comprehensive site surveys, including but not limited to ceiling and floor intrusive surveys, to verify the as-built information provided by the University of Manchester before commencing the proposed works.
- 1.3 The Contract for proposed works in the Eddie Newcombe building is traditional full design. The Tender documentation has been developed to a RIBA Stage 4i level of detail by the M&E consultant and the M&E contractor will then be responsible for taking responsibility of the design through to coordinated working drawings, fabrication information and as-installed information.
- 1.4 The works are identified on the design team drawings and involve providing new services and stripping back, modifying and extending existing services systems to facilitate the proposed layouts and servicing requirements. The project includes:
- Provision of new kitchen / teapoint, breakout, forensic lab, and meeting / office rooms. Existing air grilles, attenuators, and ductwork to be relocated and/or re-utilised where possible. Provision of new air grilles, attenuators, and ductwork in newly constructed rooms. New builder's work apertures to be created in new walls and existing wall penetrations to be extended to accommodate new ductwork where necessary, as detailed in design drawings.
 - New domestic /drainage connections to be made from existing domestic /drainage system to serve the new kitchen / teapoint
 - Provision of 1 No. new Heat Recovery Unit to replace existing HRU 1 in situ due to an increase in total required air flow rate for a higher occupancy in the new design
 - Provision of updated power and data to refurbished spaces
 - Replacement of lighting in refurbished areas to meet updated space requirements.
 - Provision of new fire alarm system services in refurbished areas to meet the updated space requirements.
 - Provision of new door access control systems in refurbished areas to meet the updated space requirements.
- 1.5 Works are undertaken in the Eddie Newcombe building with services to be maintained live to other areas of the adjacent spaces (John Owens Building).

2. The site.

- 2.1 The Eddie Newcombe Building is a two-storey building (lower ground and ground floor) and is currently occupied by university staff. The Eddie Newcombe Building will house the relocated Security, Research and Non-Operational teams – part of the ITS function.
- 2.2 The M&E installer shall consider the as-built information provided by the University and reflect this in their proposed works phasing.
- 2.3 Protection and safety of the existing building is covered in section A34.
- 2.4 Refer to the wider design tender pack for further information relating to the site including further surveys.
- 2.5 It is imperative that vehicle and pedestrian access to the existing live building and associated departments is maintained throughout the works.

- 2.6 Any isolation or shut-downs of existing systems are to be agreed in advance with the University and the required method statements submitted well in advance of any works.
- 2.7 Works to existing systems need to take into account connections to adjacent areas with any impact or temporary downtime notified to the University and managed.
- 2.8 Out-of-hours work may be required to facilitate connection into existing systems, isolations, etc, whilst maintaining a live building.

3. Client/ professional team.

- 3.1 Refer to the Tender pack for names and contact information of parties involved in the design and construction of the project and its administration.

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1. Summary of building engineering services systems to be provided.

1.1 The building engineering services systems covered under the scope of this document include systems described under the following Uniclass system categories, and any other system or sub-system detailed in the attached specification(s) or on the associated tender drawings:

- Ac_70 Electrical activities
- Ss_25 Wall and barrier systems – holes/chases/covers/bunds/supports for engineering services
- Ss_25_60 Wall and barrier accessory systems – sundry insulation/proofing work/fire stops
- Ss_50_30 Above-ground drainage collection systems
- Ss_55_70 Water distribution and supply systems
- Ss_60_40 Space heating and cooling systems
- Ss_60_60 Refrigeration systems
- Ss_65_40 Ventilation systems
- Ss_65_80 Air conditioning systems
- Ss_70_10 Electrical power generation and transmission systems
- Ss_70_30 Electricity distribution systems
- Ss_70_80 Lighting systems
- Ss_75_10 Communications systems
- Ss_75_40 Security systems
- Ss_75_50 Safety and protection systems
- Ss_75_70 Control and management systems

2. Schedule of drawings.

2.1 Refer to the tender pack for tender drawing schedule.

3. Scope of work.

3.1 All Works detailed in the specification or schedules or shown on the tender drawings, and the following site-based activities (only activities specifically declared as "at works" or "off-site" may take place off site):

1. Undertake specific design activities as indicated in section A20.
2. Provide Co-ordinated Working Drawings, Installation Drawings, Builder's Work Information, Builder's Work Details and Record Drawings, as defined in BSRIA BG 6 and as specified in section A11 of this specification.
3. Provide detailed wiring diagrams for all equipment and control panels as specified in section A11 of this specification.
4. Undertake surveys as detailed in section A12 of this specification.
5. Ensure the complete integration of the Works with the remainder of the project.
6. Inspect all plant, equipment and materials as delivered or, where specified, at the manufacturer's works.
7. Arrange delivery, offloading, lifting, hoisting and all other storage and movement of all plant, equipment and materials as specified in section A34 of this specification.
8. Install and fix correctly all plant, equipment and materials including positioning, levelling, packing, and shimming. Install and fix all secondary steelwork necessary to support the

installed plant. Provide all supports up to and including the final attachment to primary structure.

9. Supply and install all collars, flashings, kerbs, stopping up and sealing required for the associated building engineering system(s) to achieve weatherproofing and acoustic stopping of services passing through the internal and external elements of the building.
10. Ensure all associated work (including electrical wiring, connecting pipework, builder's work, etc), is properly executed.
11. Test and commission the complete installation(s) as specified in section B4 of this specification.
12. Prepare such reports, calculations and details as required for submission to any appropriate authority including the co-ordination of such information by suppliers, specialists etc needed to be included in any submission.
13. Demonstrate that the equipment is capable of the performance and method of operation specified, and that the overall and complete systems perform correctly in the required manner and as intended by the specification to the satisfaction and acceptance of the Contract Administrator (including return visits for seasonal tests). Provide the full set of test results in an approved format for all tests, commissioning and balancing operations. Refer to sections B4 and *Building monitoring and management systems* (Ss_75_70_54_10) of this specification.
14. Provide operating and maintenance instruction manuals for the complete systems as specified in section A37 of this specification.
15. Provide building log-book(s) as specified in section A37 of this specification. (On projects that have separate mechanical and electrical Installers this duty is the mechanical Installer's duty, unless specified otherwise.)
16. Instruct the Employer's staff in the use, operation and maintenance of the installations, as specified in section A37 of this specification.
17. Hand over all specified tools, keys, spares, oils, chemicals, etc as detailed in section A37 and elsewhere in the specification.
18. Remove existing building engineering services systems as described elsewhere in this specification, where applicable.
19. Mark on site actual locations of all builder's work holes, chases etc as described in section A11 of this specification.
20. Carry out maintenance of existing building engineering services systems during or throughout, as appropriate, the Works.
21. Provide material samples, method statements, equipment technical literature and any other submissions detailed within this specification. Refer in particular to sections A11 and A33 of this specification.
22. Ensure all materials, equipment and components used, together with methods of installation, comply with Statutory Requirements.
23. Prepare an asset register and provide asset labelling as specified in section A37 of this specification.

4. Schedule of timings.

- 4.1 Allow the time periods detailed in the main contract preliminaries, or, where the main contract preliminaries are silent, allow the time periods listed below for the follow items relating to submission of and comment on information.

Item	Clause	Timing
Comment on installer's drawings / models and technical submissions	A11, 6	At least ten working days
Comment on samples	A33	Within ten working days of receipt
Issue of draft operating and maintenance instruction manuals and record drawings / As-built building information model	A37, 1	Prior to the testing and commissioning period, or eight weeks prior to completion or completion of section, whichever is earlier
Comment on draft operating and maintenance instruction manuals and record drawings / As-built building information model	A37, 1	Within four weeks of receipt of the drawings

5. Services strategy.

5.1 Refer to the engineering specification sections for further details.

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1. Design criteria.

- 1.1 Refer to individual engineering specification sections for design criteria.
- 1.2 Comply with all University codes and EPM documents unless detailed and agreed in the derogation schedule.
- 1.3 Comply with all relevant standards and Codes of Practice. Refer to the derogation/clarification information for any agreed derogations against the standards.

2. Codes and standards.

2.1 Statutory requirements and regulations.

- 2.1.1 Carry out the Works in accordance with all relevant standards and Codes of Practice current at the time of Tender and applicable to the location of the project, and all Statutory Instruments and Regulations as they apply to the project,
- 2.1.2 Ensure that all products that are subject to 'The Construction Products Regulations' (CPR) bear a UKCA/UKNI/CE marking as required by relevant market and are accompanied by a Declaration of Performance (DoP). Include the DoP, along with any other information required to be provided by the Regulations, in the operating and maintenance manual.
- 2.1.3 Ensure that all energy-related products that are subject to 'The Ecodesign for Energy-Related Products Regulations' are compliant on installation with the applicable implementing measure(s) listed in the Schedule 1 - Declaration of Conformity as amended from time to time by The Ecodesign for Energy-Related Products and Energy Information (Amendment) Regulations. Ensure that all energy-related products bear a UKCA/UKNI/CE marking as required by relevant market and comply with all other labelling requirements of the Energy-Related Products Regulations.
- 2.1.4 Comply with *Fire Prevention on Construction Sites, The Joint Code of Practice on the Protection from Fire of Construction Sites and Buildings Undergoing renovation*, published by the Fire Protection Association, including, where required, producing a strategy for the execution of your Works in accordance with the Code.
- 2.1.5 Carry out the Works in accordance with the requirements and regulations of all relevant local authorities, fire brigades, and utility providers including drainage, electricity, gas, telecommunications, and water supply. Notify all such authorities in accordance with their regulations and obtain any required approvals for the installation.

2.2 Reference documents.

- 2.2.1 Legislation, standards and guidance applicable to individual systems and products are listed in the individual system and reference specification sections.

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1. Testing and commissioning.

- 1.1 For mechanical testing and commissioning requirements refer to section B4 and the testing and commissioning clauses of the individual system specification sections.
- 1.2 For electrical testing and commissioning requirements refer to section B4 and the testing and commissioning clauses of the individual system specification sections.
- 1.3 Ensure that the commissioning of metering installations and effective user interfaces, are included in the commissioning of the building services installations, as applicable.

1.4 Systems to be commissioned.

- 1.4.1 The systems that will be commissioned in this project are shown in the following tables.

1.4.1.1 Heating, ventilation and air-conditioning systems

Element description	Applicable specification sections (in addition to B4)
Low temperature hot water systems	<i>Low-temperature hot water heating systems</i> (Ss_60_40_37_48)
Ventilation systems	General space ventilation systems (Ss_65_40_33), Heating and cooling coils (Pr_60_65_37), Ductwork and fittings (Pr_65_65_25), Fans (Pr_65_67_29)
Heating and cooling terminal units	Heating systems – local heating units (Ss_60_40_37), Fan coil unit air conditioning systems (Ss_65_80_05_30), Climatic ceiling and beam systems (Ss_60_40_13), Fan coil units (Pr_70_65_03_29)
Heat recovery	<i>Low-temperature hot water heating systems</i> (Ss_60_40_37_48), <i>Heat recovery distribution equipment</i> (Pr_60_60_36)

1.4.1.2 Electrical and control systems

Element description	Applicable specification sections (in addition to B4)
Low voltage power systems	Low-voltage site connection systems (Ss_70_30_45_40), Low-voltage distribution systems (Ss_70_30_45_45), Small power systems (Ss_70_30_80)
Lighting installations	General lighting systems (Ss_70_80_33), General lighting systems – emergency lighting systems (Ss_70_80_33)
Security systems	Access control systems (Ss_75_40_02),
Fire and smoke alarm systems	<i>Fire and smoke detection and alarm systems</i> (Ss_75_50_28)
Public address / paging systems	Emergency assistance call systems (Ss_75_50_11_25)
Earthing and bonding systems	<i>Earthing and bonding systems</i> (Ss_70_30_25_25)
Information and communication technologies (ICT) installations	Local area network (LAN) systems (Ss_75_10_21_48), Data distribution systems (Ss_75_10_21_21)
Metering, monitoring and management systems	<i>Metering, monitoring and management systems</i> (Ss_75_70_54)

1.4.1.3 Plumbing systems

Element description	Yes/no	Applicable specification sections (in addition to B4)
Drainage systems		Above-ground wastewater drainage systems (Ss_50_30_04)
Domestic hot and cold water systems		Hot and cold water supply systems (Ss_55_70_38)

1.5 Specialist commissioning engineer.

- 1.5.1 Directly employ a specialist company to undertake commissioning of the mechanical engineering systems.
- 1.5.2 Ensure that the specialist company undertakes a review of the installation drawings and include any additional components deemed by the specialist to be required to ensure all systems are fully commissionable.
- 1.5.3 Ensure that the specialist company is a member of the Commissioning Specialists Association (CSA).
- 1.5.4 These clauses relate to commissioning of the mechanical engineering systems. The commissioning of other engineering systems, or items of plant, may be undertaken by the Installer or the manufacturer but ensure that commissioning of interfaces between systems is witnessed by all parties concerned and proven to operate to the satisfaction of all parties concerned.

1.6 General.

- 1.6.1 Provide the Contract Administrator two weeks' notice in writing when your Works, or parts thereof, are ready for testing and commissioning. Carry out the tests and issue the results to the Contract Administrator. After successful completion of all commissioning, carry out specific demonstrations as requested by the Contract Administrator to prove that all test results accord with the specification. Agree the dates and times of such demonstrations with the Contract Administrator. The Contract Administrator may require up to one week's notice to attend such demonstrations.
- 1.6.2 The extent and proportion of results to be witnessed by the Contract Administrator will be at the discretion of the Contract Administrator.
- 1.6.3 Make provision for all independent inspections / insurance company approvals etc of components or parts of the installation, where required by legislation.
- 1.6.4 Notify the necessary statutory authorities (Building Control, Fire Officer, Environmental Health, etc) in respect of all tests and demonstrations required by them.
- 1.6.5 Comply with the requirements of the Building Regulations (Part L) for the inspection and commissioning of the building engineering systems. Prepare all necessary submittals including commissioning plans and reports. Obtain all compliance approvals from the building control authority.
- 1.6.6 Establish procedures with all parties to allow demonstration of normal, emergency, shutdown and standby mode operation of plant and systems.
- 1.6.7 If the initial tests fail to demonstrate that the plant and equipment are properly installed and functioning correctly, investigate the cause of the failure. If this is due to incorrect or faulty work by you, or your sub-traders or suppliers, then without delay, carry out such remedial measures and adjustments as may be necessary and repeat the commissioning and testing procedure to the satisfaction of the Contract Administrator.
- 1.6.8 Where portions of the Works are commissioned and tested separately, upon completion or completion of section, as defined in the main contract preliminaries, demonstrate to the Contract Administrator that all the separate sections are capable of proper simultaneous operation.
- 1.6.9 In cases where the construction programme is such that there is a need to return to a portion of the building previously handed over and currently occupied by the Employer in order to undertake testing, balancing, adjustment, etc, take all necessary precautions against, and be responsible for

repairing, any damage caused whilst working in such areas for that purpose (unless such damage is proven to be outside your reasonable control).

- 1.6.10 Provide all necessary skilled and unskilled labour and all necessary instruments and testing equipment for the purposes of commissioning and testing of the installation. Produce up-to-date calibration certificates for all testing equipment on request.

2. Practical Completion and handover.

2.1 Practical Completion.

- 2.1.1 Practical Completion of the Works, or agreed phase or part of the Works, will not be effected until all obligations under the Main Contract conditions are fulfilled, and, in addition in relation to the engineering systems installation, that it is demonstrated to the satisfaction of the Contract Administrator that the following aspects are complete:

1. All installation Works are complete other than minor 'snags', omissions or defects that could reasonably be completed within an agreed programme without causing disruption to the Employer's or their Agent's use of the Building or agreed part thereof. In respect of this clause, specifically but not uniquely, the Contract Administrator shall be the sole arbiter of what may be considered 'minor', 'reasonably be completed', 'an agreed programme' and 'disruption to the Employer'.
2. All tests and demonstrations have been undertaken in the presence of the Contract Administrator as required in the specification(s).
3. All final copies of the Building Engineering Systems Record Drawings, schedules, operating and maintenance instruction manuals and 'Part L' Log-books have been supplied to the Contract Administrator in an agreed format.
4. All spares, keys, tools, oils, chemicals 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 in accordance with the programme for handovers agreed with the Contract Administrator.
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 has been passed to the Client.

- 2.1.2 In the case of phased or partial handovers continue to operate and maintain all elements outside the partial handover that are necessary for full enjoyment of the handed-over area and access thereto.

2.2 Instruction of Employer's representatives.

- 2.2.1 At a time to be agreed prior to completion, or completion of section as defined in the main contract preliminaries, instruct the number of representatives of the Employer agreed with the Contract Administrator, in the use and correct operation of the Works, being satisfied that such staff are capable of taking over the installation. Throughout this period of instruction, be responsible for the correct operation and maintenance of the installation.
- 2.2.2 Submit to the Contract Administrator a detailed programme for the training of the Employer's staff.
- 2.2.3 Issue handouts for the training sessions in the form of précised versions of the Operating and Maintenance Instructions detailing in simple terms the functions and method of operation of each system.

- 2.2.4 Issue a certificate of attendance to each attendee at the end of each training session.

3. Aftercare.

3.1 Installer's obligations following Practical Completion.

- 3.1.1 Carry out seasonal commissioning of the following mechanical and associated systems, in accordance with this specification:
- mechanical ventilation and air conditioning system including heat recovery devices
 - VRF and split system heating / comfort cooling / air conditioning / heat recovery systems
 - domestic hot water systems
 - domestic cold water systems
- 3.1.2 Provide a mechanism by which the Employer can provide feedback on the performance of the building before, during and after seasonal commissioning.
- 3.1.3 Carry out meter reconciliation and other post-handover works to meters as detailed in specification section *Metering, monitoring and management systems* (Ss_75_70_54).

Appendix A – Cleaning and chemical treatment.

1. References.

1.1 General.

- 1.1.1 This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.
- 1.1.2 Comply fully with the edition (including amendments, replacements and associated normative references) of each of the documents listed below, current at the time of tender.
- 1.1.3 Where a standard referred to in this section conflicts with a standard referred to in the associated 'products' section of this specification, the standard referred to in this 'system' specification section takes precedence.

1.2 Legislation.

The Water Supply (Water Fittings) Regulations
The Water Supply (Water Quality) Regulations
The Biocide Products Regulations

1.3 Standards.

BS 7593	Code of practice for the preparation, commissioning and maintenance of domestic central heating and cooling water systems
BS 8551	Provision and management of temporary water supplies and distribution networks (not including provisions for statutory emergencies). Code of practice
BS 8552	Sampling and monitoring of water from building services closed systems. Code of practice
BS 8558	Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Complementary guidance to BS EN 806
BS 8580-1	Water quality. Risk assessments for Legionella control. Code of practice
BS EN 806-1	Specifications for installations inside buildings conveying water for human consumption. General
BS EN 806-4	Specifications for installations inside buildings conveying water for human consumption. Installation
BS EN 806-5	Specifications for installations inside buildings conveying water for human consumption. Operation and maintenance
BS ISO 5667-24:2016	Water quality. Sampling. Guidance on the auditing of water quality sampling

1.4 Guidance and other reference documents.

BSRIA BG 29/2021	Pre-commission cleaning of pipework systems (except as modified by the requirements of this section of the specification)
BSRIA BG 50/2021	Water treatment for closed heating and cooling systems
CIBSE Code W	Commissioning Code W: Water distribution systems
CIBSE TM13	Minimising the risk of Legionnaires' disease
HSE ACOP L8	Legionnaires' disease. The control of legionella bacteria in water systems. Approved Code of Practice and Guidance
HSE HSG 274	Legionnaires' disease: Technical Guidance. Parts 1, 2 and 3
PD 855468	Guide to the flushing and disinfection of services supplying water for domestic use within buildings and their curtilages

2. General.

2.1 General.

- 2.1.1 Design, provide and carry out appropriate flushing, chemical cleaning and water treatment procedures, including all necessary equipment. Do so in compliance with the above reference documents to prevent during the Works, and to enable risk control during the lifetime operation, of contamination, scale build-up, corrosion, erosion, and general fouling.
- 2.1.2 Comply with the principles within BSRIA BG 29/2021 for all closed pipework systems having a water capacity in excess of 200 litres, except as modified by the requirements of this appendix of the specification.
- 2.1.3 For domestic-sized heating and cooling systems within residential dwellings, i.e., those with a water capacity below 200 litres, comply with BS 7593.
- 2.1.4 Where connections are required between new and existing systems, adopt the procedures in BSRIA BG 29/2021, Section 8, except as modified by the requirements of this appendix of the specification.
- 2.1.5 In all cases, comply with BSRIA BG 29/2021, clause 4.1.2 Organisation and Planning.

2.2 Cleaning and water treatment specialist.

- 2.2.1 Within four weeks of appointment, and before carrying out any of the installer's design responsibilities relating to water systems, appoint a suitably qualified, ISO certified cleaning and water treatment specialist to carry out the following:
 - Advise on pipework system design/layouts and methods of water treatment.
 - Ensure adequate provision of dirt pockets at the base of risers, full-bore flushing drains and connections, header flanges, commissioning sets, strainers, air vents and dirt separators, flushing loops, etc. for flushing, chemical cleaning and water treatment, including pre-treatment, chemical and physical methods and for system lifetime general maintenance.
 - Sample and analyse the incoming mains water service at an early stage to inform the development of the flushing, chemical cleaning and water treatment strategy.
 - Sample and analyse the water quality within any existing system to which the Works are to be connected upon completion and advise on any remedial action required before such connection can occur.
 - Confirm the volume of each of the pipework systems.

- Confirm all manufacturers/suppliers of chemical treatments to be used, including their detailed chemical content.
- Confirm inhibitor manufacturer's target range concentration.
- Confirm the concentrations and quantities each of biocide wash, intermediate inhibitor and final inhibitors and biocides.
- Confirm that biocides meet the requirements of the Biocide Products Regulations.
- Confirm the water quality Employer's Requirement for all water and other fluid systems.
- Produce a programme and (as detailed in clause 2.3) method statements for carrying out flushing, chemical cleaning and water treatment works.
- Produce risk assessments in accordance with HSE ACOP L8 and associated guidance.
- Obtain approvals from the local water authority for disposal of contaminated water.
- Carry out pre-commissioning checks.
- Carry out water chemical and microbiological sampling throughout the Works, seven days before Practical Completion and at one-month intervals for six months after practical completion.
- Carry out flushing, chemical cleaning and water treatment in accordance with the method statements, the above reference documents and the particular requirements of the building.
- Demonstrate to the Contract Administrator that the flushing, chemical cleaning and water treatment works have been successfully carried out.
- Produce detailed records of the complete flushing, chemical cleaning and water treatment procedure, for inclusion in the O&M manuals.
- Produce written procedures and method statements for ongoing water treatment to comply with the above reference documents.

2.3 Method statements.

2.3.1 Arrange for the cleaning and water treatment specialist to produce a detailed written strategy for flushing, chemical cleaning and water treatment in accordance with the above reference documents, this section of the specification and the particular requirements of the building. As a minimum in the strategy include a method statement that has been agreed with the Contract Administrator and make any amendments required in the event of non-compliance with the reference documents. Ensure the method statement includes a step-by-step procedure for achieving and demonstrating flushing and cleaning velocities, and includes each of the following requirements:

- dynamic flushing
- degreasing
- biocide wash
- removal of surface oxides
- effluent disposal/final flushing
- passivation
- corrosion inhibitor/biocide dosing
- disinfection of domestic water services and open systems
- the dates on which sampling will take place
- locations from where samples will be taken
- water properties to be analysed and pass/fail criteria
- the person/company who will carry out the analysis
- the need for duplicate sampling (such as separate samples being taken by each party).

2.4 Mains water.

2.4.1 Provide a dedicated mains water supply, where necessary, for system flushing, of adequate size and pressure, to ensure that the minimum flushing velocities/flow rates can be achieved.

2.5 Pipework distribution.

2.5.1 Regulating valves

2.5.1.1 Ensure that all regulating valves are sized in accordance with CIBSE Commissioning Code W such that at the design flow rate the valve is not less than 25% open.

2.5.1.2 During the flushing and cleaning procedure bypass low flow, high resistance regulating valves, if necessary, to ensure that the minimum flushing velocities/flow rates are achieved.

2.5.2 Control valves

2.5.2.1 Ensure that automatic control valves do not hinder the cleaning and flushing process by arranging that their control function(s) are temporarily overridden to promote full flow through the device during flushing.

2.5.3 Dead legs and dirt pockets

2.5.3.1 Ensure that all pipework systems are designed to eliminate dead legs of length exceeding three internal pipework diameters. In the situations where dead legs are unavoidable such as dirt pockets, incorporate suitably sized drain valves to facilitate draining and flushing.

2.5.3.2 Loop all dead legs to allow effective circulation during the cleaning process and in the permanent installation. Size the loop at full bore up to 50 mm diameter and a minimum of either 50 mm diameter or 50% full bore (whichever is the greater) above 50 mm diameter. Install a lock shield valve in the loop to allow full flow for flushing and a pressure independent control valve set to establish a trickle flow at all other times.

2.5.3.3 Where the loop is for a future tenant connection extension, or similar with a particular flow requirement, install a commissioning set in the loop to simulate the pressure loss of the future tenant equipment and a pressure independent control valve set to establish a trickle flow at all other times.

2.5.4 Strainers

2.5.4.1 Ensure that all strainers have a basket capable of withstanding the maximum pump head without distortion. Provide pressure test points across all strainers so that the pressure drop can be monitored. Provide drain valves on the flanges and/or end caps of all Y-pattern strainers larger than DN50 to facilitate local draining of the body and local pipework prior to basket removal, and to allow back-flushing of the strainer. Ensure that the mesh size of the basket is selected with regard to the particular application and with reference to the manufacturer's recommendations. Provide additional strainer baskets of the mesh gauges needed to suit flushing and cleaning. Inspect the condition of, and clean, all strainer baskets at each stage of flushing and cleaning.

2.5.5 Test points

2.5.5.1 Ensure all test points are located at the side of pipework systems, not at the top or bottom where they can become air locked or act as dirt pockets.

2.5.6 Plant and component isolation

2.5.6.1 Ensure that all systems are designed to enable the isolation and bypass of all sensitive plant and equipment such as boilers, chillers, fan coil units, radiators, other terminal units, expansion units, control valves, etc. during the course of the flushing and cleaning operation.

2.5.6.2 Provide fixed full-bore bypasses, complete with associated isolating valves, as close to the plant as possible. Where significant length of ferrous pipe remains between an isolating valve and the plant item being isolated, provide a removable spade in the terminating flange to the plant item or provide means of temporary capping for alternative types of connection.

2.5.6.3 Only carry out flushing or cleaning of sensitive plant items and components with the approval of the cleaning/water treatment specialist and the plant or component manufacturer.

2.5.7 Pumps

2.5.7.1 Agree the use of system pumps for dynamic flushing with the Contract Administrator via the specialist's method statement. Provide additional suitable pumps in the event that all cleaning and

flushing velocities are not able to be demonstrated with either the available mains water pressure or using the system pumps, or if approval to use the system pumps is withheld for whatever reason.

- 2.5.7.2 Where system pumps are to be used, replace all pump seals on completion of the cleaning process.

2.5.8 Drainage

- 2.5.8.1 Ensure that there are adequate drain points, of either full-bore capacity or of sufficient dimension to achieve the required flushing velocity and to provide drainage, within close proximity to gullies that can be used for draining and flushing. Obtain approvals from the local water authority for disposal of contaminated water.

2.5.9 Pipework visual inspection

- 2.5.9.1 Specially prepare easily demountable sections of pipework, complete with isolation valves, on each system to allow visual inspection of the internal surfaces after chemical cleaning. Agree locations with the Contract Administrator.

2.6 Chemical treatment.

- 2.6.1 Employ a suitably qualified water treatment specialist to carry out the following work.
- 2.6.2 Assess water treatment requirements for cleaning and chemical treatment of the systems, provide all necessary components and consumables, and undertake appropriate tests. Add to all non-potable systems all necessary water treatment chemicals to inhibit the growth of microbiological organisms, limit the build-up of solids and scale and prevent corrosion.
- 2.6.3 Use only established methods of chemical treatment that have a proven track record of successful performance over a minimum period of 5 years under conditions comparable to those in the applicable systems within the Works. Refer any alternative or innovate technologies to the Contract Administrator for consideration.
- 2.6.4 Ensure that the chemicals proposed are entirely compatible with all material and components present in the system. Provide written evidence from all suppliers confirming acceptance.
- 2.6.5 Prior to the application of the water treatment chemicals to the pipework system and the system being finally filled, set to work and commissioned, undertake a thorough pre-commissioning clean.
- 2.6.6 Add no water treatment chemicals to the system until the water treatment specialist provides the Contract Administrator with a certificate detailing the pre-commissioning cleaning actions undertaken, and the areas affected once this work has been undertaken. Do not drain the system once the water treatment chemicals are added. Should draining of the system be necessary for any reason completely re-dose the system.
- 2.6.7 Use only the minimum amount of chemicals to meet the manufacturer's recommended concentration levels. Handle chemicals in accordance with the requirements of the HSE. Obtain the local water authority's approval before discharging any chemicals to drain.
- 2.6.8 Provide for maintenance purposes sufficient quantities of both corrosion/scale and biological growth inhibitor to completely re-dose the system. Provide these chemicals in fully enclosed containers constructed to the manufacturer's recommendations, adequately labelled and stored safely in the plant room. Provide a pair of safety gloves and goggles for the administering of the chemicals. Provide full instruction on the dosing procedure and fix them adjacent to the dosing pot in a framed melamine poster. Provide an eye irrigation kit, wall-mounted adjacent to the dosing pot. Provide all chemicals in containers that are suitably sized for easy and safe handling.

2.7 Corrosion monitoring equipment.

- 2.7.1 Where scheduled and/or indicated by the drawings, supply and install corrosion monitoring devices complete with pipework probe and corrosion coupon of identical metal to that of the pipework

system in which they are installed. Provide devices that are either mains or battery powered complete with on-board processing and algorithms to facilitate corrosion and temperature measuring and logging. Incorporate warning function by LED and volt-free contact to transmit to BMS, LAN or cloud-based readout for remote monitoring as appropriate.

2.8 Limestone scale prevention equipment.

- 2.8.1 Where scheduled and/or indicated in the drawings, provide a limestone scale prevention unit based on the controlled release of zinc into the water stream, incorporating a powered electrolytic anode with controller, pulse output water meter and filter.
- 2.8.2 Where possible install the anode in the rising main before any cold water storage cistern. If space is limited, and with the Contract Administrator's agreement, install the anode downstream of the storage cistern. For direct feed systems, install the unit in the pipework feeding the hot and cold outlets, with the anode no less than 3m before the water heater. Select and size the anode based on pipework size and flow demand with the pulse output water meter connected to the controller to ensure correct zinc treatment dosing. If required install a water filter, particularly if the anode system is to be installed in an area where construction is taking place.
- 2.8.3 Ensure that the system is WRAS approved and that the system is commissioned by the manufacturer.

3. Scope of works.

3.1 General.

- 3.1.1 The following systems are included in the scope of this specification:
 - low temperature hot water (LTHW)
 - chilled water cooling (CHW)
 - condenser water (closed circuit)
 - cooling tower make-up water
 - domestic cold water
 - domestic hot water
 - rainwater harvesting
 - irrigation water system (fluid category 5 break cistern)
- 3.1.2 Carry out flushing, chemical cleaning and water treatment for closed recirculation systems (e.g., LTHW, CHW, closed circuit condenser water) in accordance with BSRIA BG 29/2021 (as modified by the requirements of this section of the specification), BSRIA BG 50/2021, HSE ACOP L8, CIBSE TM13, The Water Supply (Water Fittings) Regulations and this specification.
- 3.1.3 Carry out flushing, chemical cleaning and water treatment for domestic water services (e.g., domestic cold, domestic hot, cooling tower make-up, rainwater harvesting, irrigation water) in accordance with BS 8558, BS EN 806-4, HSE ACOP L8, CIBSE TM13, The Water Supply (Water Fittings) Regulations and this specification. Take account of the pipework system manufacturers' recommendations on disinfection.

3.2 Open evaporative cooling systems, showers, spray taps and all hot and cold water systems.

- 3.2.1 Engage a competent person with the necessary understanding of the particular systems and of the ecology of legionella to carry out a detailed risk assessment on all new or existing systems that form part of the Works.
- 3.2.2 If a risk of exposure to water droplets and aerosol is identified, control that risk in accordance with HSE ACOP L8, associated guidance and CIBSE TM13.

- 3.2.3 Develop a written scheme for controlling risk. One month before contract programmed Practical Completion present the scheme to the Contract Administrator and Employer for approval. Ensure the scheme is fully capable of being implemented and properly managed by the building owner/occupier, and includes the following:
- an up-to-date plan showing the layout of the plant or system, including any parts temporarily out of use (a schematic plan would suffice)
 - a description of the correct and safe operation of the system
 - the precautions to be taken
 - checks to be carried out to ensure efficacy of the scheme and the frequency of such checks
 - remedial action to be taken in the event that the scheme is shown not to be effective
- 3.2.4 Control the risk from exposure by means that include:
- controlling the risk of water spray
 - avoidance of water temperatures and conditions that favour the proliferation of legionella bacteria and other micro-organisms
 - avoidance of water stagnation
 - avoidance of the use of materials that harbour bacteria and other micro-organisms, or provide nutrients for microbial growth
 - maintenance of the cleanliness of the system and the water in it
 - use of water treatment techniques
 - action to ensure the correct and safe operation and maintenance of the water system
- 3.2.5 Provide details of how to use and carry out the various control measures and water treatment regimes including:
- the physical treatment programme, e.g., the use of temperature control
 - the chemical treatment programme, including a description of the manufacturer's data on effectiveness, the concentrations and the contact time required
 - health and safety information for storage, handling, use and disposal of chemicals
 - system control parameters (together with allowable tolerances), physical, chemical and biological parameters, together with measurement methods and sampling locations, test frequencies and procedures for maintaining consistency
 - remedial measures to be taken in case the control limits are exceeded, including lines of communication
 - cleaning and disinfection procedures
- 3.2.6 Include a description of the correct operation of the system plant including:
- commissioning and re-commissioning procedures
 - shutdown procedures
 - checks of warning systems and diagnostic systems in case of system malfunctions
 - maintenance requirements and frequencies
 - operating cycles – including when the system plant is in use or idle
- 3.2.7 To enable the building owner/occupier to monitor the condition and performance of the system, include in the scheme clear instructions for:
- checking the performance of the system and its component parts
 - inspecting the accessible parts of the system for damage and signs of contamination
 - monitoring to ensure that the treatment regime continues to control to the required standard.

4. Chemical and microbiological analysis.

- 4.1 Arrange for all tests to be undertaken at an independent UKAS accredited test laboratory with specialist experience of the systems from which the water is sampled. Issue a report and all the test

- results to the Contract Administrator, indicating any non-compliances and contaminants likely to have a detrimental effect on water systems.
- 4.2 At an early stage of the project sample and analyse the incoming water supplies, to inform the development of the flushing, chemical cleaning and water treatment strategy. Include a microbiological analysis of the water, including, as a minimum, readings for TVC (total viable count) at 37°C at 48 hours, TVC at 22°C at 72 hours, iron bacteria, identifying bacteria pseudomonads, sulphate-reducing bacteria and nitrate-oxidising bacteria, plus any criteria that do not comply with the EU Drinking Water Standards and Water Supply (Water Quality) Regulations.
- 4.3 Repeat the chemical and microbiological analysis of the incoming water and system water one week before any pressure testing (and again one week before flushing if any of the systems have been filled for more than one week).
- 4.4 For each system, or hydraulically separated sub-system therein, select numbers and locations of sample points and carry out sampling at frequencies in accordance with BSRIA BG 29/2021, Appendix A, Table 8 and Table 9.
- 4.5 Sample, analyse and report results of chemical and microbiological water samples from each system for record purposes during both flushing stages. For steel systems carry out a soluble iron test immediately after completion of the dynamic flush.
- 4.6 Carry out distributed random sampling from each closed system and any non-domestic open system following the introduction of corrosion inhibitors and biocide dosing. Take water from representative system extremities and low points. At an agreed position in each system take two samples simultaneously for record purposes, one to be kept by the Contract Administrator and one for testing by the specialist. Ensure the test samples include, as a minimum:
- 4.6.1 Chemical analysis
- sample number
 - sample point
 - system
 - colour
 - clarity
 - odour
 - solids-visual
 - pH at 20°C
 - electrical conductivity at 20°C
 - total dissolved solids at 105°C
 - suspended solids
 - ammonical nitrogen as N
 - nitrate as N
 - nitrite as NaNO₂
 - total alkalinity as CaCO₃
 - alkalinity, bicarbonate, as CaCO₃
 - alkalinity, hydroxide, as CaCO₃
 - hardness, total, as CaCO₃
 - chloride
 - sulphate
 - soluble iron
 - total iron
 - soluble copper
 - total copper
 - soluble zinc
 - total zinc
 - molybdate or chemical inhibitor levels

- 4.6.2 Microbiological analysis
- TVC at 37°C/24 hours
 - TVC at 22°C/72 hours
 - microfungi
 - coliform bacteria including E.coli
 - pseudomonads species at 30°C including pseudomonads aeruginosa
 - flavobacterium
 - bacillus
 - nitrate / nitrite-reducing bacteria
 - sulphate-reducing bacteria
 - nitrate-oxidising bacteria
- 4.7 Repeat this test within seven days before practical completion to demonstrate compliance and provide results to the Contract Administrator.

5. Filling and flushing.

5.1 General.

- 5.1.1 Check the contents of all strainers for potential microbiological activity on a regular basis during these procedures. Analyse any solid contaminants to check whether they have a microbiological content.
- 5.1.2 If there are any potential detrimental contaminants, provide for comment a detailed method statement for determining the most appropriate method of water treatment.
- 5.1.3 Carry out all necessary corrective water treatment remedial works to the satisfaction of the Contract Administrator, to provide at Practical Completion, systems that are not conducive to microbiological growth.
- 5.1.4 Re-visit site each month for six months after Practical Completion to carry out full microbiological testing as detailed above, and any necessary corrective measures to ensure the procedures continue to control contamination, scale build-up, corrosion, erosion, general fouling, and biological fouling; and that the system continues to operate safely.

5.2 Filling and flushing – dynamic.

- 5.2.1 Carry out all filling, flushing and cleaning of each closed system and any non-domestic open system in accordance with BSRIA BG 29/2021.
- 5.2.2 Do not commence filling unless the means of maintaining positive pressurisation within the system has been commissioned and is fully operational.
- 5.2.3 During filling, flushing and cleaning, maintain a positive pressure (relative to atmosphere) at all times within all of the pipework system to avoid creating unnecessary levels of dissolved oxygen in the water.
- 5.2.4 Minimise water consumption, without compromising the efficacy of the flushing process, by adopting closed-loop recirculation techniques in conjunction with temporary high-flow side-stream filtration devices.
- 5.2.5 Assemble each pipework system from pipework and ancillaries that have been stored in a clean condition. Form joints to leave a clean bore, check for internal contaminants and cap pipework open ends as the Works proceed.
- 5.2.6 Prior to commencing filling and/or flushing of the pipework systems, carry out a thorough inspection of the system to ensure that the system is complete and watertight.

- 5.2.7 Programme the Works to ensure that, once filled, the system clean (dynamic flushing) commences within 48 hours, to minimise the risk of biofilm development. If the system is to be left for more than 48 hours before the commencement of dynamic flushing, re-fill with biocide-dosed water (and antifreeze chemical if external ambient temperatures are likely to drop below 2°C).
- 5.2.8 Ensure that all equipment that is sensitive to sediment remains valved off and bypassed throughout the flushing procedure.
- 5.2.9 During flushing, temporarily replace sensitive components such as control valves with purpose-made spool pieces where those components are susceptible to damage from debris or impose a high resistance to the flushing path.
- 5.2.10 Inject mains cold water into the pipework system via a temporary connection from the mains or via a flushing tank and temporary high-pressure pump. Employ suitable back-flow prevention devices between the incoming main and the system fill point.
- 5.2.11 Leave the system charged for 48 hours to soften any sediment and then drain down and clean out all dirt pockets and strainers. Refill and drain the system at least two more times checking, dirt pockets and strainers each time.
- 5.2.12 Carry out dynamic flushing at the velocities identified in Table 7 of BSRIA BG 29/2021 or design velocity plus 10%, whichever is the greater. Where it is not possible to achieve these velocities, ie large bore pipework, employ alternative cleaning methods to the water treatment specialist's recommendations and the Contract Administrator's approval.
- 5.2.13 Commence the flushing of horizontal mains to each floor at the top floor and work down through the building.
- 5.2.14 Take flow measurements at each floor branch commissioning station and any other commissioning station and provide a record of proof that the required flushing velocity was achieved. Record the values obtained and offer for demonstration to the Contract Administrator.

6. Final flushing and passivation.

6.1 Final flushing.

- 6.1.1 Remove all chemicals by clean water rinsing and flushing to achieve a neutral pH value of approximately seven. Achieve this by a dynamic flush of the system, in accordance with BSRIA BG 29/2021, taking particular care to ensure that there are no dead legs.
- 6.1.2 Forward and backward flush all plant, chillers, boilers, fan coils, radiators, etc.

6.2 Overall benchmark of success of system cleaning and flushing.

- 6.2.1 At all stages of the cleaning and treatment process for closed and non-domestic open systems achieve the requirements set out in BSRIA BG 29/2021, Section 3, except where specifically varied from in this specification. At each stage inform the Contract Administrator of the times of demonstration of completion of the process so as to allow witnessing, and certify the conditions achieved at each stage. Advise the Contract Administrator at the earliest opportunity of any indication from test results that water quality at Practical Completion may not be acceptable.
- 6.2.2 Achieve the following requirements from BSRIA BG 29/2012 (not the 2021 version) with results obtained from laboratory analysis for each system or hydraulically separated sub-system therein.
 - The criteria for physical and chemical parameters, identified in Table 4 and agreed in the sampling and analysis plan, at seven days after completion of pre-commission cleaning. The cleaning specialist is responsible for achieving compliant values, and non-compliant values will not be acceptable.

- Regular monitoring and maintenance of water quality through to Practical Completion, at least every two weeks up to Practical Completion with pass criteria as defined in Table 4, and as described in the sampling and analysis plan.
 - The criteria in Table 5 at Practical Completion.
- 6.2.3 Prior to connecting new system(s) to an existing system(s), achieve the following requirements from BSRIA BG 29/2012 (not the 2021 version) with results obtained from laboratory analysis for the new system(s).
 - The criteria for physical and chemical parameters, identified in Table 4 and agreed in the sampling and analysis plan, at seven days after completion of pre-commission cleaning. The cleaning specialist is responsible for achieving compliant values, and non-compliant values will not be acceptable.
 - The criteria in Table 5 at Practical Completion.

6.3 Passivation.

- 6.3.1 Carry out passivation immediately after the final flushing in order to render the active metal surfaces passive. Achieve this by introducing a passivating agent, either as a separate chemical or as part of water treatment corrosion inhibitor chemicals.

7. Chemical cleaning.

7.1 General.

- 7.1.1 Carry out a soluble iron test to ensure that the concentration of the system does not exceed 3 mg/l. Close all drain cocks and remove, clean and replace all strainers. Commence chemical cleaning within 24 hours of the completion of the dynamic flushing.
- 7.1.2 If it is thought that chemical treatment of any part of the plant would prove detrimental, even though the cleaner is a neutral and non-aggressive formulation, valve these off and exclude them from the entire cleaning procedure.

7.2 Degreasing.

- 7.2.1 Degrease the internal surface of the pipework to ensure that subsequent chemical cleaning operations are successful. Use a mild alkali formulation such as caustic solution or a detergent, or alternatively an organic solvent. Arrange for the specialist to provide a detailed method statement confirming the preferred product and procedure.

7.3 Biocide wash.

- 7.3.1 Where systems have not been filled with biocide treated water during pressure testing, subject them to a biocide wash as part of the chemical cleaning process in order to control bacteria and biofilms which may become established inside pipework during the installation process.

7.4 Removal of surface oxides.

- 7.4.1 Do not use inhibited acid cleaning for the removal of surface oxides. Use a formulated product such as polymer cleaners (dispersants), chelants (complexing agents) or neutral pH cleaners.
- 7.4.2 Provide a detailed method statement confirming the preferred product and procedure.
- 7.4.3 Carry out a pressure test of the system after cleaning as the scavenging effect of some cleaning may remove scale or other heavy deposits.

7.5 Visual inspection.

- 7.5.1 Demonstrate the condition of the internal pipework surfaces to the Contract Administrator by removal of demountable sections of pipework on each system as detailed in this specification.

8. Corrosion inhibitor/biocide dosing.

- 8.1 On completion of the foregoing actions, dose the system with a suitable corrosion/scale inhibitor and biocide dosing. Determine the exact type and concentration following the water analysis described previously.
- 8.2 Give consideration to the use of molybdate-based inhibitor in preference to nitrate-based inhibitors in order to mitigate the risk of the formation of biofilms within sealed systems.
- 8.3 For systems that include copper and other metals also include appropriate inhibitors.

9. Domestic water services.

- 9.1 Do not charge, even for pressure testing, any water system, until immediately prior to it being brought into regular use. If a system is charged, for any reason, more than seven days before regular use, do not drain it down. After the disinfection process charge the system and keep it charged.
- 9.2 For all systems, hot or cold, including calorifiers, water heaters, etc. in which all outlets are not in regular use, i.e. daily, thoroughly flush at a minimum frequency of once per week by opening all taps/valves in sequence working away from the source to progressively draw the fresh water through the system. This applies to premises temporarily taken out of use or the period between commissioning and regular use.
- 9.3 Use the disinfectant chemical chlorine dioxide to carry out disinfection of the entire domestic hot and cold water services (including supplementary systems detailed above) throughout the building, in accordance with BS 8558, BS EN 806-4, PD 855468 and to the satisfaction of the employer's microbiologist (if appointed) and Health Care Premises microbiologist (if appointed) and the local water authority's representative. Carry out tests sufficient to demonstrate compliance with the microbiologist's and authority's requirements and forward the supervised sampling and bacteriological and chemical results of such tests to the Contract Administrator.
- 9.4 Obtain written confirmation from the respective product manufacturers that all plastic pipework and other products containing plastics (e.g., 'O' rings) that are likely to come into contact with the chemicals that may be added to the system during installation, or as part of an ongoing water treatment maintenance regime, are suitable for such use. Provide copies of confirmation to the Contract Administrator prior to installation, and include copies in the O&M Manual.
- 9.5 Prior to carrying out any system disinfection verify and record the quality of the chemicals to be used by means of appropriate tests. Reject and do not use any sub-standard chemical.
- 9.6 Repeat the disinfection until a satisfactory bacteriological and chemical level is achieved. It is permissible to employ the local water authority to carry out the disinfection of the systems.
- 9.7 Send copies of the bacteriological analysis results, carried out by an accredited laboratory, certifying the water to be suitable for consumption and fitness for purpose to the Contract Administrator for record purposes, and include them in the commissioning report.

Appendix B – Testing and commissioning of mechanical systems.

1. Reference documents.

1.1 General.

- 1.1.1 Comply fully with the edition (including amendments, replacements and associated normative references) of each of the documents listed below, current at the time of tender.
- 1.1.2 Where a standard referred to in this section conflicts with a standard referred to in the associated 'products' section of this specification, the standard referred to in this 'system' specification section takes precedence.

1.2 Legislation.

Building Regulations Approved Documents
Non-domestic building services compliance guide

1.3 Guidance and other reference documents.

ASHRAE	ASHRAE Handbook, HVAC Applications
BSRIA TM1/88.1	Commissioning of HVAC Systems: Guidance on the division of responsibilities
BSRIA AG 9/2001	Standard specification for BMS
BSRIA AG 16/2002	Variable flow water systems. Design, installation and commissioning guidance
BSRIA AG 20/95	Commissioning of pipework systems. Design considerations
BSRIA BG 1/2009	Building services job book – a project framework for engineering services
BSRIA BG 2/2010	Commissioning water systems
BSRIA BG 6/2018	Design framework for building services
BSRIA BG 8/2009	Model commissioning plan
BSRIA BG 11/2010	Commissioning job book. A framework for managing the commissioning process
BSRIA BG 44/2013	Seasonal Commissioning
BSRIA BG 49/2015	Commissioning air systems
BSRIA BG 57/2015	Legionnaires' disease. Risk Assessment
BSRIA BG 58/2015	Legionnaires' disease. Operation and maintenance log book
BESA DW/143	Guide to good practice. Ductwork air leakage testing
BESA TR/6	Guide to good practice. Site pressure testing of pipework
BESA TR/20	Installation and testing of pipework systems
BRA / IoR	Guide to good commercial refrigeration practice: Part 5 – commissioning
CIBSE Guide H	Building control systems
CIBSE Commissioning Code A	Air distribution systems

CIBSE Commissioning Code B	Boilers
CIBSE Commissioning Code C	Automatic controls
CIBSE Commissioning Code M	Commissioning management
CIBSE Commissioning Code R	Refrigerating Systems
CIBSE Commissioning Code W	Water distribution systems
CIBSE Knowledge Series KS09	Commissioning variable flow pipework systems
Good Practice Guide 347: Installation and commissioning of refrigeration systems. Carbon Trust, 2003	

2. Systems to be commissioned.

- 2.1 For details of the systems to be commissioned, refer to specification section B4, clause 1.5.

3. General.

3.1 Roles and responsibilities.

- 3.1.1 Follow the defined position of the various parties in the commissioning process as set out in BSRIA TM 1/88.

3.1.2 Specialist commissioning engineer

- 3.1.2.1 Directly employ a “specialist commissioning engineer” to undertake commissioning of the mechanical engineering systems. Appoint the specialist commissioning engineer at the most appropriate time in the pre-construction period to ensure the necessary involvement and site visits for examination of drawings and exchange of information. Ensure that the specialist commissioning engineer undertakes a review of the installation drawings and include any additional components deemed by the specialist commissioning engineer to be required to ensure all systems are fully commissionable. Identify those systems that must also be commissioned and operational (e.g., electrical power systems, etc) in order that successful commissioning of the mechanical systems may occur. Advise the Contract Administrator, well in advance of the start of testing and commissioning, of any issues identified by the specialist commissioning engineer as being likely to affect the successful outcome of the commissioning.
- 3.1.2.2 These clauses relate to commissioning of the mechanical engineering systems. The commissioning of other engineering systems, or items of plant, may be undertaken by the installer or the manufacturer but commissioning of interfaces between systems is to be witnessed by all parties concerned and proven to operate to the satisfaction of all parties concerned.

3.1.3 Witnessing agent

- 3.1.3.1 Appoint a “witnessing agent” to undertake the duties detailed in CIBSE Commissioning Codes. These duties are separate from and are not to be confused with the witnessing carried out by the Contract Administrator or his representative.

3.2 Commissioning periods.

- 3.2.1 Identify clearly, as an integral part of the construction programme, the periods representing the testing and commissioning of the engineering works and separately identify all associated costs in the tender make-up sheet.

3.3 Labour, materials and other provisions.

- 3.3.1 Provide all labour, materials, equipment and plant necessary to achieve the standards and performance specified for testing and commissioning.
- 3.3.2 Provide all test equipment necessary for testing and commissioning and on request demonstrate that the instruments used are accurate within the permitted tolerances when compared with recognised standards, and that they have been calibrated within the last 12 months.
- 3.3.3 Provide adequate specialist staff to operate and maintain the systems throughout the testing and commissioning procedures.
- 3.3.4 Where required by specification section A42, provide fuel, water and electricity, as necessary, for the execution of the specified works:
 - for testing of sections of work, items of plant and each completed system
 - for commissioning, performance and acceptance testing and demonstration of all systems

3.4 Commissioning method statement.

- 3.4.1 Submit, well in advance of the programmed commissioning stage, a method statement showing a full understanding of the testing and commissioning requirements. Set out in the statement the methods and resources to be employed at each stage of the process, and a programme to identify all the systems involved, their dependency on the operation of other mechanical and electrical systems and on the availability of water, electricity, gas, energy sources, and drainage.

3.5 Rectification of defects.

- 3.5.1 Repeat as necessary, until satisfactory, any testing and commissioning and/or re-commissioning arising from rectification, at any stage, of defects in workmanship, materials, performance, maladjustments and other irregularities.

3.6 Reports and records.

- 3.6.1 Submit throughout the commissioning period, on a weekly basis, commissioning progress reports.
- 3.6.2 Keep progressive records of testing and commissioning results and other "as installed" information for completion of record drawings and operation and maintenance instruction manuals.

3.7 Witnessing and notification.

- 3.7.1 Allow a minimum of seven working days' notice, in writing, for appropriate persons to attend inspections and witness tests or demonstrations at works or on site.
- 3.7.2 Provide all necessary facilities and assistance for the employer's insurance company representative to attend inspections or witness tests, as required.
- 3.7.3 All client costs associated with abortive witnessing (i.e., where the system(s) being demonstrated fail to achieve the specified performance, and the demonstration has to be repeated at a later date) may be deducted from monies owing to the installer.

3.8 Definitions.

- 3.8.1 The definitions apply as listed in BSRIA publications BG 2/2010 and BG 49/2015, for commissioning of air and water systems in buildings.

3.9 General.

- 3.9.1 Follow the recommendations, on planning, installation, inspection, reporting and documentation of the BSRIA publications BG 2/2010 and BG 49/2015, the CIBSE Commissioning Codes and BESA DW Ductwork Specifications.
- 3.9.2 Pay particular attention to the following:
- protect sensitive or fragile items of plant and electrical equipment from dirt, damp and other damage
 - observe manufacturers' setting-to-work procedures and recommendations
 - determine and record the correct operation and sequence of automatic- or manually-operated fire control, alternative working selection, or duplicate plant changeover controls
 - ensure safety in the event of failure of, and following sudden resumption of, electricity supply by the correct operation of safety interlocks and equipment protection devices designed to protect personnel, such as those associated with the high voltage side of electrostatic filters and with remote electrically operated plant
 - lock in their finally commissioned positions all regulating valves, dampers and similar devices, or where locking is not possible, permanently mark the final agreed setting positions
 - ensure grease or lubricant is applied as required for working parts at all times and prior to handover, and fit extended grease nipple points to all inaccessible positions
 - after completion and acceptance of commissioning, return all systems and consumables to an 'as new' condition
 - ensure sufficient tappings for pressure measurement are installed adjacent to differential pressure control valves and flow limiting valves to enable these valves to be properly commissioned
 - check the selections for commissioning sets or other flow measurement devices are as specified in specification section Pr_65_54, in respect of the signal pressure generated at the specified water flow rate, and the pressure loss imposed on the system
 - check that the minimum straight upstream and downstream pipe lengths recommended by the manufacturer are present for each commissioning set or other flow measurement device

4. Testing at works.

- 4.1 Ensure inspecting and testing at manufacturer's works, where specified in the 'engineering system' specification sections, comply with standards and codes of practice, and, if specified, are witnessed by the appropriate parties.
- 4.2 Include in the operation and maintenance instruction manuals duplicate test certificates for works tests.

5. Static testing.

5.1 General.

- 5.1.1 Carry out satisfactory pressure, air leakage and thermal expansion tests before the application of paint, insulation or other cladding, as appropriate.

5.2 Pre-commissioning checks for pipework and ductwork systems.

- 5.2.1 Visually examine the installation to ensure the following:
- the piping/ductwork is supported adequately
 - piping/ductwork is arranged, insulated, painted, identified and labelled correctly, as applicable
 - hand wheels or levers are fitted to valves/dampers with clear indication of open/closed position and the direction to open or close

- grub screws on all motorised valves/dampers fixings have been correctly tightened
- electrical bonding is complete
- before soundness testing, all joints on underground piping are exposed and provided with adequate temporary support
- all valves, dampers, actuators, sensors and test locations have been suitably labelled
- test and purge points are fitted where appropriate and are accessible by test equipment
- warning notices are correctly installed
- installation drawings and line diagrams have been prepared and fitted at the primary gas meter and/or elsewhere as appropriate

5.3 Concealed sections of work.

- 5.3.1 Individually test while still visible, any sections of a system that are to be permanently buried or concealed.

5.4 Pressure and leakage testing.

- 5.4.1 Carry out pressure and air leakage testing in sections as the work proceeds and to suit the construction programme.
- 5.4.2 Carry out pressure and air leakage testing on complete systems, following any cleaning or scavenging, but before any disinfection or fumigation specified.
- 5.4.3 Carry out pressure testing after a preliminary inspection for leakage with the pipework full of water at nominal pressure.
- 5.4.4 Fill each system with the appropriate hydraulic or pneumatic test medium at normal pressure and inspect for leakages.
- 5.4.5 Apply the full pressure tests specified and with the pressurising equipment disconnected, hold these pressures for the period specified, without signs of leakage or distress to the system.

5.5 Thermal expansion tests.

- 5.5.1 In conjunction with programme requirements, bring steam, condensate or high temperature hot water (HTHW) systems up to operating conditions, allow the system to cool and then check for leakages.
- 5.5.2 Where early concealment of a system is dictated by the particular nature of the programme for the works, make allowance for temporary provision of heating or cooling equipment.

5.6 Protection of system equipment.

- 5.6.1 When pressure testing, remove or isolate items of equipment set to operate below the test pressure. If not removed, limit expansion joint movement using bolts.

5.7 Draining after testing.

- 5.7.1 Drain pipework systems following testing and refill with clean water, treated water, preserving solution, inert gas or low-pressure air as appropriate to suit the stage of the programme for the works and as recommended in section 4 of BSRIA BG 2/2010.

5.8 Pipework distribution systems.

- 5.8.1 Comply with the procedures in BESA TR/6, where applicable the water authority's requirements, and the precautions in HSE Guidance Note GS4.
- 5.8.2 Test concealed or buried pipework before any permanent covering is applied and advise appropriate personnel, in advance, of the time pressure tests may be witnessed.

5.8.3 Hydraulically pressure test for one hour's duration as follows:

5.8.4 Steam, condensate, HTHW and MTHW pipework

- 5.8.4.1 Steam: test pressure = 1.5 x boiler maximum safety valve release pressure
- 5.8.4.2 Condensate: test pressure upstream of trap set = 1.5 x maximum working pressure of pressurised steam main
- 5.8.4.3 Condensate: test pressure downstream of trap set = 7 bar gauge
- 5.8.4.4 HTHW: test pressure = 1.5 x maximum working pressure of system, i.e., safety valve setting, or 40 bar gauge whichever is greater
- 5.8.4.5 MTHW: test pressure = 1.5 x maximum working pressure of system, i.e., safety valve setting, or 10 bar gauge for 6 bar gauge operating systems and 25 bar gauge for 16 bar gauge operating systems whichever is greater
- 5.8.4.6 Visually re-check the system when the working fluid is applied and the system is at working pressure and temperature and again after the system has been allowed to cool and the working fluid is again introduced.

5.8.5 LTHW, chilled water and condenser cooling water pipework

- operating gauge pressure less than 3.5 bar: test gauge pressure = 7.0 bar
- operating gauge pressure 3.5 to 7.0 bar: test gauge pressure = 2 x operating pressure
- operating gauge pressure 7.0 to 16.0 bar: test gauge pressure = 1.5 x operating pressure

5.8.6 Hot and cold water pipework, internal domestic, not buried

- operating gauge pressure less than 3.5 bar: test gauge pressure = 7.0 bar
- operating gauge pressure 3.5 to 7.0 bar: test gauge pressure = 2 x operating pressure
- operating gauge pressure 7.0 to 16.0 bar: test gauge pressure = 1.5 x operating pressure

5.8.7 Fire mains

- operating gauge pressure less than 3.5 bar: test gauge pressure = 7.0 bar
- operating gauge pressure 3.5 to 7.0 bar: test gauge pressure = 2 x operating pressure
- operating gauge pressure greater than 7.0 bar: test gauge pressure = 14 bar or 1.5 x operating pressure, whichever is the greater

5.8.8 Feeds, open and closed vents, drains, overflow and warning pipes

- operating gauge pressure less than 3.5 bar: test gauge pressure = 7.0 bar
- operating gauge pressure 3.5 to 7.0 bar: test gauge pressure = 2 x operating pressure
- unpressurised gravity drain pipework: air test equal to 38 mm water gauge

5.8.9 Mains and pressurised cold water, external buried

- operating gauge pressure less than 7.0 bar: test gauge pressure 10 bar or 1.5 x operating pressure, whichever is the greater
- operating gauge pressure greater than 7.0 bar: test gauge pressure 14 bar or 1.5 x operating pressure, whichever is the greater

5.8.9.1 Where MDPE or similar non-metallic pipework is used, obtain the manufacturer's assistance to ensure correct procedures for the pressure testing. Prior to commencement of pressure testing, provide a certified manufacturer's drawing showing all restraint and provisions for expansion and demonstrate that such requirements have been met.

5.8.10 Plastic pipework

5.8.10.1 For plastic pipework systems within the scope of BS EN 806 (those conveying water for human consumption), hydraulically pressure test in accordance with BS EN 806-4, interpreting "Maximum

Design Pressure" to mean 1.5 times the maximum operating pressure of the system, and using method C in preference to method B where this choice is applicable.

- 5.8.10.2 For other plastic pipework systems, hydraulically pressure test in accordance with the procedure for plastic pipework in BESA TR/6, using a test pressure of 1.5 times the maximum working pressure, or the maximum working pressure plus 5 bar, whichever is the greater, or as specified in the system specification section.

5.9 Plant and equipment testing.

- 5.9.1 For tanks and cylinders operating at atmospheric pressure, test the structural soundness and water tightness under 'tank full' conditions. Ensure that there are no resulting distortions or leakages.
- 5.9.2 Hydraulically test calorifiers and heat exchangers in accordance with specification sections Pr_60_50_20 and Pr_60_60_38_85.
- 5.9.3 Pressure test boilers to twice the operating pressure or to the manufacturer's safety limit, whichever is the lower pressure.
- 5.9.4 Unless otherwise agreed, inspect fans for balance under supervision of the manufacturer's representative.
- 5.9.5 Keep a systematic record of all tests.

6. Commissioning.

6.1 Commissioning codes.

- 6.1.1 Commission installations in accordance with current best practice, the current Building Regulations, and with the procedures, checks and suggested tolerances provided in the CIBSE Commissioning Codes, BSRIA Guides and other documents as listed in clause 1.

6.2 Installation (static completion).

- 6.2.1 Achieve a state of readiness to commence commissioning when each commissionable system has been successfully completed as follows:
- installed in accordance with the specification and drawings with all outstanding remedial works completed
 - final installation inspection carried out, all mechanical and electrical inspection and pre-commissioning check lists completed
 - successfully pressure and leakage tested as specified
 - flushed and cleaned and refilled or protected, all in accordance with specification section B4 appendix 1 and BSRIA BG 2/2010, as specified
 - all test certificates, reports and manufacturers' information collated
 - surrounding areas clean, and free from obstruction for access to commissionable equipment
 - identification and labelling complete
 - with all dampers, valves, control devices, test points, gauges, thermometers and other specified items adjusted and in good working order
 - with the installation checked mechanically and electrically for safe operation and ready for commissioning
- 6.2.2 Do not commence commissioning until the building is in a condition suitable for commissioning works to commence.

7. Particular test procedures.

7.1 General.

- 7.1.1 Refer to the “Testing and commissioning” clauses in each of the applicable ‘engineering system’ specification sections.
- 7.1.2 Where a system is not covered in the following sub-clauses or in the “Testing and commissioning” clauses in the applicable ‘engineering system’ specification section, carry out test procedures in accordance with the manufacturer’s written instructions, the relevant British or other Standards.
- 7.1.3 Obtain system design performance, flow rates and velocities from the drawings, specifications and schedules. Where there is conflict between the drawings, specifications and schedules, draw this to the attention of the Contract Administrator and seek clarification on the values to be used for commissioning.
- 7.1.4 Verify that the values for system design performance, flow rates and velocities still remain valid for the equipment selected for use within the works and make any adjustments necessary to the installation schematic drawings and summation of flow rates to account for the actual configuration of the installation.
- 7.1.5 In the commissioning method statement, record the design information to be used for commissioning, or make reference to the other specific documents in which it is contained.

7.2 Commissioning and balancing of low temperature hot water heating and chilled water systems.

- 7.2.1 Carry out checks and procedures in accordance with CIBSE Commissioning Code W and check lists in BSRIA BG 2/2010. Prior to commissioning, clean water systems as detailed in BSRIA BG 29/2021.
- 7.2.2 Apply tolerances defined in CIBSE Commissioning Code W.
- 7.2.3 Use instruments for measurement detailed in BSRIA BG 2/2010, section 5.
- 7.2.4 Allow for one change of pulley and/or belts for each belt-driven pump drive, as necessary, when operating the pump and measuring the actual system characteristics, to achieve the specified performance.

7.2.5 Constant volume water distribution systems

- 7.2.5.1 Set to work and regulate constant volume water distribution systems in accordance with CIBSE Commissioning Code W and procedures in BSRIA BG 2/2010.
- 7.2.5.2 Proportionally balance the sub-circuit downstream of each branch valve, and similarly proportionally balance all branches within the system.
- 7.2.5.3 Commission constant speed pumps in accordance with CIBSE Commissioning Code W and BSRIA BG 2/2010, including recording pump performance at the design condition.
- 7.2.5.4 Demonstrate the proportional balance of the system with all control valves fully open.

7.2.6 Variable volume water distribution systems

- 7.2.6.1 Set to work and regulate variable volume water distribution systems in accordance with CIBSE Commissioning Code W and procedures in BSRIA BG 2/2010. Where necessary refer also to BSRIA AG 16/2002, section C and CIBSE KS9.
- 7.2.6.2 Proportionally balance the sub-circuit downstream of each differential pressure control valve or flow limiting valve.
- 7.2.6.3 Set up and adjust all differential pressure control valves and flow limiting valves (including bypass differential pressure control valves), in accordance with CIBSE Commissioning Code W and with the valve manufacturer’s instructions. Where specified, employ the valve manufacturer to undertake the setting up and adjustment of these valves.

- 7.2.6.4 Commission variable speed pumps and their variable speed drives in accordance with CIBSE Commissioning Code W and BSRIA BG 2/2010, including recording pump performance at a minimum of four load conditions. Set differential pressure set points for pump speed control in accordance with CIBSE KS9. Ensure that all inverters and their controls are adjusted and commissioned by the inverter manufacturer in conjunction with the commissioning engineer responsible for commissioning the system served by the pump. Ensure that the specified minimum and maximum speeds are set.
- 7.2.6.5 Demonstrate the proportional balance of the system with all control valves fully open. Demonstrate that all differential pressure control valves and flow limiting valves (including bypass differential pressure control valves) are correctly adjusted. Also demonstrate the operation of the system in a number of simulated part load conditions. Include in the commissioning method statement proposals for the number of part load conditions to be simulated, the means of simulating them, and the method of proving successful system operation. Obtain the Contract Administrator's agreement to the methodology prior to the start of commissioning.
- 7.2.6.6 Monitor the pump speeds during the environmental testing period to demonstrate that the speed changes as the load changes.

7.3 Commissioning of heat networks.

- 7.3.1 Carry out commissioning following the procedures in CIBSE Commissioning Code M: Commissioning Management, Code B: Boilers, Code C: Automatic Controls, Code W: Water Distributions Systems and an energy balance to ensure the metering is working correctly.

7.3.2 Documentation of procedure

- 7.3.2.1 Establish a commissioning and testing procedure based on the design specification description of operation and the BMS & Controls specification section *Building monitoring and management systems* (Ss_75_70_54_10). Ensure that the procedure involves proving and testing during day and night operation and at various times during the first year in service, when suitable system loads are available. Where necessary, arrange for artificially induced loads by changing set points or using load banks.
- 7.3.2.2 Arrange that on completion of commissioning a written handover process is followed to enable the operating organisation to take full control.

7.3.3 Energy centre plant

- 7.3.3.1 Ensure that each item of plant in the energy centre is commissioned and that the commissioning procedure incorporates the integrated operation of the entire plant to deliver the required levels of service at the expected levels of operation and efficiency.
- 7.3.3.2 Arrange that the stable and efficient operation of the plant is demonstrated at all expected load conditions and in particular at low load conditions.

7.3.4 Low-carbon heat source

- 7.3.4.1 Arrange a specific demonstration to show that the low-carbon heat source is controlled to operate as the lead unit and to maintain its output as secondary heat sources are brought into line.

7.3.5 Sensor points

- 7.3.5.1 Arrange that each sensor point connected to the BMS or SCADA system is checked to prove it is correctly addressed and providing a consistent and correct signal.

7.3.6 Low flow conditions

- 7.3.6.1 Arrange for specific checks to be carried out at times of minimum demand to verify that bypass flows have been correctly set up and controlled and that the required pressure differences are achieved at all points of the network and that excessive pressure differences are not found at periods of low flow.

7.3.7 On-site acceptance testing general procedures

- 7.3.7.1 Appoint an appropriately qualified heat network specialist to carry out on-site acceptance tests, including:
- energy centre heat efficiency (%)
 - average CO₂ content of heat produced at the energy centre over an agreed period of time (kgCO₂/kWh)
 - heat network loss per dwelling or thermal substation (kWh)
 - average flow and return temperatures at energy centre boundary (°C)
 - district heating network loss per linear metre
 - average return temperature from each building or block and a selection of HIUs while domestic hot water is being drawn off (°C)
 - seven-day “reliability run” to show that the plant runs as required
- 7.3.7.2 Where practical, begin acceptance testing at the energy centre and move progressively to the heat consumers and subsequently proceed to demonstrate that the integrated operation of the entire heat network will deliver the required levels of service and expected levels of operation and efficiency.
- 7.3.7.3 On completion of the testing provide a written Acceptance test summary report produced by the heat network specialist summarising the acceptance testing, including any problem encountered and fault mitigation measures taken. Where tests have failed, provide a failure log detailing the mitigation carried out to achieve full acceptance in order that performance guarantees can be met.
- 7.3.7.4 In residential developments, carry out an initial set of tests on a small number of dwellings to establish common criteria that can be followed before testing the remainder of the estate.
- 7.3.7.5 Following commissioning of all the HIUs and secondary/tertiary circuits within the building/s, carry out independently inspected acceptance tests on a sample (in increments of 10%) of the circuits until it can be established that the service levels and design return temperatures have been achieved.
- 7.3.7.6 Assess and adjust the operation and control of the main system circulating pumps and differential pressure sensors to ensure they comply with the design description of operation, especially when newly built-out phases are brought online.

7.3.8 Dwellings acceptance testing procedures

- 7.3.8.1 Carry out the following checks and present to the Contract Administrator for witnessing and validation:
- 7.3.8.2 Check of heat meter function and unit installation - for each dwelling:
- Check meter function, including visual check to ensure the meter is installed correctly with no error messages and that it is recording flow rate, flow & return temperatures and kWh during subsequent tests.
 - Check HIU installation, including visual check to ensure it is installed as per manufacturer's recommendations.
 - Check insulation installation, including check of primary and secondary side insulation to ensure it is installed to the specification requirements.
- 7.3.8.3 In standby mode - for each dwelling:
- Check normal operation of primary valve to ensure that heating is off and there is no DHW draw or recent demand and that the meter flow rate is below the maximum acceptance testing criteria.
 - Check standby flow volumes are normal, heating is switched off and there is no DHW draw; or check the meter flow rate stabilises below acceptance testing criteria, via the AMR, and/or that the average hourly flow rates are below acceptance testing criteria over an 8-hour period.
 - Check VWART meets minimum requirements. For the same measurement periods as the previous item, via the AMR (minimum half-hourly reads), calculate VWART and check against acceptance testing criteria.

7.3.8.4 Domestic hot water performance – for each dwelling:

- Check DHW set point against acceptance testing criteria.
- Check DHW delivery time and flow rate, including the opening of the kitchen tap and recording delivery time and flow rate against acceptance testing criteria.
- Check DHW outlet temperature is as specified and record stabilised temperature against acceptance testing criteria.
- Check adequate performance of TMV, including opening and recording temperature at each appliance when set on maximum heat against, acceptance testing criteria.
- Check primary return temperature, including opening appliance, leaving on for a 10-minute period and recording return temperature at meter (or via AMR) against acceptance testing criteria.

7.3.8.5 Space heating – for each dwelling:

- Check secondary flow temperature (or return temperature) set point, including visual check of secondary flow/return temperature (depending on control strategy) set-point against acceptance testing criteria.
- Check VVART meets minimum requirements when space heating operating. Ensure there is no DHW draw. Set TRVs on all radiators to maximum (if radiators present) and set thermostats to maximum to enable continuous heating. Leave heating in operation for a minimum of 1 hour for radiators or 3 hours for underfloor heating and calculate VVART (via AMR) against acceptance testing criteria.
- Check secondary temperatures and commissioning, including recording flow and return temperatures at each manifold loop/ radiator and checking against acceptance testing criteria. Record loop flow rate or pre-settable TRV setting at each manifold loop/radiator and check against acceptance testing criteria/space heating design.

7.3.9 Network acceptance testing procedures

7.3.9.1 Carry out the following checks and present to the Contract Administrator for witnessing and validation:

7.3.9.2 Check of plant room metering:

- Check plant room heat meter function, including visual check of meter(s) to ensure correct installation with no error messages. Check that the meter(s) is recording flow rate, flow temperature, return temperature and kWh.
- Check AMR function, to verify that the AMR system is recording output from plant room meter(s) and all end point (dwelling) meters with no anomalous readings (e.g., zero reads or reads that are too high).

7.3.9.3 Network performance:

- Ensure no/low bypass flows, including calculation of percentage bypass flows over a 24-hour period using AMR.
- Check that network flow temperatures are set to target temperature, by either checking the BMS flow temperature setting, or checking instantaneous flow temperature.
- Check that network flow temperatures are stable, including measurement of network flow temperatures at the plant room boundary over a 24-hour period at a minimum of 30-minute intervals (via AMR), with more than 95% of readings being within 3°C of target flow temperature.
- Check that average network flow and return temperatures are equal to or below target, by measuring average network flow and return temperatures at the plant room boundary over a 24-hour period and comparing against target.
- Check that average network losses per dwelling are equal to or below target, by measuring the total network losses over a 24-hour period based on total kWh consumption at the plant room boundary minus total dwellings' consumption. Divide by total number of dwellings and hours to yield the average W/dwelling losses and compare against target losses to check the target has not been exceeded by more than 20%.

7.3.10 Key evidence requirements

- 7.3.10.1 Provide documentation to demonstrate the following procedures in accordance with the installation quality assurance process:
- Evidence that thermal insulation has been witnessed to have been applied to the specified standards, incorporating photographic evidence where witnessing was not able to be undertaken prior to concealment.
 - Schedule of bypass valves required to maintain flow temperatures at times of low demand incorporating their location, product/model number and specification (including the minimum bypass flow rate).
 - Outline of the as-built metering strategy, following the procedures as laid out in CIBSE TM39 and including a separate metering strategy schematic diagram.
 - Independent verification that all dwellings and the heat network have passed the specified acceptance testing procedures.

7.3.11 Post-handover support

- 7.3.11.1 Arrange to provide supporting attendance for a minimum of 12 months after handover of the completed installation to carry out seasonal checks and to fine-tune the control system.

7.4 Commissioning of refrigeration systems.

- 7.4.1 Follow the procedures given in CIBSE Commissioning Code R for use and handling of refrigerants, pressure and leak testing, evacuation and dehydration, charging and lubrication of refrigeration systems. Also follow the manufacturer's written instructions.
- 7.4.2 Carry out checks and procedures for preliminary checks, testing, setting to work and adjusting detailed in CIBSE Commissioning Code R and the manufacturer's written instructions. Use instruments and apparatus detailed in CIBSE Commissioning Code R. Apply tolerances defined in CIBSE Commissioning Code R.

7.5 Commissioning and balancing of air distribution systems.

- 7.5.1 Carry out checks and procedures in accordance with CIBSE Commissioning Code A, section A1 and check lists in BSRIA BG 49/2013, section 9. Prior to commissioning, clean air ductwork systems and remove all debris.
- 7.5.2 Air leakage test all air ductwork including associated equipment in accordance with BESA DW ductwork specifications (refer to specification section Pr_65_65_25).
- 7.5.3 Apply tolerances defined in CIBSE Commissioning Code A.
- 7.5.4 Use instruments and methods of measurement detailed in CIBSE Commissioning Code A, Appendix AA3.1 and in BSRIA BG 49/2015, sections 5 and 6.
- 7.5.5 Set to work and regulate air distribution systems in accordance with CIBSE Commissioning Code A, and procedures detailed in BSRIA BG 49/2015, section 7.
- 7.5.6 Determine the air quantities by the velocity pressure method, using a pitot tube and inclined gauge manometer or electronic manometer.
- 7.5.7 Where, due to space limitations or air turbulence within the ductwork, the total air quantity cannot be determined by the velocity head method, calculate volume flow rates using a manometer at the main outlet or discharge louvres. Likewise, for the same conditions, the air quantities at the inlets or outlets or branch ducts may be added to provide a result for the branch duct connection.
- 7.5.8 Adjust ductwork dampers, diffusers and grilles to provide specified air movement, without draughts and free from excessive air turbulence or unacceptable noise.
- 7.5.9 Locate test points at appropriate positions in the ductwork where air turbulence is minimal.

- 7.5.10 Allow for one change of pulley and/or belts for each belt-driven fan drive, as necessary, when operating the fan units and measuring the actual system characteristics, to achieve the specified performance.
- 7.5.11 For twin-fan units, provide full commissioning data for fan 1 with check figures on all main branches for fan 2. Test and prove the auto-changeover functionality on twin-fan units.

7.6 Commissioning of thermal energy meters.

- 7.6.1 Carry out testing, verification and commissioning of thermal energy meter equipment in accordance with specification section *Metering, monitoring and management systems* (Ss_75_70_54).

7.7 Specialised equipment.

- 7.7.1 Commission specialist equipment at a suitable stage in the program such that the equipment can be put into storage or operated continuously, to avoid re-contamination.

7.8 Thermal imaging.

- 7.8.1 Where specified, carry out a survey using a thermal imaging camera capable of producing a digital image that can be downloaded and viewed on a computer, incorporated into reports and printed.
- 7.8.2 Arrange for the survey to be carried out by a specialist company or for the camera to be operated by a person specifically trained in its use.

7.9 Ultra-sonic flow measurement.

- 7.9.1 Where water flow rate measurement by conventional means is problematical, eg, on existing systems with inadequate or inoperative orifice plates, the installer may, with the written permission of the Contract Administrator, use a portable clamp-on ultra-sonic flow meter, utilising transit time flow measurement technology.
- 7.9.2 Take measurements in accordance with the instrument manufacturer's instructions, with regard to the setting-up and operation of the instrument, and the selection of the measuring position (distance from bends, etc).
- 7.9.3 Ensure that the instrument is suitable for the fluid, temperature, pipework material and anticipated flow rate to be measured. Ensure that the instrument has a stated accuracy on flow rate measurement of $\pm 3\%$ or better. Ensure that the instrument has a current calibration certificate and include a copy of the calibration certificate in the commissioning report.

8. Commissioning and testing report.

8.1 Content.

- 8.1.1 Prepare and supply two copies of the typed commissioning report, each bound, or presented in a ring binder folder sectioned with index to cover each engineering service. Base the commissioning report on the information required by the CIBSE Commissioning Codes, and include the following topics:
- works test certificates
 - site test certificates
 - commissioning inspection reports
 - commissioning results and final settings
 - performance and acceptance test reports
 - pressure vessel certificates and electrical certificates as required by the employer's insurers

8.2 Air handling equipment commissioning sheets.

- 8.2.1 Ensure air handling equipment commissioning sheets include all the design information and measured data in the pro-forma air distribution system fan performance test sheet in BSRIA BG 49/2015, but also the following items:
- for units containing mixing chambers, the total air volume, return air volume and outside air volume (m^3/s)
 - air-side and water-side coil pressure drops
 - filter pressure drops
 - fan curves with the measured operating points and design operating points marked on (multiple points for variable speed fans)

8.3 Exhaust/extract fan commissioning sheets.

- 8.3.1 Ensure fan commissioning sheets include all the design information and measured data in the pro-forma air distribution system fan performance test sheet in BSRIA BG 49/2015. Include fan curves with the measured operating points and design operating points marked on (multiple points for variable speed fans).

8.4 Diffusers, grilles and registers, commissioning sheets.

- 8.4.1 Ensure diffusers, grilles and registers commissioning sheets include results/information for the following items:
- fan systems and/or zone number
 - room number or area designation
 - outlet code number, corresponding to outlet code number on air balance code drawing
 - size of outlet - manufacturer's listed size
 - type of outlet - manufacturer's model designation
 - manufacturer of outlet
 - manufacturer's effective area for each size
 - required air flow rate (m^3/s) at each outlet
 - initial air flow rate (m^3/s) at each outlet
 - final air flow rate (m^3/s) at each outlet
 - setting of regulating device
 - all relevant measuring device calibration charts
 - percentage of design volume achieved
- 8.4.2 Provide line drawings of each air distribution system (including fans, supply, recirculation and extract air terminals, and volume control devices) indicating zone numbers with all components identified using alpha-numeric references that correspond to the commissioning sheets.

8.5 Water system commissioning sheets.

- 8.5.1 Ensure the water system proportional balance commissioning sheets include all the design information and measured data in the pro-forma water balance test sheet in BSRIA BG 2/2010. Include all relevant calibration charts for flow measurement devices.
- 8.5.2 Ensure that the pump commissioning sheets include all the design information and measured data in the appropriate pro-forma plant performance test sheet in BSRIA BG 2/2010. Include pump curves with the measured operating points and design operating points marked on (multiple points for variable speed pumps).
- 8.5.3 For all plant items record the following:
- inlet water temperature (where appropriate)
 - leaving water temperature (where appropriate)

- pressure drop across item of plant (kPa)

8.5.4 Provide line drawings of each water distribution system (including pumps, strainers, check valves, regulating valves, commissioning sets and terminals units) indicating zone numbers with all components identified using alpha-numeric references that correspond to the commissioning sheets.

8.6 Heating coil and cooling coil commissioning sheets.

8.6.1 Ensure the commissioning sheets for heating and cooling coils include the following design information and measured data:

- manufacturer, model, serial number and rated capacity
- pressure drop across control valves (for 3-port valves, measure in full flow and bypass)
- bypass DRV setting (where appropriate)
- air flow rate
- air temperature (dry bulb and wet bulb) on-coil
- air temperature (dry bulb and wet bulb) off-coil
- water temperature on-coil
- water temperature off-coil
- water pressure drop across coil
- air pressure drop across coil

8.7 Ventilation heat recovery device commissioning sheets.

8.7.1 Ensure the commissioning sheets for heat recovery devices include the following design information and measured data (as appropriate to the device):

- manufacturer, model, serial number and rated capacity
- donor airstream air flow rate
- donor air temperature (dry bulb and wet bulb) on-coil
- donor air temperature (dry bulb and wet bulb) off-coil
- receiving airstream air flow rate
- receiving air temperature (dry bulb and wet bulb) on-coil
- receiving air temperature (dry bulb and wet bulb) off-coil
- donor air pressure drop across device
- receiving air pressure drop across device
- flow rate of the associated hydronic circuit (where relevant to run-around coils)
- pressure drop of the associated hydronic circuit (where relevant to run-around coils)
- flow and return fluid temperatures of the associated hydronic circuit (where relevant to run-around coils)

8.8 Heat network commissioning sheets.

8.8.1 Ensure the commissioning sheets for heat networks include the following information and measured data.

8.8.2 HIU and heat meter settings:

- Differential pressure across HIU.

8.8.3 Heat meter readings during standby:

- Average flow rate
- Average flow temperature
- Average return temperature.

8.8.4 DHW – all dwellings:

- DHW setting and delivery temperature at kitchen sink

- Cold water delivery temperature when running at stabilised conditions
 - Heat meter readings of flow and return temperatures during DHW delivery
 - DHW delivery: the time to attain 45°C, kitchen tap flow rate, final kitchen outlet temperature and bath outlet temperature.
- 8.8.5 Space heating – underfloor heating:
- Space heating setting
 - Differential pressure control valve setting
 - Space heating pump setting
 - Heat meter readings during space heating
 - UFH manifold readings (loop flow temperature and flow rate).
- 8.8.6 Space heating – radiators:
- Space heating setting
 - Differential pressure control valve setting
 - Space heating pump setting
 - Heat meter readings
 - Radiator readings (flow temperature and circuit temperature drop)
 - Radiator valve setting.

9. Performance and acceptance testing.

9.1 General.

- 9.1.1 Commission all systems and plant, to the design performance specified, and obtain satisfactory results prior to making arrangements for performance demonstration and acceptance.
- 9.1.2 Use record sheets as detailed in BSRIA publications BG 2/2010, BG 46/2015 and BG 49/2015 and in the clauses above, to establish results, actual and design, for the final acceptance of the commissioning and performance testing stages.
- 9.1.3 Ensure all necessary calibration data, pump and fan characteristic curves, and details of plant duty are readily available on site, together with copies of all commissioning results and a set of 'as-installed' record drawings of the installation, showing all plant settings, air volumes, temperatures, water flow rates, pump heads and noise level readings as measured in the final commissioned state. Include these in the commissioning and testing report.

9.2 Demonstration.

- 9.2.1 Demonstrate, for each commissioned system or item of plant, in a manner appropriate to the function and performance requirement, that each system installation performs correctly, provides the duties required and maintains conditions within the specified limits under varying plant loading.

9.3 Controls.

- 9.3.1 Include the proper functioning of automatic controls, protective and alarm devices during acceptance tests, as well as demonstrating that the commissioning results are acceptable and within tolerances previously agreed with the Contract Administrator. Where unacceptable results are obtained, re-commission the system after any necessary adjustments or modifications.

9.4 BMS soak test and environmental tests.

- 9.4.1 Following completion of all testing and commissioning, witnessing, demonstrations, and rectification of any outstanding items, carry out a BMS soak test and environmental tests in accordance with specification section *Building monitoring and management systems* (Ss_75_70_54_10). Refer to

specification section *Building monitoring and management systems* (Ss_75_70_54_10) for the duration of these tests, which is usually not less than seven days.

- 9.4.2 Arrange the necessary attendance from all personnel, sub-traders and specialists to successfully complete the tests.

9.5 Approvals.

- 9.5.1 Once the installations are in a suitable condition, arrange for inspections to take place by statutory bodies and others who are required to give approval to any of the engineering systems. These include the following, as applicable:
- local water authority
 - local gas authority
 - employer's insurance company
- 9.5.2 Obtain approvals in writing and include copies of the approvals in the operating and maintenance instruction manuals.

10. Seasonal commissioning.

10.1 Scope.

- 10.1.1 Seasonal commissioning constitutes the validation of building performance under full-load operating conditions during the peak heating and peak cooling seasons, as well as under part-load conditions. During the 18 months after handover, seasonally commission the building's environmental systems as part of this contract. Include the engineering service systems detailed in specification section B4 in this seasonal commissioning exercise.
- 10.1.2 Prior to the start of seasonal commissioning, confirm that:
- all meters are reading correctly
 - all BMS graphics are reading correctly
 - the BMS graphics are a reasonable representation of the system schematics
 - the automatic meter-reading system (if applicable) is connected and recording data from all relevant meters over a suitable time period
 - all remote monitoring has been established and is operational
 - all systems have been commissioned at maximum and minimum loads
- 10.1.3 Visit, and arrange for the BMS installer and the specialist commissioning engineer to visit the building on a quarterly basis during the 18 months after practical completion on a quarterly basis in order to carry out adjustments/fine tuning of the mechanical services installations throughout the building.

10.2 Quarterly report.

- 10.2.1 Produce, and submit no later than one week prior to each quarterly seasonal commissioning review meeting, a quarterly report on the operation of the mechanical services installations.
- 10.2.2 Include in the quarterly report an assessment of the overall consumption of electricity, gas, other fuels where applicable, and water, of the building and compare this with the design data. Also assess the performance against design of all major systems and sub systems. Identify, as applicable, daily and monthly:
- building cooling consumption
 - building heating consumption

- provision of cooling by different devices, the seasonal performance of those devices (for example, chillers, heat pumps, dry air coolers etc), and the hourly performance cross-referenced to outside air temperature
- provision of heating and hot water by different devices, the seasonal performance of those devices (for example, boilers, combined heat and power devices, solar thermal panels, biomass boilers, heat pumps, etc), and the hourly performance cross-referenced to outside air temperature
- provision of water from any rainwater harvesting systems and compare to relevant rainwater levels
- electricity generated by different devices and the performance of those devices (for example CHP, solar PV panels, fuel cells, etc)

10.3 Seasonal commissioning activities.

10.3.1 Carry out the following seasonal commissioning activities as a minimum:

- comparison of meter data with predicted performance
- review of set points and dead bands
- review of real occupancy hours and level (with the building FM manager)
- discussion of perceived performance / comfort levels
- review of sensor and driver plots and compare with actual occupancy
- detailed performance review of weather compensation
- detailed performance review of night set back
- detailed performance review of night purging
- detailed performance review of heat reclaim devices

10.3.2 Agree working periods for carrying out seasonal commissioning activities with the client's facilities management personnel and ensure that these working periods fit in with the client's business operations. Arrange for facilities management or maintenance staff to be available to assist with plant operation / switching, shut-downs, access arrangements etc. It may be necessary for certain tasks to be carried out when the building is heavily, or conversely lightly, populated. Agree with the facilities management staff when these conditions occur and programme seasonal commissioning activities accordingly.

10.3.3 Advise the Contract Administrator at least two weeks in advance of when seasonal commissioning will be taking place. Allow facilities management personnel and / or the Contract Administrator's appointed representative to observe the seasonal commissioning work.

10.3.4 Be responsible for executing all seasonal commissioning work, including the provision of appropriately qualified personnel and all necessary equipment and materials. Organise all input required from plant and equipment suppliers and sub-contractors.

10.3.5 Correct any performance deficiencies found during seasonal commissioning.

10.3.6 Carry out all seasonal commissioning work in accordance with the project commissioning specification, an approved commissioning method statement, manufacturers' guidelines and the day-to-day operational requirements of the people using the building.

10.3.7 Ensure that seasonal commissioning works are fully recorded, signed off by the commissioning team representative and retained in the building documentation. Following seasonal commissioning works, make any required changes to building documentation such as Record Drawings, Operating and Maintenance Instruction Manuals, the Building Manual, the Building Log Book or the Building User Guide. Also properly inform facilities management personnel, end-users and the Contract Administrator, about any changes that have been made during seasonal commissioning works.

10.3.8 As the seasonal commissioning activities are part of the works under the contract, ensure that they are carried out by the same organisation or team as the pre-handover commissioning works. Assume roles and responsibilities as described in BSRIA BG 1/2009, BG 11/2010, BG 6/2014 and the CIBSE Commissioning Codes apply.

- 10.3.9 For phased handovers, the principles of seasonal commissioning still apply. Repeat the seasonal commissioning activities for each phase or handover. Seasonally commission any plant or systems that are affected by work in a particular phase, as the works may have an impact on the performance of plant at full load, or design, conditions.
- 10.3.10 With phased handovers, take account of those already using the building from earlier occupations, particularly where central plant and systems are concerned. Give careful thought to programming the seasonal commissioning works to cause as little disruption as possible, to maintain any essential services where necessary, and to keep occupants informed of planned works to enable them to make suitable arrangements where the works may affect their business activities.
- 10.3.11 As the building may be occupied during seasonal commissioning, comply with all health and safety requirements and carry out any commissioning works in accordance with the necessary statutory and good practice requirements.

11. Schedule of commissioning deliverables.

11.1 Documentation.

- 11.1.1 Issue the following documents for comment by the Contract Administrator:
- commissioning method statement
 - commissioning logic diagram and programme for integration into the construction and finishes programmes
 - ductwork leakage testing method statement with acceptance criteria and proposed sectional testing drawings
 - static pressure testing method statement with acceptance criteria and proposed sectional testing drawings
 - flushing, chemical cleaning and water treatment method statement with acceptance criteria
 - flushing, chemical cleaning and water treatment logic diagram and programme for integration into the construction, commissioning and finishes programmes
 - integrated performance testing method statement with acceptance criteria
 - calibration certificates for all instrumentation used during testing and commissioning
 - ductwork leakage testing report and certificates
 - static pressure testing report and certificates
 - commissioning report and certificates, detailing the commissioning results and commenting on the performance of systems
 - schedule recording all plant settings including appropriate references to plant items
 - environmental testing report
 - acoustic testing report
 - disinfection certificates for mains and potable water systems and water treatment certificates for all water systems
 - a “Written Scheme of Examination” where appropriate
- 11.1.2 Incorporate these documents within the operating and maintenance instruction manuals. Modify and update operating details to reflect commissioning results.

11.2 Demonstration/witnessing.

- 11.2.1 The Contract Administrator or their appointed representative may require to witness, or have demonstrated, any or all of the following:
- the flushing, cleaning, water treatment and disinfection of all water systems
 - the pre-commissioning activities in accordance with the commissioning specification
 - normal emergency, shutdown and standby mode operation of plant and systems

- that the equipment is capable of the performance and method of operation specified
- that the overall and complete systems perform correctly in the required manner and as intended by the specification, including return visits for seasonal tests
- leakage testing of ductwork
- preliminary static pressure testing of pipework
- final static pressure testing of pipework
- ventilation system commissioning results
- water systems commissioning results, including, for variable volume water distribution systems, demonstration of setting of differential pressure control valves, and demonstration of part-load operation
- operation and resetting of fire dampers (in presence of District Surveyor/Building Control Body if required)
- performance testing of life safety ventilation systems (in presence of District Surveyor/Building Control Body if required)
- operation of all hot and cold water outlets and authentic equal pressures at hot and cold water system outlet points
- measurement of domestic hot water temperature at each outlet
- operation of all drainage outlets, including condensate drainage systems
- operation of principal plant items in accordance with the specification
- demonstration of electrical testing/commissioning, cable insulation testing, cable continuity testing, earth fault loop impedance testing, prospective short circuit current testing, circuit labelling
- controls/BMS testing and commissioning to demonstrate that the BMS equipment and systems supplied function and operate in accordance with the specification and drawings
- partial load testing of plant
- functional testing of all safety interlocks
- acoustic tests, including full octave spectrum measurements in each internal space and externally at each site boundary
- the operation of plant and systems for specified periods of time to prove plant reliability

Appendix C – Testing and commissioning of electrical systems.

1. Reference documents.

1.1 General.

- 1.1.1 Comply fully with the edition (including amendments, replacements and associated normative references) of each of the documents listed below, current at the time of tender.
- 1.1.2 Where a standard referred to in this section conflicts with a standard referred to in the associated 'products' section of this specification, the standard referred to in this 'system' specification section takes precedence.

1.2 Legislation.

All data protection legislation including the General Data Protection Regulations

1.3 Standards.

BS 4444	Guide to electrical earth monitoring and protective conductor proving
BS 4737	Intruder alarm systems (complete series)
BS 5000-11	Specification for rotating electrical machines of particular types or for particular applications. Small-power electric motors and generators
BS 5266-1	Emergency lighting. Code of practice for the emergency lighting of premises
BS 5306-0	Fire protection installations and equipment on premises. Guide for selection, use and application of fixed firefighting systems and other types of fire equipment
BS 5611	Application guide for on-load tap-changers
BS 5839	Fire detection and fire alarm systems for buildings (full series)
BS 6266	Fire protection for electronic equipment installations. Code of practice
BS 7430	Code of practice for protective earthing of electrical installations
BS 7671	Requirements for electrical installations. IET Wiring Regulations
BS 8243	Installation and configuration of intruder and hold up alarm systems designed to generate confirmed alarm conditions. Code of practice.
BS 8434	Methods of test for assessment of the fire integrity of electric cables
BS 8591	Remote centres receiving signals from alarm systems. Code of practice
BS EN 54	Fire detection and fire alarm systems (full series)
BS EN 1838	Lighting applications. Emergency lighting
BS EN 50147-1	Anechoic chambers. Shield attenuation measurement
BS EN 50171	Central power supply systems
BS EN 50518	Monitoring and Alarm Receiving Centre (full series)
BS EN 55011	Industrial, scientific and medical equipment. Radio-frequency disturbance characteristics Limits and methods of measurement

BS EN 55016-2	Specification for radio disturbance and immunity measuring apparatus and methods. Methods of measurement of disturbances and immunity. Measurement of disturbance power
BS EN 60034	Rotating electrical machines (full series)
BS EN 61439	Low-voltage switchgear and controlgear assemblies (full series)
BS EN 60849	Sound systems for emergency purposes
BS EN 60896	Stationary lead-acid batteries (full series)
BS EN 60947	Low-voltage switchgear and control gear (full series)
BS EN 61180	High-voltage test techniques for low-voltage equipment. Definitions, test and procedure requirements, test equipment
BS EN 61439-1	Low-voltage switchgear and controlgear assemblies. General rules
BS EN 61439-2	Low-voltage switchgear and controlgear assemblies. Power switchgear and control assemblies
BS EN 61439-3	Low-voltage switchgear and controlgear assemblies. Distribution boards intended to be operated by ordinary persons. (DBO)
BS EN 61557	Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. Equipment for testing, measuring or monitoring of protective measures. (full series)
BS EN 62676	Video surveillance systems for use in security applications. (full series)
BS EN ISO 2178	Non-magnetic coatings on magnetic substrates. Measurement of coating thickness. Magnetic method.
BS EN ISO 2409	Paints and varnishes – Cross cut test
BS EN ISO 10012	Measurement management systems. Requirements for measurement process and measuring equipment
BS ISO 8528-6	Reciprocating internal combustion engine driven alternating current generating sets. Test methods

1.4 Guidance and other reference documents.

CIBSE Commissioning Code L: Lighting (SLL Commissioning Code L)

IET Code of Practice for Low and Extra Low Voltage Direct Current Power Distribution in Buildings

IET Practical considerations for d.c. installations

Association of Manufacturers and suppliers of Power Systems and ancillary equipment (AMPS) standard test procedures

2. General (applicable to all testing and commissioning procedures).

2.1 Carry out inspection and tests to comply with any British or International standards as necessary on all equipment and installations.

2.2 Comply with all aspects of section A32 (Management of the works) of this specification.

- 2.3 Where a substation, HV/LV transformer, HV switchgear, LV switchgear, generator, UPS system or Motor Control Centre(s) have been completely assembled at a manufacturer's works, arrange for the employer's representative to inspect and witness tests on the completed equipment at the works. Give the employer and Contract Administrator at least 14 days' notice of the tests so that they can attend if they wish.
- 2.4 For on-site testing give the employer and the Contract Administrator at least 7 days' notice of the tests so that they can attend if they wish.
- 2.5 Whether or not this opportunity is accepted by the employer provide the complete set of test results and inspection reports to the Contract Administrator after the tests have been completed and before the equipment is installed.
- 2.6 Retest on site any such item of equipment that has been partially dismantled for transportation, unless otherwise agreed with the Contract Administrator.
- 2.7 Prepare and submit a fully detailed programme and method statement for the testing, commissioning and demonstration of each system stating exactly how these are to be carried out and whether they interface with other systems. Ensure the programme includes a schedule of tests to be applied to the system to demonstrate that the fault diagnostic routines function as required. Submit the programme and statement to the Contract Administrator for comment one month in advance of the test. Notify manufacturers or specialists of the dates as appropriate.
- 2.8 Arrange for the attendance of a tester to carry out all required tests. Ensure that this tester is not the same person who carried out the installation, unless agreed with the Contract Administrator.
- 2.9 Supply all test instruments. Ensure they are calibrated immediately prior to commencement of testing and operated by trained personnel. Arrange for all calibration certificates to be available for inspection at the time of the tests. Prior to commencement of tests ensure the Contract Administrator is asked to comment on the suitability of the proposed test equipment and methods of testing being adopted.
- 2.10 Provide all specialist equipment, to test and demonstrate the various systems as required.
- 2.11 Arrange and carry out disconnection or similar operations to satisfy the requirements for testing, etc, and the reinstatement of the installation after tests.
- 2.12 Carry out the test procedures in the following clauses in addition to any tests required by the particular system section, or any other product section, of this specification, as a minimum.
- 2.13 Provide certificates for all testing and commissioning carried out. Include all recorded test results in the operating and maintenance manuals as a record of commissioning prior to contract completion.
- 2.14 Ensure all control arrangements, settings and sequences on completion of commissioning and demonstration are recorded, added to the Record Drawings and included within the operating and maintenance manuals.

2.15 Training.

- 2.15.1 Provide training (either pre- or post-contract completion, as directed by the Contract Administrator), for nominated client's / end-user's representatives in all aspects of the installation operation that are the user's responsibility. Refer to the particular specifications for training requirements for that system.

3. Particular test procedures.

- 3.1 Carry out the following procedures as necessary in accordance with the relevant British or other standards.

3.2 Ensure that the work's test engineer controls all tests undertaken at the manufacturer's works.

3.3 Ensure that, in the presence of the employer's representative, all tests undertaken at site are controlled by the installer/manufacturer.

3.4 LV switchgear.

3.4.1 Factory acceptance testing

1. Inspect and test the switchgear assembly fully in accordance with BS EN 61439, and in particular BS EN 61439-1 to comply with type testing or partial type testing.
 2. Ensure that all switchgear and the assembly has been type tested, approved and certified by a UKAS accredited test facility and provide a letter of conformity with the relevant test certificates.
 3. Ensure that all meters fitted to any switchgear have a valid calibration certificate.
 4. Inspection of the assembly including inspection of wiring;
 5. Perform an Electrical operation test;
 6. Perform a Dielectric test;
 7. Check the protective measures and electrical continuity of the protective circuit.
- 3.4.1.1 Ensure that for projects where business continuity is of the utmost importance such as data centres perform and demonstrate the satisfactory completion of the following tests:
8. Perform a visual inspection of all cable support, cable glands plate entries, paint finishes, terminal shrouds, labelling, warning notices and panel mounted equipment.
 9. Check for cleanliness of all internal chambers and enclosures and correct fitting of seals
 10. Undertake torque testing on all bolts on primary flange / busbar joints and random check on 10% of all other connections. Check that the paint marking on each bolt has been made by the manufacturer to indicate that the bolts have been torqued using a calibrated wrench. Ensure a list of torque settings for each size/type of bolt is included in the test pack and included in the O&M manual.
 11. Check phase & earth clearances
 12. Check earthing / bonding
 13. Polarity and phase rotation to check that the has no cross phases.
 14. Undertake a flash insulation test / pressure test to 2kv ac for 5 seconds as BS EN 61439-1
 15. Perform a small wiring insulation test
 16. Check protection devices against schematics, setup the protection relays with settings from protection/selectivity study.
 17. Check the control fuse/MCB ratings against schematics
 18. Check the CT ratings against schematics
 19. Perform a secondary injection of protection relays/modules within all devices
 20. Setup the metering and controls
 21. Check the control and operation of battery tripping units / power supplies
 22. Setup the SCADA, load management systems, etc
 23. Perform a ductor (micrometer) test on main and branch busbars

24. Confirm local/automatic control of devices
25. Check that the circuit breaker operation includes opening / closing and tripping interlock operation and safety key / padlocking facilities. Check key operation with key exchange boxes where applicable.
26. Undertake load bank testing – 100% load using resistive loadbank and thermal imaging tests undertaken during load bank testing. (4 hours or until the internal temperature becomes stable whatever is the longest period.)
27. Perform the ems/pms/scada interface testing with laptop
28. Check the load management system cause and effect (if applicable)
29. Ensure that the settings of all air circuit breakers and moulded case circuit breakers are in accordance with the design settings as detailed in the schedules.

3.4.2 Pre-commissioning

- 3.4.2.1 Ensure that prior to energisation, testing or on-site commissioning that the following, in accordance with the appropriate British Standards is performed:
1. Systematically clean all LV distribution panels of all debris, foreign bodies and dust immediately before testing and commissioning. Retain covers in place after cleaning unless it is necessary to remove for testing and commissioning.
 2. Inspect all electrical distribution systems prior to energisation to ensure that the installed system complies with the requirements of this specification.
 3. Visual inspection of all cable support, cable entries, labelling, warning notices and panel mounted equipment
 4. Perform a continuity test of protective earth (PE) and all conductors
 5. Perform a continuity check of earth bonding to covers, door, etc
 6. Check the continuity of connections to main earth termination
 7. Check the terminal lugs and bolts for correct tightness
 8. Check the busbar joints for correct tightness
 9. Check the polarity to all instruments, VT and CT
 10. Check that all devices are correctly racked/mounted
 11. Perform an Insulation test
 12. Verify the correct functioning of all residual current devices (RCD), and confirm that the surge protection devices (SPDs) and arc fault detection devices (AFDDs) are correctly installed and do not indicate any faults. Ensure the AFDDs are tested using the test button on the device, and the RCD using a RCD tester as part of the testing and commissioning.
 13. Ensure that all switchgear and distribution boards have been correctly labelled, and all distribution board schedules are correct and in place.

3.4.3 On-site tests

1. Undertake a visual inspection of all cable support, cable entries, labelling, warning notices and panel mounted equipment
2. Check the small wiring insulation test and polarity
3. Perform a flash insulation test (power section only)
4. Undertake ductor tests on main busbars

5. Check the Earthing / bonding
6. Check the polarity to all instruments, VTs and CTs
7. Check that all devices are correctly racked/mounted
8. Confirm local/automatic control of devices
9. Confirm protection relay setting by secondary injection
10. Confirm operation of all protective devices
11. All metering functions and interfaces
12. Alarm and monitoring, BMS/LMS/PMS/SCADA /UPS/generator interface tests
13. Site load testing with UPS / generator systems in operation to test complete system.

3.4.4 HV and LV switchgear functional tests

3.4.4.1 Carry out the following functional tests, where applicable on switchgear to verify the correct operation:

1. Visual inspection of all cable support, cable entries, labelling, warning notices and panel mounted equipment
2. Motorised operation of any switchgear;
3. Contacts, whether volt-free or not;
4. Power factor correction including sequencer and contactors;
5. G99 isolation testing of both mechanical and electrical interlocks;
6. Castell key operation;
7. Switch earth position if installed;
8. Any other control function on the switchgear.
9. Small wiring insulation test and polarity
10. Flash insulation test (power section only)
11. Ductor tests on main busbars
12. Earthing / bonding
13. Check of polarity to all instruments, VT and CT
14. Check that all devices are correctly racked/mounted
15. Confirm local/automatic control of devices
16. Confirm protection relay setting by secondary injection
17. Confirm operation of all protective devices
18. All metering functions and interfaces
19. Alarm and monitoring, bms/lms/pms/scada /ups/generator interface tests
20. Site load testing with UPS / generator systems in operation to test complete system.
21. In carrying out the above tests ensure that interlocks and keys effectively prevent any cross phasing, paralleling or unintended action by the switchgear.

3.4.5 Protection tests

3.4.5.1 Undertake the following Protection System tests:

1. Within all switchboards, test every protective relay to ensure it functions correctly.
2. Check that the current transformers are correctly installed and connected.
3. Verify the action of all such relays by secondary injection methods.
4. Check that the system has been graded and that the correct settings have been set up.
5. Check that the grading settings have been correctly recorded in test sheets and that these settings are recorded in the operation and maintenance manual.

3.5 Cables.

3.5.1 LV cables

- 3.5.1.1 Test all installed LV cables fully in accordance with BS 7671.
- 3.5.1.2 Carry out the insulation, continuity and conductor resistance tests required. Be responsible for the conducting of the tests and the subsequent recording and certification of the results. Ensure that, throughout all such tests, both ends of every cable are monitored by a competent person.
- 3.5.1.3 Ensure that when testing long cables that probably have considerable capacitance, be aware of the dangers of stored energy and the need to earth down, in a controlled manner, all cores after each test.
- 3.5.1.4 Ensure that on every paper insulated cable a “crackle test” is performed on the impregnated bindings before making each joint, to ensure that they contain no moisture.
- 3.5.1.5 Ensure that for large section circuits consisting of more than one conductor per phase, verify the equality of load current sharing between the parallel conductors.

3.6 Emergency lighting.

3.6.1 General

- 3.6.1.1 Fully test and inspect emergency lighting installations in accordance with this specification and generally as outlined in BS 5266, BS 1838, and BS 7671, after first disconnecting all luminaires to prevent damage to the electronic circuits. Provide measured readings of all tests undertaken.
- 3.6.1.2 Carry out full testing and commissioning of the automatic emergency lighting testing and monitoring system where specified as set out in section *General lighting systems – emergency lighting systems* (Ss_70_80_33) of this specification.
- 3.6.1.3 Carry out adjustments and calibration of all automatic control devices and systems to provide optimum operation.
- 3.6.1.4 Make available a suitable operative, familiar with lighting controls, as may be required to assist any specialist equipment supplier/manufacturer throughout the commissioning period.
- 3.6.1.5 Ensure that CAD record drawings of the lighting installation and associated controls are completed and available on site to specialist equipment supplier/manufacturers prior to commissioning commencement.
- 3.6.1.6 Replace all failed lamps of the installed luminaires during the course of the contract works.
- 3.6.1.7 Thoroughly clean all luminaires and ensure they are in a new clean condition at handover.
- 3.6.1.8 Fully demonstrate the complete operation of the emergency lighting installation to the satisfaction of the Contract Administrator and client's representative.
- 3.6.1.9 Arrange a mutually agreed programme for the above demonstrations with the Contract Administrator, providing at least ten working days' notice.
- 3.6.1.10 Prepare a method statement for the tests, detailing how they are to be undertaken.

- 3.6.1.11 Submit the programme for comment at least four weeks in advance of commencement of testing.
- 3.6.1.12 Arrange for all specialist equipment suppliers/manufacturers to provide a minimum of one full day's instruction of the complete emergency lighting system for the Employer's representative prior to the contract completion date, and ensure that the demonstration also includes the automatic testing and monitoring system where specified.

3.6.2 Tests to be conducted prior to commissioning

- 3.6.2.1 A visual inspection of the whole installation covering equipment and cable where accessible, to verify compliance with BS 5266-1, BS EN 1838, BS 7671 and this specification.
- 3.6.2.2 Inspect and test the electrical installation in accordance with BS 7671 and record all results on approved test record sheets
 - Test conductors and other circuit components prior to them being connected to electronic components in order to avoid damage during the electrical installation test procedures. Test electronic equipment in accordance with the manufacturers' instructions.
 - Clearly note on the circuit charts and in operating and maintenance procedures the presence of electronic components with an indication that testing procedures may result in damage.
 - Where any part of the installation is to be concealed within the building fabric carry out tests to ensure that the installation is satisfactory prior to concealment.
- 3.6.2.3 Upon completion of the works subject the whole installation to the tests detailed and note every defect, correct them and bring to the attention of the Contract Administrator.
 - In the event of any test indicating failure to comply, repeat that test and any preceding it whose results may have been influenced by the faults indicated, after the fault has been rectified.

3.6.3 Tests to be conducted during commissioning

- 3.6.3.1 Carry out the following tests and inspections:
 - Test the operation of all luminaires and emergency lighting luminaires accessories and items of equipment and check for proper function.
 - Carry out functional test of all light switches, emergency lighting test switches and control devices.
 - Demonstrate the operation of each self-contained luminaire under simulated mains failure condition to prove the luminaire output for the specified time and that the battery is fully recharged within 24 hours.
 - Under emergency lighting conditions, check adequate illumination is available for safe movement on the escape / open areas and all escape route safety signs / fire-fighting equipment location signs and other safety signs identified from risk assessment are visible with the normal lighting extinguished.
 - Carry out full emergency illuminance test in accordance with Annex B of BS 5266 or submit lighting calculations for the scheme.
 - Carry out full duration test of three hours, including confirmation that adequate illumination is available for safe movement on the escape and open areas at the end of the test.
 - Carry out full functional test of the automatic test system for emergency lighting and confirmation that all inputs / outputs are fully operational.
- 3.6.3.2 Submit the completion certificate in Annex F of BS 5266-1 to the Building Control Officer. Where light level calculations by the designer is the chosen compliance route, submit the calculations with the completed certificate.

3.7 Fire alarm.

- 3.7.1 Arrange for the manufacturer or their representative to test and commission the complete fire alarm system fully in accordance with BS 5839 and this specification.

3.7.2 General

- 3.7.2.1 Carry out, on completion of the installation works, together with the selected specialist equipment manufacturers, the complete testing, commissioning and demonstration of the system operation as detailed below.
- 3.7.2.2 Make available suitable operatives, familiar with the fire detection system, as may be required to assist the manufacturer throughout the commissioning period.
- 3.7.2.3 Ensure that CAD record drawings of fire alarm systems are completed and available on site to manufacturers prior to commissioning commencement.
- 3.7.2.4 Ensure that the tests are largely composed of simulated faults that are artificially imposed on the system. Check all visual units, alphanumeric displays, and printers to establish that all programmed messages are displayed correctly. Ensure all control panel switches undergo functional demonstration of correct operation.
- 3.7.2.5 Complete and produce the commissioning and test certificate for scrutiny before any part of the project can be handed over and accepted.
- 3.7.2.6 Ensure that 'As Fitted' drawings and manuals are available before the demonstration and instructions.
- 3.7.2.7 Fully demonstrate the complete operation of the system to the satisfaction of the Contract Administrator and, where appropriate, the Fire Officer.

3.7.3 Tests to be conducted prior to commissioning

- 3.7.3.1 Prior to commissioning carry out the following tests:
- 3.7.3.2 Carry out a visual inspection of the whole of the installation, including equipment and cabling in subways, walkways, crawl ways, ceilings and floor voids where accessible.
- 3.7.3.3 Check insulation resistance tests cover all circuits forming part of the system and made between phases, phase to neutral, phase to earth and neutral to earth. Ensure that the method of undertaking insulation resistance tests does not adversely affect any sensitive system components, and if required, isolate sensitive devices prior to undertaking the tests.
- 3.7.3.4 Check correct polarity of the alarm devices, bells, sirens, klaxons, etc, and all items where correctness of polarity is essential
- 3.7.3.5 Check the programming of the fire alarm system to ensure all detectors are in the correct zone. Base the zoning arrangement on the arrangement shown on the drawings and/or as required by the British Standard. Allow for making minor adjustments to the zoning arrangement to suit the final position of the fire doors and other zone boundaries. Agree all such adjustments with the Contract Administrator.

3.7.4 Tests to be carried out during commissioning

- 3.7.4.1 During commissioning carry out testing in accordance with the requirements of BS 5839 and BS EN 54, including, but not limited to, the following:
 - 1. Test the operation of all panels, accessories and items of equipment and check for proper function, including such items as may have been supplied by others but wired under the electrical installation. Carry out these tests under normal operating conditions, including the discharge and recharging of the 'battery' system, and record the results.
 - 2. Functional test of all manual "break glasses"
 - 3. Functional test of all smoke detectors by use of an approved smoke generator testing device
 - 4. Functional test of all "fixed temperature" or "rate of rise" heat detectors, by an approved heat source testing device

5. Simulated tests for fire or fault alarm at detectors and manual contacts as may be instructed by the Contract Administrator, with all tests agreed and recorded on to a system checklist to be approved prior to any witness testing being carried out.
 6. Testing of all sprinkler sensors and fusible link units
 7. Testing of all visual indicators under simulated operational conditions with sounders out of circuit
 8. Testing of auxiliary signals to remote panels and via BT lines, etc
 9. Five simulated faults, at randomly chosen locations on each loop circuit and sounder interface secondary circuit, for each of the following type:
 - i. open circuit
 - ii. short circuit
 - iii. sensor removal/alarm device removal
 - iv. earth fault
 10. Simulated charger and battery faults for all power supply units (panels, interface units, etc), followed by a battery discharge test (i.e., 24-hour quiescent detection of the full alarm system, followed by 30 minutes alarm operation)
 11. Simulated operation of mechanical plant where such faults (if any) are required to operate the fire alarm system (e.g., fire/smoke dampers).
- 3.7.4.2 Ensure that during routine fire alarm system testing, certain functions are inhibited, i.e., gas supply shut-off valve, smoke damper operation, etc. Provide suitable key switch facilities.

3.7.5 Audibility tests

- 3.7.5.1 Carry out, prior to full commissioning of the rest of the system, the following tests:
1. Fully test the fire alarm system audible alarm facility to ensure that the correct audibility levels are achieved as required by the relevant standards.
 2. Carry out tests on completion of the installation when all mechanical plant is fully functioning to ensure that realistic results are obtained, including all normal background noise levels.
 3. Measure and record the sound pressure level in each room, area or plant space. Carry out and record the number of tests necessary to have results from the highest to lowest background noise conditions in each area to obtain average values.
 4. Inform the Contract Administrator, in writing, of any areas where the required audibility levels are not achieved.
- 3.7.5.2 Arrange for the manufacturer to carry out the audibility tests twice. Carry out the first test on completion of the system when all mechanical plant is fully functioning to ensure that realistic results are obtained. Carry out the second test approximately six months later when the building is operating under normal conditions. Carry out both tests in the presence of the Contract Administrator.
- 3.7.5.3 In the event that the required audibility levels are not achieved, provide any additional sounders and wiring required to rectify this, and repeat the audibility tests at no additional cost to the contract.

3.7.6 Documentation

- 3.7.6.1 Provide the required fire alarm system test certificate(s), issued by the specialist manufacturer, in the forms as detailed in BS 5839 and other relevant standards.
- 3.7.6.2 Record all audibility test results, present in tabulated form and include in the operating and maintenance manuals.

- 3.7.6.3 Provide a full set of zoning diagrams to depict the exact zoning arrangement as required by the British Standards. Frame, glaze and mount adjacent to the main panel and repeater panel in agreed positions to facilitate clear recognition of alarm condition location.
- 3.7.6.4 Provide full details and include within the tender for the provision of a full 12 months' system maintenance contract including system inspection and test as recommended by BS 5839.

3.8 Intruder alarm.

- 3.8.1 Arrange for the specialist security Installer to carry out the testing and commissioning of the system as detailed below and in the relevant parts of the specification section *Security detection alarm systems* (Ss_75_40_75).

3.8.2 Testing

- 3.8.2.1 On completion of the installation, undertake full technical and performance tests on the entire system, including, as a minimum, the following tests:
 - Check all wiring is correctly terminated and labelled.
 - Check all equipment is correctly labelled.
 - Confirm the supply voltage is correct at all parts of the system.
 - Verify that the system continues to work when the main power supply is disconnected.
 - Test the correct operation of all detectors, and the elimination of false alarms.
 - Test the correct operation of manually operated devices.
 - Test the correct operation of annunciation devices, and measure and record sound levels.
 - Test the operation of all software functions.
 - Test the operation of remote monitoring and control via the LAN.
 - Test the effectiveness of access level settings.
 - Test the receipt of all types of alarm signals to the remote monitoring facility.
 - Test tamper protection of devices, enclosures, and wiring.
- 3.8.2.2 Ensure that the entire system satisfies all test criteria.
- 3.8.2.3 Before demonstrating the system, submit to the Contract Administrator full tests results, as well as a certificate of conformity that lists details of all aspects of the system that do not conform to the intended requirements.

3.8.3 Commissioning

- 3.8.3.1 Demonstrate to the Contract Administrator that the system complies with all technical and functional requirements of the specification
- 3.8.3.2 Demonstrate all functions of the intruder alarm system to the users and the user's insurers, after successful demonstration to the Contract Administrator.
- 3.8.3.3 Ensure all control arrangements, settings and sequences on completion of commissioning and demonstration are recorded and added to the record drawings and included within the operating and maintenance manuals.

3.9 Access control.

- 3.9.1 Carry out the testing and commissioning of the system in accordance with the requirements as detailed below, and in section *Access control systems* (Ss_75_40_02) of the specification.

3.9.2 Testing

- 3.9.2.1 Obtain all permissions and consent as might be necessary to remain compliant with the requirements of the General Data Protection Regulations.
- 3.9.2.2 On completion of the installation, undertake full technical and performance tests on the entire system, include as a minimum the following tests:

- Check all wiring is correctly terminated and labelled.
- Check all equipment is correctly labelled.
- Confirm the supply voltage is correct at all parts of the system.
- Verify that the system continues to work when the main power supply is disconnected.
- Test the correct operation of all devices.
- Test the correct operation of manually operated devices.
- Test the correct operation of annunciation devices, and measure and record sound levels.
- Test the operation of all software functions.
- Test the operation of remote monitoring and control via the LAN.
- Test the effectiveness of access level settings.
- Test tamper protection of devices, enclosures, and wiring.

3.9.3 Commissioning

3.9.3.1 Undertake the following commissioning procedures:

- Test all reader devices and demonstrate that the system meets with the overall operation and control functional requirements detailed.
- Calibrate all field devices.
- Provide a hard copy print-out of the events recorded during the commissioning.
- On completion of the commissioning and testing, provide a certificate of conformity.
- Setup the operator and supervisor security access levels on the integrated system.
- Setup the alarm annunciation on the operator computers and all remote computers.
- Fully demonstrate software graphics.
- Ensure that site plans used by the computer software are current.
- Check release times for each door.
- Check door held open signal.

3.9.4 Communication link

3.9.4.1 Where a remote monitoring centre is used, ensure that the alarm communication link to the remote centre is fully tested and commissioned as follows:

- Check the link before connecting the system.
- Warn the remote centre of the test.
- Initiate the alarm, contact the remote control centre / station and confirm that the alarm condition has been received.
- Confirm the end of testing once the system links have been fully commissioned.

3.9.5 Interfaces

3.9.5.1 Commission every system scheduled below independently and as an integrated, co-ordinated system as detailed within the specification:

- Access control system
- Surveillance system
- Alarm monitoring system
- Intercom facilities
- Fire alarm system
- BMS
- Vehicle traffic light system
- Lighting control

3.9.5.2 Commission the access control system under normal power supply conditions, followed by a simulated power failure that proves that the backup UPS supports the system.

3.9.5.3 Test, prove and commission the interfaces with the following systems under normal and emergency power modes:

- Fire detection and alarm system
- BMS.

3.9.5.4 Ensure all control arrangements, settings and sequences on completion of commissioning and demonstration are recorded and added to the record drawings, and included within the operating and maintenance manuals.

3.10 Vertical or horizontal busbar systems.

3.10.1 Test all busbar systems fully in accordance with BS 7671 and to the requirements specified in section *Power busbar trunking (Ss_60_70_48_66)* of this specification.

3.10.2 Carry out the following tests:

- Visual inspection
- Insulation tests
- Earth bonding and continuity tests.

3.11 Lighting and power installations.

3.11.1 For all lighting and power installations, inspect and test the complete installation fully in accordance with BS 7671.

3.11.2 Carry out the inspection and tests in the same sequence as set out in BS 7671, and in such time as to allow any remedial work to be completed within the contract period.

3.11.3 Prior to void-closures, carry out, as a minimum, insulation resistance testing to all mains voltage cabling, and supply the results to the Contract Administrator for comment.

3.11.4 Ensure tests also include any part of an existing installation related to the new work. Carry out the following BS 7671 tests before making the system live:

- Visual inspection, including verifying that:
 - the cable containment is supported adequately;
 - all luminaires are complete with lamps and accessories;
 - lamps are of the correct colour, rating and manufacturer selection;
 - control devices have been correctly installed;
 - all switch plates align straight and true;
 - all required labelling has been provided;
 - luminaires and lamps are in clean condition;
 - SPDs are operational;
- Continuity of protective conductors including main and supplementary equipotential bonding;
- Continuity of ring final circuit conductors;
- Insulation resistance, ensuring that devices such as AFDDs and SPDs are not damaged, or cause incorrect results when the test is performed;
- Site applied insulation resistance;
- Verification of protection by separation of circuits;
- Verification of protection against direct contact by barrier or an enclosure provided during erection;
- Electrical resistance of floors and walls that provide protection against direct contact;
- Polarity;
- Earth electrode resistance;

3.11.4.1 Carry out the following BS 7671 tests after making the system live:

- Earth fault loop impedance;
- Prospective fault current;
- Functional testing (testing of RCDs, RCBs, AFDDs, interlocks, etc).

- 3.11.4.2 Test and commission the lighting system in accordance with CIBSE Commissioning Code L.
- 3.11.4.3 Engage the specialist equipment installer/manufacturer to set up, prove the operation and function and fully commission the lighting management system together with its associated control devices.
- 3.11.4.4 Set up, prove the operation and function and fully commission all individual control devices including switches, presence detectors, photocell sensors, and contactor/relay units, etc.
- 3.11.4.5 Carry out adjustments and calibration of all automatic control devices and systems to demonstrate optimum performance and operation.
- 3.11.4.6 Record all control arrangements, settings, sequences and functions on completion of commissioning and demonstrations.
- 3.11.4.7 Demonstrate the operation of all control functions to the satisfaction of the Contract Administrator and Employer's representative after commissioning has been fully completed.
- 3.11.4.8 Provide out-of-hours attendance, as necessary, during periods of darkness, for the demonstration and verification of operation and function of particular lighting systems.
- 3.11.4.9 Make average illuminance measurements of the installed lighting system, as recommended by the CIBSE Code for Lighting, throughout all areas of the building. Incorporate the results on the lighting system 'Record' layout drawings.
- 3.11.4.10 Test the installed lighting system progressively during construction and upon final completion of the whole installation. Test the complete lighting system, including luminaires, control devices and all associated equipment in accordance with the manufacturer's recommendations.
- 3.11.4.11 Measure the installed cable lengths for underwater lighting circuits and submit a report in writing to the Contract Administrator.
- 3.11.4.12 Verify that the control devices for underwater lighting operated correctly.

3.12 Electromagnetic compatibility issues.

- 3.12.1 Where section *Electrical activities – electromagnetic compatibility and screening (EMC)*(Ac_70) of this specification requires that a specialist be employed to report on electromagnetic compatibility issues, ensure that the specialist carries out an ambient electromagnetic interference (EMI) survey of the areas of the building described in section *Electrical activities – electromagnetic compatibility and screening (EMC)*(Ac_70), using an appropriate instrument. Make an inspection to ensure that the specialist's recommendations have been fully implemented before making the electrical system live.
- 3.12.2 After the electrical system is live but before the protected systems and equipment are operated, arrange for the specialist to carry out EMI tests to confirm that the electric and magnetic field strengths are within the required limits.
- 3.12.3 Ensure that the EMI survey and tests are carried out in accordance with appropriate standards including BS CISPR 16, BS EN 50147-1 and BS EN 55011.

3.13 DC supplies and batteries.

- 3.13.1 Carry out, on any dc supply installed, all relevant tests required by BS 7671. Carry out all tests as recommended by the manufacturer on any rechargeable batteries installed, in compliance with a relevant standard such as BS EN 60896-11 and the
 - IET: Code of Practice for Low and Extra Low Voltage Direct Current Power Distribution in Buildings
 - IET: Practical considerations for d.c. installations

3.14 Miscellaneous – motors.

3.14.1 Motor starters and controllers / motor control centres

- 3.14.1.1 Subject the panels, before dispatch, to physical inspection, insulation testing, sequence and component operation testing. Provide certificates recording the works inspections and tests.
- 3.14.1.2 Following installation on site, check and provide evidence that all wiring connections are correct.
- 3.14.1.3 Check that the functioning of all components and controls is correct, including the correct functioning of all interfaces with associated equipment. Measure power wiring insulation and earth loop impedance and record the results.
- 3.14.1.4 Arrange for special units such as variable frequency inverters to be checked and commissioned by their manufacturers, or according to the manufacturers' specific instructions for the units fitted.
- 3.14.1.5 Measure and record all motor currents. Set motor overloads to motor nameplate full load currents. Note that star/delta starters normally have overloads installed in the delta loop and set to full load current x 0.58.
- 3.14.1.6 Ensure that during commissioning and testing no motor that has reached normal operating temperature is started more frequently than twice in one hour, or according to the motor manufacturer's instructions if different.
- 3.14.1.7 Carry out, on any DC supply installed, all relevant tests required by BS 7671 and this specification.

3.14.2 Motor drives

- 3.14.2.1 Ensure that every belt coupling is accurately aligned and tensioned in accordance with the belt manufacturer's instructions.
- 3.14.2.2 Set all starter overloads to the motor nameplate full load current
- 3.14.2.3 Where thermistor relay operation is fitted, check it.
- 3.14.2.4 With the motor delivering its maximum required duty measure (with suitable true r.m.s. instruments) and record the following:
 - 1. for 3-phase motors - each phase-to-phase voltage (400 V nominal); for 1-phase motors – the phase-to-neutral voltage (230 V nominal);
 - 2. for 3-phase motors - each phase current; for 1-phase motors – the line current;
 - 3. the motor shaft speed;
 - 4. for belt coupled machines - the driven pulley shaft speed.

3.15 Earthing and bonding.

- 3.15.1 Where a building is equipped with a lightning protection system, test the system in accordance with this specification, including testing its bonding to other systems, and in accordance section *Earthing and bonding systems* (Ss_70_30_25_25) of this specification.
- 3.15.2 Test that all earthing and bonding is fully in compliance with BS 7671 and BS 7430, and prove all protective conductors are fully in accordance with BS 4444.
- 3.15.3 Carry out full impedance/continuity testing of all service carriers prior to connecting to the earthing system, to the Contract Administrator's satisfaction.
- 3.15.4 On completion of the contract works, carry out all necessary tests to prove the effectiveness of the complete earthing system. Ensure that the earth electrode system achieves an overall resistance as detailed in specification section *Earthing and bonding systems* (Ss_70_30_25_25) noting the requirement to provide additional electrodes if the systems fail to meet the specified resistance to earth.

3.16 Telecommunications.

- 3.16.1 Where external and internal telephone wiring is installed, carry out testing fully in accordance with the telephone service provider's (TSP) specification and section *Telecommunications systems* (Ss_75_10_21_88) of this specification.
- 3.16.2 Where internal and site-wide telephone and data wiring form one integral wiring system, test it as detailed in the Data section, clause 3.17 of this specification section.
- 3.16.3 Carry out the following tests:
- visual inspection, verifying that:
 - the cable containment is supported adequately;
 - control devices have been correctly installed;
 - all cabling is correctly installed and secured;
 - all required labelling has been provided;
 - continuity of protective conductors including main and supplementary equipotential bonding;
 - verification of protection by separation of circuits;
 - verification of protection against direct contact by barrier or an enclosure provided during erection.

3.17 Data.

3.17.1 General

- 3.17.1.1 Thoroughly test the cabling installation to confirm that the components and installation practices meet the defined standards in specification section *Data distribution systems* (Ss_75_10_21_21) and any specific client specifications.

3.17.2 UTP cable tests

- 3.17.2.1 Test all UTP horizontal and riser cables, following installation, for:
- pair polarity;
 - crossed pairs;
 - continuity;
 - short circuits;
 - length;
 - attenuation;
 - cross talk (near and far end);
 - PS-NEXT;
 - EL FEXT;
 - PS-ELFEX;
 - propagation delay;
 - delay skew.
- 3.17.2.2 Check the results against declared published results for the types of cable used and notify the Contract Administrator of any variations.
- 3.17.2.3 Ensure each pair in each link is tested from both ends and the worst pair results used as the test result.

3.17.3 Fibre optic cable tests

- 3.17.3.1 Test all optical fibre cabling on the reel prior to installation using a light meter.
- 3.17.3.2 Do not use cables with any identified faults; remove such cables from site.
- 3.17.3.3 Test all fibre optic cables following installation, including the following tests:

- visual check for damage to each terminated connector;
- Optical time-domain reflectometer (OTDR) from both ends;
- attenuation measurement using a light source and power meter;
- front-lit microscope examination at 200X, for each termination connector.

3.17.3.4 Examine each optical element for the following:

- random mated loss at connectors;
- sudden step in attenuation coefficient or back scatter;
- losses due to excessive bending;
- different lengths recorded at each end of an element.

3.17.3.5 Record the following test results, for each end of each cable:

- length;
- random mated loss of each mated connected pair (to a resolution of 0.02 dB or better).

3.17.4 Test equipment

3.17.4.1 Provide a valid calibration certificate that is less than six months old for each item of test equipment brought to site to measure performance data. Make the calibration certificate available for inspection on site.

3.17.4.2 Ensure UTP test equipment can provide Level II accuracy for both channel and basic link in accordance with requirements of the American National Standards Institute (ANSI) Technical Services Bulletin EIA/TIA TSB67.

3.17.4.3 Ensure all fibre optic test equipment complies with the appropriate standards.

3.17.4.4 Ensure the light source and power meter pair provide attenuation accuracy better than 0.02 dB and operate at 850 nm and 1310 nm.

3.17.4.5 Provide microscope(s) for inspection of terminated fibre optic connectors, conforming to the following:

- magnification of 200X minimum;
- allow connection of SC connectors;
- built-in front illumination;
- built-in infra-red blocking filter.

3.17.4.6 Maintain full records of all testing carried out and the results of the tests, and include in the operating and maintenance manuals.

3.18 Radio and television aerial systems.

3.18.1 With the system manufacturer, fully test, commission and demonstrate the system in accordance with the manufacturer's recommendations and those of the standards listed in section *Radio and television distribution systems* (Ss_75_10_70) of this specification, and as detailed below. Liaise with manufacturers of the interfaced systems to ensure all tests and demonstrations are fully co-ordinated.

3.18.2 Testing and commissioning

3.18.2.1 Undertake preliminary checks to ensure that the system and system components are in a satisfactory and safe condition before commencing the commissioning.

3.18.2.2 On completion of the installation undertake the complete testing, commissioning and demonstration of the system operation in accordance with the British Standards to verify the following.

- correct antenna alignment;
- correct signal strength for all digital TV channels (terrestrial and satellite);
- correct signal strength for all FM channels;
- correct signal strength at every outlet.

3.18.3 Commissioning

- 3.18.3.1 Undertake operational selective viewing and/or listening tests on all channels provided, at each co-axial socket outlet including any reconnected existing outlets to demonstrate the following:
- that all channels and teletext operate satisfactorily;
 - there is no discernible difference in picture, sound or teletext quality of the same receiver, whether connected to the co-axial socket outlets specified or to the aerial input of the headend equipment, using attenuators if necessary;
 - measuring and recording of the signals levels throughout the system at the input and output of each amplifier and at the output of the antenna(s) headend equipment;
 - the operation of the TV sound and volume control at each outlet.
- 3.18.3.2 Record all signal dB losses and signal strength throughout the system on completion of the commissioning and demonstration, and include this information on the as-fitted” drawings and within the operating and maintenance manual.
- 3.18.3.3 Issue a system test certificate detailing compliance with all the relevant British Standards and this specification.

3.19 Lightning protection and surge protection.

- 3.19.1 Ensure that the complete lightning protection system and surge protection devices are fully tested by the specialist installer all in accordance with BS EN 62305.
- 3.19.2 Make provision for witnessing of the testing procedure by the Contract Administrator.
- 3.19.3 With its test link removed and without any bonding to other services, measure the earth resistance of every individual earth electrode. Ensure such resistance in ohms does not exceed ten times the number of down conductors on the structure.
- 3.19.4 Measure with the test links in place the resistance to earth of the complete lightning protection system at any point on the building. Ensure that all results from this test do not exceed ten ohms. Carry out this test prior to bonding to other services. If the overall resistance exceeds ten ohms provide, at no additional cost to the employer, any means (e.g., the addition of earth mats or plate electrodes) as recommended by BS EN 62305, to reduce the overall resistance.
- 3.19.5 Fully tabulate all test results and record in the operating and maintenance manuals

3.20 Thermal imaging/acoustic vibration testing.

- 3.20.1 In locations where a thermal image survey of cable terminations, busbar field connections and general switchboard components, or an acoustic vibration test, is specified:
- Carry out the survey using a thermal imaging camera capable of producing a hard copy or of producing a digital image that can be viewed on a computer and printed therefrom.
 - Arrange for the survey to be carried out by a specialist company or for the camera to be operated by a person specifically trained in its use.
 - Carry out an acoustic vibration survey to ascertain the origin of any unusual or unacceptable noise.

4. Instrumentation.

- 4.1 Supply all test instruments for the tests required. Ensure that all such instruments are calibrated and supply the current calibration certificate for each. Ensure that all such instruments comply with BS EN ISO 10012.

5. Certificates and schedules.

- 5.1 Ensure that all completion certificates, test certificates, schedules and reports required by the relevant BS or International or other standards are recorded and produced before handover of the project. As a minimum, provide the following documents for each system:
1. works test certificates;
 2. certificates for type-tested components;
 3. site commissioning certificates;
 4. record drawings;
 5. warranty certificates for the installation and individual components;
 6. operating and maintenance instruction manuals;
 7. records of test results, documented to confirm compliance with the design and/or specification;
 8. schedule of the contact details of the support and maintenance companies for each of the products.
- 5.2 Include copies of all completion certificates, test certificates, schedules and reports within the operating and maintenance manuals at completion of the project.

End of section B4.

C Alterations.

C20 Alterations and demolitions

Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
P01	05/08/25	Stage 4i Issue	EJG/EY	RCM/CW	EJG
P02	15/08/25	Updated Stage 4i Issue	CW	EJG	EJG

This document has been prepared for University of Manchester only and solely for the purposes expressly defined herein. We owe no duty of care to any third parties in respect of its content. Therefore, unless expressly agreed by us in signed writing, we hereby exclude all liability to third parties, including liability for negligence, save only for liabilities that cannot be so excluded by operation of applicable law. The consequences of climate change and the effects of future changes in climatic conditions cannot be accurately predicted. This document has been based solely on the specific design assumptions and criteria stated herein.

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1. Performance objectives.

- 1.1.1 Strip out, modify and extend systems to facilitate the refurbishment as described in this specification and the tender information.
- 1.1.2 Undertake refurbishment works in a live building and agree all methodologies, programme, phasing, isolations and shut-downs in advance with the University.
- 1.1.3 Ensure continued availability of services to the areas within the building that are out of scope – the remainder of the Eddie Newcombe Building and the John Owens Building during the works and provide the same level of performance as prior to the works.
- 1.1.4 Strip-out services as required by the design drawings to facilitate the reconfiguration of existing system to serve the new layouts.

1.2 Domestic hot and cold water systems

- 1.2.1 To convey cold wholesome water to the new kitchenette, without waste, misuse, undue consumption or contamination (including degradation of the 'fluid category' as defined by the Water Regulations Guide) of the water supply or the cold-water system all in accordance with applicable regulations and standards and other design parameters.
- 1.2.2 To convey cold water at a sufficient volume flow rate and a suitable pressure to comply with the recommended guidance flow rates, storage volumes and maximum/minimum water velocities in pipes and fittings.
- 1.2.3 To generate and convey hot water to serve the domestic hot water requirements of the altered building in compliance with all applicable regulations, standards and other design parameters.

1.3 Above ground foul drainage systems

- 1.3.1 Provide all foul drainage above ground pipework to serve the new appliances in the kitchenette for connection to the below ground drainage systems.
- 1.3.2 Base the above ground foul drainage design on System III as defined in BS EN 12056-2 and using the tabulated discharge units as shown in Table 2 within this BS EN document.
- 1.3.3 Install the foul drainage installation to meet the performance objectives stated in BS EN 12056, the Building Regulations and all other technical manuals and guides applicable, included within this specification. Install the system using the minimum pipework and fittings necessary to carry away all foul discharges from the building to the below ground drainage system, quickly, quietly and with freedom from nuisance or risk of injury to health. Prevent air from the discharge pipes from entering the building. Clearly identify all pipelines in accordance with BS 1710.
- 1.3.4 Install all drainage pipework to convey discharges without crossflow, back-fall, leakage or blockage. Adequately test, clean and maintain the system at all times throughout the construction process.

1.4 Low temperature hot water systems

- 1.4.1 To distribute low temperature hot water to serve repositioned / additional heat emitters, to maintain the heating internal design temperatures in each space.

1.5 Ventilation systems

- 1.5.1 To provide mechanical ventilation to the remodelled areas at the Lower Ground Floor by supplying outside air to, and extracting vitiated air via the new grilles / louvres / diffusers. Provide a new HRU to match the increased ventilation requirements of the refurbished spaces.

1.6 Low-voltage distribution systems

- 1.6.1 Reusing existing LV distribution systems unless otherwise specified on the drawings or MCB schedules with a new distribution board is required..

1.7 Lighting and small power

- 1.7.1 To provide new effective internal artificial LED lighting throughout the remodelled area(s), including the use of repositioned / new light fittings and switches, that will meet the design criteria.
- 1.7.2 To provide new small power throughout the remodelled area(s), including the use of repositioned / new outlets and switches.
- 1.7.3 To strip out the existing installation only serving within the existing refurbishment area(s) if any new provision shows on the drawings.
- 1.7.4 To retain all the existing installations serving within the existing refurbishment area(s) indicated on the drawings with blue colour.
- 1.7.5 To retain and identify all the existing installations that are running via the refurbishment area(s) but serving the area not under the refurbishment scope.

1.8 Fire and smoke detection and alarm systems

- 1.8.1 To retain most of the existing installation unless otherwise specified in the drawings with new provisions.
- 1.8.2 To extend and modify on the existing system to suit areas with new provisions indicated in the drawings.

1.9 Security system

- 1.9.1 To retain most of the existing installation unless otherwise specified in the drawings with new provisions.
- 1.9.2 To extend and modify on the existing system to suit areas with new provisions indicated in the drawings.

1.10 Data distribution systems

- 1.10.1 Provide a complete structured cabling installation to support the data, video and ancillary systems installation to be provided for (The University of Manchester).
- 1.10.2 To upgrade the existing system with Cat.6A cabling.
- 1.10.3 To provide new data outlets throughout the remodelled area(s), including the use of repositioned / new outlets and switches.
- 1.10.4 To strip out the existing installation only serving within the existing refurbishment area(s) if any new provision shows on the drawings.
- 1.10.5 To retain all the existing installations serving within the existing refurbishment area(s) indicated on the drawings with blue colour.
- 1.10.6 To retain and identify all the existing installations that are running via the refurbishment area(s) but serving the area not under the refurbishment scope.

1.11 Above ground foul drainage systems

- 1.11.1 To provide foul drainage above ground to serve the new kitchenette, for connection to the below ground drainage systems.

2. Submittals.

2.1 General

2.1.1 Submit the following for the Contract Administrator's comment:

- programme of works
- drawing production schedule
- detailed site survey and verification of the extent of services in the relevant areas
- strip-out drawings
- full technical method statements for the strip-out works
- technical submissions for new equipment
- co-ordinated working drawings
- co-ordinated reflected ceiling plans
- co-ordinated installation drawings
- builders work information / details
- approved plumber's certification
- manufacturer's details of isolation valves and any additional pipework ancillaries
- certificate of soundness
- purging certificate
- testing and commissioning certificates
- safety record

2.1.2 Provide technical method statements for the following aspects of the work:

- detailed survey to identify the full extent of systems to be decommissioned and current status of decommissioning
- decommissioning of systems
- removal of debris/materials and equipment from site
- health and safety considerations arising from the proposed works and method of execution
- permit-to-work system
- safety lock-off and tag-off system

2.1.3 Provide samples of all items that may be viewed in or on the building, within the normally occupied space or on the exterior. Submit all samples and ensure comments are received and acted upon prior to confirming orders for supply. Any products not conforming to the approved range of samples will be rejected.

2.2 Record drawings

2.2.1 Submit record drawings for all altered or diverted services, including the new items of equipment and systems installed under the contract.

2.2.2 Identify the extent of any redundant services left concealed or buried following the works. Define the location of such systems and their respective means of safe isolation, and include a system-by-system description.

2.2.3 Modify existing record drawings to reflect those existing items of equipment and systems that are impacted by these alterations / decommissioning / demolition works.

2.3 Operating and maintenance instruction manuals

2.3.1 Submit operating and maintenance instructions manuals for the new items of equipment and systems installed under the contract.

2.3.2 Modify existing operating and maintenance instructions manuals to reflect those existing items of equipment and systems that are impacted by these alterations / decommissioning / demolition works.

3. System description.

3.1 General.

- 3.1.1 The description of the engineering systems within this document is provided for guidance only. Determine the actual level of service alteration / removal required based on a detailed survey during the tender period.
- 3.1.2 Whilst this specification defines particular requirements in relation to the building services systems, include any works required to comply with all statutory regulations applicable to the scope of works, whether or not these are explicitly described herein.
- 3.1.3 If in doubt about the scope of works or about the effect an element of work may have on other areas of the building / site, consult with the Contract Administrator.
- 3.1.4 Remove, adapt, relocate and modify the existing mechanical, electrical and public health engineering systems as indicated on the drawings and within this specification.
- 3.1.5 Ensure that any existing services to the adjacent areas / floors are maintained and any alterations required to the services are carried out to achieve this.
- 3.1.6 During the removal of services, take great care not to damage the building structure. Repair damage caused to any element of the building at no additional cost to the contract.
- 3.1.7 Make good any existing services penetrations through the structure where they are not able to be re-used.
- 3.1.8 Execute all works without causing a nuisance to other building occupiers, due to noise or other issues. Undertake movement of materials, equipment and tools in a sensitive and non-disruptive manner.
- 3.1.9 It is likely that there could be cases where the full extent of the works required cannot be ascertained until concealed areas are opened. These may include but not limited to the following:
- ~ Damaged services proposed to be re-used needing remedial work.
 - ~ Diversions / extension / modifications of existing services where necessary
 - ~ Non-compliant existing services needing replacement / remedial works

Such items shall be brought to the attention of the Contract Administrator.

3.2 Making safe and decommissioning

- 3.2.1 Provide a qualified and competent engineer based on site to be responsible for:
- the isolation and making safe of systems
 - implementing and operating a permit-to-work system
 - implementing a safety 'lock-off and tag-off' system logging and recording the decommissioning, including the production of a status document at the end of the contract covering all systems
- 3.2.2 Carry out the decommissioning of all engineering services systems identified in the tender documents. Employ, on a sub-contract basis, any specialists required to ensure that the equipment is properly decommissioned and made safe as required. Where equipment/systems are required to be stripped out, carry out decommissioning to a sufficient extent to render systems into an inert state, to allow them to be stripped-out by unskilled personnel.
- 3.2.3 The scope of the decommissioning works includes but is not limited to:
- isolate incoming low voltage, telecommunications, gas and water services at the service entry point of each individual system
 - drain down fluid systems in a sequenced manner to ensure that there are no isolated legs remaining and water leakage is kept to an absolute minimum

- make all necessary provisions for venting and draining of water systems, including determining the location of system air vents and drain points, to allow systems to be adequately drained prior to removal, and to avoid potential damage to components due to partial vacuum
- where existing drain points are not sufficient for the complete safe draining of a water system, make the necessary alterations to allow the system to be drained
- capture, store, remove from site and dispose of all fluids drained from engineering systems
- obtain the written agreement of the Employer and the Water Authority prior to discharging chemically treated water into the foul drainage system
- safely remove from site and dispose of all other fluids, and chemically treated water that cannot be discharged into a foul drainage system
- safely remove all hazardous materials associated with the engineering systems, such as lamps, fire alarm detectors, etc
- isolate and disconnect any remote signalling equipment associated with fire alarm systems, lifts, etc

3.3 Strip out

3.3.1 As part of the strip-out works, remove the following plant items;

- Lower Ground Floor HRU01

3.3.2 As part of the strip-out works, remove all redundant bracketry, supports, bases etc.

3.4 Storage and reuse of existing equipment for future use

3.4.1 Disconnect and store all existing equipment that is specified to be re-installed and reused as part of the refurbishment works. In general, the existing equipment to be reused comprises:

- Grilles and diffusers
- Radiators

3.5 Domestic hot and cold-water systems

3.5.1 System description

3.5.1.1 Strip-out / demolitions

3.5.1.2 Take water samples from each pipework system on each floor and in the central risers, to establish the water quality prior to any works taking place. Submit these results to the Contract Administrator for comment.

3.5.1.3 Verify that existing means of isolation are effective and able to close successfully against the prevailing system pressure without leakage. Provide additional means of isolation if required to facilitate the strip out and alteration works. Ensure isolation valves installed on branches are no more than two pipe diameters away from the connection point.

3.5.1.4 Notify the utility company of the proposed works and liaise with them to ensure all works are in accordance with their requirements.

3.5.1.5 Ensure no dead-legs remain during or following the works. Fully drain down all redundant pipework.

3.5.1.6 Alterations

3.5.1.7 Provide new undercounter water heater and relocate existing kitchenette zip tap into the newly formed kitchenette and make any necessary pipework alterations, as shown on the drawings and in accordance with the water heater schedule.

3.5.2 System components and equipment

3.5.2.1 Only install WRAS approved water fittings and materials.

- 3.5.2.2 Fit check valves to both hot and cold supplies where a shut off valve is fitted to the outlet nozzle of a mixing appliance.
- 3.5.2.3 Do not use copper and galvanized steel together in a drinking water installation.
- 3.5.2.4 Ensure that any cut off ends (dead-legs) do not exceed 2x pipe diameters in length. If necessary reconfigure the system to achieve this limit.
- 3.5.2.5 Where backflow prevention devices have a relief outlet port (e.g. an 'RPZ valve assembly'), agree their installation in advance with the water supply company/authority.
- 3.5.2.6 Do not use flexible hose connections.
- 3.5.2.7 Ensure all pipework systems and associated appliances are protected against backflow or back syphonage in accordance with the requirements of The Water Supply (Water Fittings) Regulations, WRAS guidance and applicable standards.
- 3.5.2.8 Ensure means are provided to accommodate temperature-related expansion of the hot water volume contained downstream of a backflow protection device or pressure-reducing valve to avoid overpressurisation in the system, which can cause pressure-related pipework failures.

3.6 Above ground foul drainage systems

3.6.1 System description

3.6.1.1 Strip-out / demolitions

- 3.6.1.2 Strip-out redundant foul drainage pipework back to the main vertical soil vent pipe (SVP).
- 3.6.1.3 Where open ends of pipe, fittings etc. are left exposed during the strip-out works fix a suitable proprietary plug or cap to such open ends so as to prevent the ingress of any foreign matter. Ensure that the aforementioned plug or cap also prevents the egress of liquid from within the system.

3.6.1.4 Alterations

- 3.6.1.5 Provide new above ground foul drainage to the newly formed kitchenette to serve the relocated zip tap and new kitchen sink.
- 3.6.1.6 Install the public health foul drainage above ground systems in accordance with all statutory requirements, the Building Regulations and BS EN 12056.
- 3.6.1.7 Ensure the design of the foul drainage above ground systems meets the requirements of BS EN 12056 and is based on the discharge unit method (DU). The frequency factor used in the flow calculations is taken from BS EN 12056-2 Table 3, but specifically as follows:

intermittent use for residential/office/dwelling houses	0.5
frequent use for hospitals/schools/hotels/restaurants	0.7
congested use for public areas	1.0
special use e.g. laboratories	1.2
appliances frequency factor for this development	0.5
- 3.6.1.8 Usage of appliances frequency factor K
- 3.6.1.9 The design of the underground drainage system(s) will be undertaken by the civil/structural engineer WML Consulting Ltd, and all details relating to this drainage will be provided by them. Connect the above ground foul drainage to the underground drainage via connections/couplings. Any gullies, channels, outlets, pipework etc at or below ground floor slab level, will be detailed and specified by the civil/structural engineer, WML Consulting Ltd.

3.6.2 System components and equipment

3.6.2.1 Pressurised pump discharge pipework

Provide control, electrical connections and power supplies to the Electrical Engineer to suit the selected unit in accordance with the specification section *Small power systems* (Ss_70_30_80).

Install discharge pipes in the positions indicated on the drawings.

Ensure pipes and fittings are PVC-U manufactured in accordance with BS EN 1452. Ensure they are straight, smooth, of true cylindrical bore, and free from all flaws and imperfections. Ensure that pipes and fittings carry the relevant BS EN marking.

Join pipes and fittings by solvent welding using the manufacturer's approved cement, or via a compression type mechanical coupling to suit the pipework material and/or the fitting being connected to using the manufacturer's approved lubricant and rubber sealing rings. Install the pipes and fittings in accordance with the manufacturer's recommendations.

Install an expansion/movement coupling either side of the joint where a pipe crosses a building expansion joint. Where differential settlement may be expected provide the 'rocker' pipe with increased fall to prevent a back-fall occurring.

3.6.2.2 Traps

Provide traps to sanitary fittings. Ensure that the deep seal traps are complete with a pipe-to-wall extension piece and wall cover flange (as necessary). Supply and install the necessary pipe adaptors.

Ensure all traps have seal depths and diameters in accordance with BS EN 12056, and that they bear the British Standard Kitemark. Ensure that they are fitted with a universal compression outlet, e.g. as indicated below:

wash hand basin	– 32 mm diameter deep seal bottle trap
sink	– 40 mm diameter deep seal tubular trap
condensate	– 32 mm/40 mm "HepVo" waterless trap
water heater	– 40 mm/50 mm "HepVo" waterless trap

Bottle traps are acceptable for use on WHBs only. Ensure that they are of the re-sealing type, and that the re-sealing insert is removable.

The architect will identify any traps to appliances that are required to be chrome plated.

3.7 Low temperature hot water and chilled water systems

3.7.1 System description

3.7.1.1 Strip-out / demolitions

3.7.1.2 Take water samples from each pipework system on each floor and in the central risers to establish the water quality prior to any works taking place. Submit these results to the Contract Administrator for comment.

3.7.1.3 Measure the flow rate, pressure and temperatures (flow and return), on each system, on each floor, prior to any works taking place. Submit these results to the Contract Administrator for comment, along with a drawing identifying where each measurement was taken, the pipe size and pipe material.

3.7.1.4 Agree suitable locations for isolation to allow the modifications to be carried out. Verify that existing means of isolation are effective and able to close successfully against the prevailing system pressure without leakage. Install new isolation valves, in a suitable location, if none exist. Note that this may require a pipe freeze, as a drain-down of the entire system may not be feasible.

3.7.1.5 Power flush all retained LTHW systems.

3.7.1.6 Alterations

- 3.7.1.7 Relocate existing and provide new radiators as shown on the MEP drawings and as included within the radiator schedule, and make any necessary pipework alterations, as shown on the drawings.

3.7.2 System components and equipment

- 3.7.2.1 Provide adequate drain cocks at low points and air vents at high points so that LTHW water systems are capable of complete draining and venting. Provide manual isolation valves on air vents, to allow maintenance/replacement of air vents without shutdown of the circuit. Configure pipework arrangements to avoid airlocks and provide all necessary drain and vent points. Provide sufficient flow regulation devices and test points, temperature and pressure gauges and tapings to properly commission the system and facilitate full post-completion operation and maintenance in accordance with B4. Provide temperature gauges on main flow and return headers. Provide all ancillaries to achieve the design intent. Show all of the above on the installation drawings.
- 3.7.2.2 Provide insulation and identification to all LTHW pipework, fittings, valves and ancillaries in accordance with specification sections *Notices, identification and labels* (Pr_40_10_57) and *Services insulation and protection products* (Pr_80_77_76),
- 3.7.2.3 Supply and install radiators in accordance with the equipment schedules, specification section *Heat emitters* (Pr_70_60_36) and the drawings and in compliance with the Construction Products Regulations.
- 3.7.2.4 Provide radiators of minimum 2 mm welded steel construction with flat front panel. Submit details to the Contract Administrator for approval prior to ordering.
- 3.7.2.5 Provide radiators in accordance with the equipment schedules with a factory-applied paint finish in a RAL colour to be agreed with the Contract Administrator.
- 3.7.2.6 Prior to placing orders for the radiators, check all radiator sizes against the heat outputs specified by the schedules, and check sill heights and the scheduled lengths of all radiators to ensure they fit into the available space, making allowance for the installation of valves. Bring any necessary modifications to the attention of the Contract Administrator.
- 3.7.2.7 Provide each radiator complete with flow and return tapings of the sizes scheduled and fitted with a key-operated air vent.

3.8 Ventilation Systems

3.8.1 System description

3.8.1.1 Strip-out / demolitions

- 3.8.1.2 Strip out ventilation ductwork, fittings, accessories and equipment (including air terminals) to facilitate the reconfiguration of the ventilation system at Lower Ground Floor level, as shown on the design drawings.

3.8.1.3 Alterations

- 3.8.1.4 Relocate existing and provide new grilles, diffusers, ductwork and dampers as shown on the MEP drawings and as included within the grille and diffuser schedules, and as shown on the drawings.
- 3.8.1.5 Provide a new HRU to meet the increased system duty, as indicated on the drawings and the HRU schedule.

3.8.2 System components and equipment

- 3.8.2.1 Provide ducting, if and as permitted in specification section Ductwork and fittings (Pr_65_65_25), and as noted below.
- 3.8.2.2 Unless stated otherwise, provide all ductwork as zinc-coated steel.
- 3.8.2.3 Install all ducting to the following pressure classifications of BESA Specification DW/144:

Duct Classifications	List of Specific Areas to comply with the following classes
Class A	All areas not specified below. (low pressure outlets)
Class B	Main floor distribution
Class C	Plant rooms and risers

- 3.8.2.4 Do not test ductwork for air leakage in accordance with BESA DW/143 and BESA DW/144. However, give particular attention to all joints to ensure that duct leakage is kept to the lowest practicable limits for the standard of ductwork specified.
- 3.8.2.5 Install zinc-coated steel ducting of the sizes and in the locations shown on the drawings and as specified herein. Fabricate all ductwork in means of escape areas from galvanised steel in accordance with BS 9999.
- 3.8.2.6 Install all ductwork in accordance with specification sections Ductwork accessories (Pr_65_65_23 and Ductwork and fittings (Pr_65_65_25).
- 3.8.2.7 Except in exposed ductwork systems where there is no suspended ceiling, install flexible ducting at final connections to all grilles and plenum boxes. Ensure all flexible ductwork is installed in accordance with specification section Ductwork and fittings (Pr_65_65_25). Fully coordinate ductwork arrangements with the final grille layouts to minimize offsets.
- 3.8.2.8 Install and provide all exposed ductwork, components and ancillaries in accordance with specification sections Ductwork accessories (Pr_65_65_23) and Ductwork and fittings (Pr_65_65_25) except where stated otherwise below.
- 3.8.2.9 Install access openings in accordance with specification section Ductwork accessories (Pr_65_65_23), additionally where shown on the drawings, and additionally as necessary to internally clean all sections of the supply and extract ductwork and air handling units.
- 3.8.2.10 Install VCDs in accordance with specification section Ductwork accessories (Pr_65_65_23), additionally where shown on the drawings and as noted below.
- 3.8.2.11 Provide balancing dampers at terminals of the opposed-blade multi-leaf type designed to give close control of airflow evenly across the face of the terminal with minimum noise regeneration.
- 3.8.2.12 Provide fire dampers constructed from corrosion-resistant materials, complete with non-vision transfer grille, which maintain integrity and do not permit passage of flame or smoke.
- 3.8.2.13 Unless otherwise specified, provide fire dampers with operation by fusible link. Where specified provide fire and smoke dampers operated by a signal from the fire protection system in line with the fire strategy.
- 3.8.2.14 Where ductwork penetrates non-fire-rated walls, floors and partitions use the following method of installation:
- 3.8.2.15 Ensure that the closure of the space around the ductwork is made with due care and attention not to damage the ductwork or insulation.
- 3.8.2.16 Install grilles, diffusers and associated plenum boxes as scheduled in locations shown on the design drawings and in accordance with specification section Air terminals and diffusers (Pr_70_65_04). Refer to the supply diffuser and extract grille schedule for further details.
- 3.8.2.17 Use concealed fixing wherever possible for neatness.
- 3.8.2.18 Select the grilles and diffusers such that noise levels due to regenerated noise do not exceed those specified in clause **Error! Reference source not found.**, the acoustic report or in specification section *Sound attenuators* (65_67_78). Note that where more than one grille is present in the room, the combined total of regenerative noise from each grille should not exceed that value stated.

3.9 Low-voltage distribution systems

3.9.1 System description

3.9.1.1 Strip-out / demolitions

3.9.2 Note that the LV distribution system for this installation extends from the existing LV switchboards to the final distribution boards. The LV main switch room is connected to the outgoing terminals of all final distribution boards, power distribution units and local isolating switches in the building. Refer to the existing LV Schematic drawing.

3.9.3 Retain and reuse all the installations unless otherwise specified in the drawings, distribution board schedules, and schematics.

3.9.3.1 Alterations

3.9.4 Provide new protective devices, cable containments and all necessary wiring for all new circuitries, even if existing distribution boards are reused.

3.10 Lighting and small power

3.10.1 System description

3.10.1.1 Strip-out / demolitions

3.10.1.2 Isolate and remove from the site all equipment, distribution cabling, associated cable containment systems, control wiring, and luminaires as per the areas where new provision is needed.

3.10.1.3 Remove all equipment from the building and dispose of it in a correct and safe manner, giving particular attention to the disposal of lamps and emergency luminaire battery packs, due to the hazardous nature of their content.

3.10.1.4 Ensure that all lamps containing mercury, such as fluorescent lamps, are disposed of in special landfill sites that are supervised by the local authority. Use only sealed lamp crushers or other safe means and ensure adequate ventilation during disposal.

3.10.1.5 Safely dispose of all equipment containing printed circuit boards (PCBs) in accordance with the relevant regulations and the local authority's requirements.

3.10.1.6 Isolate power supplies as required to allow the full strip-out of the small power supplies, including but not limited to: underfloor bus-bar, kitchen supplies, communications equipment and socket outlets. Also strip out any power supplies that supply any items of stripped-out mechanical plant and equipment.

3.10.1.7 Do not remove cabling unless both ends of the service are visible and confirmed redundant by a suitably qualified electrical engineer. If in doubt, leave all cabling in place until such confirmation is obtained.

3.10.1.8 Strip out and remove all existing small power outlets, cables and secondary containment systems, including any routed through conduits within the concrete slab if area with new provision indicates.

3.10.1.9 Remove all redundant circuits, including all cabling from the distribution board to the final circuit termination. Remove all redundant protective devices from distribution boards and fit with spare way blanking plates.

3.10.1.10 Where electrical accessories are removed from retained circuits, reconnect / rewire the circuit to allow the safe operation of the retained equipment.

3.10.1.11 Remove any surface-mounted conduits, trunking systems and wooden box panelling housing electrical cabling.

3.10.1.12 Alterations

3.10.1.13 Relocate existing / provide new engineer to state, and make any necessary cable alterations, as shown on the drawings and in accordance with schedule engineer to state.

3.10.1.14 Where existing lighting and small power circuits are to be modified to suit the new layouts, re-route the existing circuit cabling accordingly. Where this is not practicable, rewire the entire circuit with new cabling. Do not joint cables. Wire new radial power circuits serving equipment, using new circuit cabling connected to the existing distribution boards.

3.10.2 System components and equipment

3.10.2.1 Where applicable, only install equipment that complies with the Eco-design Regulations.

3.10.2.2 Only install BASEC-approved cables.

3.11 Fire and smoke detection and alarm systems

3.11.1 System description

3.11.2 Strip-out / demolitions

3.11.3 Strip out and remove fire alarm detectors, manual call points, cables, and all related components if the areas are intended to be replaced with new provisions, as indicated on the drawings.

3.11.4 Alterations

3.11.5 Reconnect any new fire alarm installation back to the existing fire alarm panels and provide reprogramming on the system for any modification.

3.11.6 Reconfigure and add new detectors to suit the rearranged layout. The works include providing all wiring, containment, and any necessary components. Refer to the drawings for the exact arrangement.

3.12 Security systems

3.12.1 System description

3.12.2 Strip-out / demolitions

3.12.3 Strip out and remove door access devices, cables, and all related components if the areas are modified to suit the new architectural arrangements.

3.12.4 Alterations

3.12.5 To provide re-programmable on the existing access control system by a university authorised operator; to allow the addition, suspension, removal of individuals or groups of users; and to allow the changing of rules associated with physical areas and new access points.

3.13 Data distribution systems

3.13.1 System description

3.13.2 Strip-out / demolitions

3.13.3 If the areas are modified to suit the new architectural arrangements, strip out and remove data outlets, cables, and all related cable containments.

3.13.4 Alterations

3.13.5 To provide all necessary MEP provisions if new or relocated cabinets are available.

3.13.6 To provide and ensure all retained data outlets with Cat 6A unshielded twisted pair (UTP) network cable connections.

3.13.7 To provide all new data outlets support with Cat 6A unshielded twisted pair (UTP) network cables.

4. Responsibilities and interfaces.

4.1 Responsibilities.

- 4.1.1 The main contractor is responsible for determining the split of responsibilities between the various sub-contract packages and their specialist suppliers.

4.2 Detail coordination

- 4.2.1 Agree all proposed methods of fixing the system(s) to structure, roof, cladding, chimneys, equipment, etc with the Contract Administrator.
- 4.2.2 Agree the colours and finishes of all exposed materials of the system(s) with the Contract Administrator.

5. Painting and thermal insulation.

- 5.1 Comply with specification section *Services insulation and protection products* (Pr_80_77_76), and schedule *Services insulation and protection products* (Pr_80_77_76).

6. Fixing to the building 'fabric'.

- 6.1 Comply with specification section *Fastener products* (Pr_20_29).

7. Identification of mechanical and electrical services.

- 7.1 Comply with specification section *Notices, identification and labels* (Pr 40_10_57).

8. Testing and commissioning.

8.1 Compliance

- 8.1.1 Comply with specification section B4.

8.2 Visual examination

- 8.2.1 Visually examine the installation, including checking for the following:
- the services are supported adequately
 - services are arranged and, where applicable painted / insulated correctly
 - handwheels or levers are fitted to valves and dampers with clear indication of open/closed position
 - electrical bonding is complete
 - installation drawings and line diagrams have been prepared and fitted at the primary meter and elsewhere as appropriate
- 8.2.2 Fully test and commission all systems remaining in operation following the completion of the works. Rectify any faults and retest accordingly prior to the building being handed over to the Employer.

9. References.

9.1 General.

- 9.1.1 Comply fully with the edition (including amendments, replacements and associated normative references) of each of the documents listed below, current at the time of tender.
- 9.1.2 Where a standard referred to in this section conflicts with a standard referred to in the associated 'products' section of this specification, the standard referred to in this 'system' specification section takes precedence.

9.2 Legislation.

Environmental Protection Act
Health and Safety at Work etc Act
Pollution Prevention and Control Act
The Building Regulations
The Construction (Design and Management) Regulations
The Construction (Health, Safety and Welfare) Regulations
The Construction Products Regulations
The Contaminated Land Regulations
The Control of Asbestos Regulations
The Control of Substances Hazardous to Health Regulations
The Electrical Equipment (Safety) Regulations
The Electricity Act (As amended by the Utilities Act)
The Electricity at Work Regulations
The Electricity Safety, Quality and Continuity (Amendment) Regulations
The Electromagnetic Compatibility Regulations
The Equality Act
The Fluorinated Greenhouse Gases Regulations
The Hazardous Waste Regulations
The Management of Health and Safety at Work Regulations
The Manual Handling Operations Regulations
The Meters (Certification) Regulations
The Notification of Cooling Towers and Evaporative Condensers Regulations
The Ozone-Depleting Substances Regulations
The Personal Protective Equipment Regulations
The Pressure Systems Safety Regulations
The Provision and Use of Work Equipment Regulations
The Regulatory Reform (Fire Safety) Order
The Site Waste Management Plans Regulations

The Supply of Machinery (Safety) Regulations
The Waste Electrical and Electronic Equipment (WEEE) Regulations
The Water Supply (Water Fittings) Regulations
The Water Supply (Water Quality) Regulations

9.3 Standards

BS 416-1	Discharge and ventilating pipes and fittings, sand-cast or spun in cast iron
BS 1363	13 A fused plugs, socket-outlets, adaptors and connection units
BS 1710	Specification for identification of pipelines and services
BS 3858	Specification for binding and identification sleeves for use on electric cables and wires
BS 4363	Specification for distribution assemblies for reduced low voltage electricity supplies for construction and building sites
BS 4514	Unplasticized PVC soil and ventilating pipes of 82.4 mm minimum mean outside diameter, and fittings and accessories of 82.4 mm and of other sizes. Specification
BS 5228	Code of practice for noise and vibration control on construction and open sites
BS 5254	Specification for polypropylene waste pipe and fittings (external diameter 34.6 mm, 41.0 mm and 54.1 mm)
BS 5266-1	Emergency lighting Part 1: Code of practice for the emergency lighting of premises
BS 5422	Method for specifying thermal insulating materials for pipes, tanks, vessels, ductwork and equipment operating within the temperature range -40°C to +700°C
BS 5733	General requirements for electrical accessories. Specification
BS 5839-1	Fire detection and fire alarm systems for buildings. Code of practice for design, installation, commissioning and maintenance of systems in domestic premises
BS 5839-6	Fire detection and fire alarm systems for buildings. Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises
BS 5970	Thermal insulation of pipework, ductwork, associated equipment and other industrial installations in the temperature range of -100°C to +870°C. Code of practice
BS 6187	Code of practice for full and partial demolition
BS 6387	Test method for resistance to fire of cables required to maintain circuit integrity under fire conditions
BS 6880-1	Code of practice for low temperature hot water heating systems of output greater than 45 kW. Fundamental and design considerations
BS 6880-2	Code of practice for low temperature hot water heating systems of output greater than 45 kW. Selection of equipment

BS 6880-3	Code of practice for low temperature hot water heating systems of output greater than 45 kW. Installation, commissioning and testing
BS 7211	Electric cables. Thermosetting insulated, non-armoured cables for voltages up to and including 450/750 V, for electric power, lighting and internal wiring, and having low emission of smoke and corrosive gases when affected by fire
BS 7375	Distribution of electricity on construction and demolition sites. Code of practice
BS 7430	Code of practice for the protective earthing of electrical installations
BS 7592	Sampling for Legionella bacteria in water systems. Code of practice
BS 7629-1	Electric cables. Specification for 300/500 V fire resistant, screened, fixed installation cables having low emission of smoke and corrosive gases when affected by fire. Multicore cables
BS 7671	Requirements for electrical installations. IET Wiring Regulations
BS 8000-0	Workmanship on construction sites. Part 0: Introduction and general principles
BS 8000-13	Workmanship on building sites. Part 13: Code of practice for above ground drainage and sanitary appliances
BS 8000-15	Workmanship on building sites. Part 15: Code of practice for hot and cold water services (domestic scale)
BS 8519	Selection and installation of fire resistant power and control cable systems for life safety and fire-fighting applications. Code of practice
BS 8551	Provision and management of temporary water supplies and distribution networks (not including provisions for statutory emergencies). Code of practice
BS 8558	Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Complementary guidance to BS EN 806
BS 8580	Water quality. Risk assessments for Legionella control. Code of practice
BS 9999	Fire safety in the design, management and use of buildings. Code of practice
BS 12735-1	Copper and copper alloys. Seamless, round tubes for air conditioning and refrigeration. Tubes for piping systems
BS EN 442-1	Radiators and convectors. Technical specifications and requirements
BS EN 442-2	Specification for radiators and convectors. Test methods and rating
BS EN 442-3	Specification for radiators and convectors. Evaluation of conformity
BS EN 681	Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications
BS EN 806-1	Specifications for installations inside buildings conveying water for human consumption. General
BS EN 806-2	Specifications for installations inside buildings conveying water for human consumption. Design

BS EN 806-3	Specifications for installations inside buildings conveying water for human consumption. Pipe sizing. Simplified method
BS EN 806-4	Specifications for installations inside buildings conveying water for human consumption. Installation
BS EN 806-5	Specifications for installations inside buildings conveying water for human consumption. Operation and maintenance
BS EN 1057	Copper and copper alloys. Seamless, round copper tubes for water and gas in sanitary and heating applications
BS EN 1074-1	Valves for water supply. Fitness for purpose requirements and appropriate verification tests. General requirements
BS EN 1124	Pipes and fittings of longitudinally welded stainless steel pipes with spigot and socket for waste water systems
BS EN 1254-1	Copper and copper alloys. Plumbing fittings. Fittings with ends for capillary soldering or capillary brazing to copper tubes
BS EN 1254-5	Copper and copper alloys. Plumbing fittings. Capillary fittings with short ends for brazing to copper tubes
BS EN 1329-1	Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure. Unplasticized poly(vinyl chloride) (PVC-U). Specifications for pipes, fittings and the systems
BS EN 1567	Building valves. Water pressure reducing valves and combination water reducing valves. Requirements and tests
BS EN 1717	Protection against pollution of potable water in water installations and general requirements of devices to prevent pollution by backflow
BS EN 12056-1	Gravity drainage systems inside buildings. General and performance requirements
BS EN 12056-2	Gravity drainage systems inside buildings. Sanitary pipework, layout and calculation
BS EN 12056-5	Gravity drainage systems inside buildings. Installation and testing, instructions for operation, maintenance and use
BS EN 12201-1	Plastics piping systems for water supply, and for drainage and sewerage under pressure. Polyethylene (PE). General
BS EN 12201-2	Plastics piping systems for water supply, and for drainage and sewerage under pressure. Polyethylene (PE). Pipes
BS EN 12201-3	Plastics piping systems for water supply, and for drainage and sewerage under pressure. Polyethylene (PE). Fittings
BS EN 12239	Ventilation for buildings. Air terminal devices. Aerodynamic testing and rating for displacement flow applications.
BS EN 12380	Air admittance valves for drainage systems. Requirements, test methods and evaluation of conformity
BS EN 12464-1	Light and lighting. Lighting of work places. Indoor work places
BS EN 12735	Copper and copper alloys. Seamless, round tubes for air conditioning and refrigeration. Tubes for equipment
BS EN 12828	Heating systems in buildings. Design for water-based heating systems

BS EN 12897	Water supply. Specification for indirectly heated unvented (closed) storage water heaters
BS EN 13030	Ventilation for buildings. Terminals. Performance testing of louvres subjected to simulated rain.
BS EN 13032-1	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Measurement and file format
BS EN 13032-2	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Presentation of data for indoor and outdoor work places
BS EN 13032-3	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Presentation of data for emergency lighting of work places
BS EN 13032-4	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. LED lamps, modules and luminaires
BS EN 13076	Devices to prevent pollution by backflow of potable water. Unrestricted air gap. Family A. Type A
BS EN 13077	Devices to prevent pollution by backflow of potable water. Air gap with non-circular overflow (unrestricted). Family A. Type B
BS EN 13501-1	Fire classification of construction products and building elements. Classification using data from reaction to fire tests
BS EN 13501-3	Fire classification of construction products and building elements. Classification using data from fire resistance tests on products and elements used in building service installations: fire resisting ducts and fire dampers.
BS EN 13501-6	Fire classification of construction products and building elements. Classification using data from reaction to fire tests on electric cables
BS EN 13959	Anti-pollution check valves. DN 6 to DN 250 inclusive. Family E, type A, B, C and D
BS EN 14324	Brazing. Guidance on the application of brazed joints
BS EN 14336	Heating systems in buildings. Installation and commissioning of water based heating systems
BS EN 14451	Devices to prevent pollution by backflow of potable water. In-line anti-vacuum valves DN10 to DN50 inclusive. Family D, type A
BS EN 14453	Devices to prevent pollution by backflow of potable water. Pipe interrupter with permanent atmospheric vent DN 10 to DN 20. Family D, type C
BS EN 14623	Devices to prevent pollution by backflow of potable water. Air gaps with minimum circular overflow (verified by test or measurement). Family A, type G
BS EN 15650	Ventilation for buildings. Fire dampers
BS EN 50107-1	Signs and luminous-discharge-tube installations operating from a no-load rated output voltage exceeding 1 kV but not exceeding 10 kV. General requirements

BS EN 50107-2	Signs and luminous-discharge-tube installations operating from a no-load rated output voltage exceeding 1 kV but not exceeding 10 kV. Requirements for earth-leakage and open-circuit protective devices
BS EN 50107-3	Product standard covering luminous signs with discharge lamps and/or LED (light emitting diodes) and/or EL (electroluminescent) light sources with a nominal voltage not exceeding 1000 V, with the exclusion of general lighting, traffic- or emergency related purpose.
B BS EN 50131-1	Alarm systems. Intrusion and hold-up systems. System requirements
BS EN 50131-3	Alarm systems. Intrusion and hold-up systems. Control and indicating equipment
BS EN 50131-6	Alarm systems. Intrusion and hold-up systems. Power supplies
BS EN 50174-1	Information technology. Cabling installation. Installation specification and quality assurance
BS EN 50174-2	Information technology. Cabling installation. Installation planning and practices inside buildings
BS EN 50174-3	Information technology. Cabling installation. Installation planning and practices outside buildings
BS EN 50525-1	Electric cables – Low voltage energy cables of rated voltages up to and including 450/470 V (U0/U). Part 1: General requirements
BS EN 50525-2-11	Electric cables – Low voltage energy cables of rated voltages up to and including 450/470 V (U0/U). Part 2-11: Cables for general applications – Flexible cables with thermosplastic PVC insulation
BS EN 50525-2-12	Electric cables – Low voltage energy cables of rated voltages up to and including 450/470 V (U0/U). Part 2-12: Cables for general applications – Cables with thermosplastic PVC insulation for extensible leads
BS EN 50525-2-21	Electric cables – Low voltage energy cables of rated voltages up to and including 450/470 V (U0/U). Part 2-21: Cables for general applications – Flexible cables with crosslinked elastomeric insulation
BS EN 50525-2-31	Electric cables – Low voltage energy cables of rated voltages up to and including 450/470 V (U0/U). Part 2-31: Cables for general applications – Single core non-sheathed cables with thermosplastic PVC insulation
BS EN 50525-2-41	Electric cables – Low voltage energy cables of rated voltages up to and including 450/470 V (U0/U). Part 2-41: Cables for general applications – Single core cables with crosslinked silicone rubber insulation
BS EN 50525-2-42	Electric cables – Low voltage energy cables of rated voltages up to and including 450/470 V (U0/U). Part 2-42: Cables for general applications – Single core non-sheathed cables with crosslinked EVA insulation
BS EN 50525-2-71	Electric cables – Low voltage energy cables of rated voltages up to and including 450/470 V (U0/U). Part 2-71: Cables for general applications – Flat tinsel cables (cords) with thermoplastic PVC insulation
BS EN 50525-3-41	Electric cables – Low voltage energy cables of rated voltages up to and including 450/470 V (U0/U). Part 3-41: Cables with special fire performance – Single core non-sheathed cables with halogen-free crosslinked insulation, and low emission of smoke

BS EN 60061-1	Lamp caps and holders together with gauges for the control of interchangeability and safety. Lamp caps
BS EN 60061-2	Lamp caps and holders together with gauges for the control of interchangeability and safety. Lampholders
BS EN 60061-3	Lamp caps and holders together with gauges for the control of interchangeability and safety. Gauges
BS EN 60061-4	Lamp caps and holders together with gauges for the control of interchangeability and safety. Guidelines and general information
BS EN 60238	Edison screw lamp holders
BS EN 60335-2-40	Household and similar electrical appliances. Safety. Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers
BS EN 60357	Tungsten halogen lamps (non-vehicle). Performance specifications
BS EN 60529	Degrees of protection provided by enclosures (IP code)
BS EN 60570	Electrical supply track systems for luminaires
BS EN 60598-2-2	Luminaires. Part 2-2: Particular requirements – Recessed luminaires
BS EN 60598-2-4	Luminaires. Part 2-4: Particular requirements – Portable general purpose luminaires
BS EN 60598-2-5	Luminaires. Part 2-5: Particular requirements – Portable general purpose luminaires
BS EN 60598-2-6	Luminaires. Part 2-6: Particular requirements – Luminaires with built-in transformers or converters for filament lamps
BS EN 60598-2-13	Luminaires. Part 2-13: Particular requirements – Ground recessed luminaires
BS EN 60598-2-14	Luminaires. Part 2-14: Particular requirements – Luminaires for cold cathode tubular discharge lamps (neon tubes) and similar equipment
BS EN 60598-2-20	Luminaires. Part 2-20: Particular requirements – Lighting chains
BS EN 60598-2-22	Luminaires. Part 2-22: Particular requirements – Luminaires for emergency lighting
BS EN 60598-2-24	Luminaires. Part 2-24: Particular requirements – Luminaires with limited surface temperatures
BS EN 60598-2-25	Luminaires. Part 2-25: Particular requirements – Luminaires for use in clinical areas of hospitals and health care buildings
BS EN 60838-1	Miscellaneous lamp holders. General requirements and tests
BS EN 60838-2-1	Miscellaneous lamp holders. Particular requirements. Lamp holders S14
BS EN 60838-2-2	Miscellaneous lamp holders. Particular requirements. Connectors for LED-modules
BS EN 60838-2-3	Miscellaneous lamp holders. Particular requirements. Lamp holders for double-capped linear LED lamps
BS EN 60839-11-1	Alarm and electronic security systems. Electronic access control systems. System and components requirements
BS EN 60839-11-2	Alarm and electronic security systems. Electronic access control systems. Application guidelines

BS EN 60927	Auxiliaries for lamps. Starting devices (other than glow starters). Performance requirements
BS EN 60947-2	Low-voltage switchgear and controlgear. Part 2: Circuit-breakers (IEC 60947-2:2016)
BS EN 60947-4-2	Low-voltage switchgear and controlgear. Part 4-2: Contactors and motor-starters – AC semiconductor motor controllers and starters
BS EN 60947-4-3	Low-voltage switchgear and controlgear. Part 4-3: Contactors and motor-starters – AC semiconductor controllers and contactors for non-motor loads
BS EN 60947-6-1	Low-voltage switchgear and controlgear. Part 6-1: Multiple function equipment – Transfer switching equipment
BS EN 60947-7-3	Low-voltage switchgear and controlgear. Part 7-3: Ancillary equipment – Safety requirements for fuse terminal blocks
BS EN 60947-8	Low-voltage switchgear and controlgear. Part 8: Control units for built-in thermal protection (PTC) for rotating electrical machines
BS EN 60968	Self-ballasted lamps for general lighting services. Safety requirements
BS EN 60969	Self-ballasted lamps for general lighting services. Performance requirements
BS EN 61000-3-2	Electromagnetic compatibility (EMC) Limits. Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)
BS EN 61000-4-5	Electromagnetic compatibility (EMC): Testing and measurement techniques – Surge immunity test
BS EN 61000-6-1	Electromagnetic compatibility (EMC). Generic standards. Immunity for residential, commercial and light-industrial environments
BS EN 61000-6-2	Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments
BS EN 61047	D.C. or A.C. supplied electronic step-down convertors for filament lamps. Performance requirements
BS EN 61111	Live working. Electrical insulation matting
BS EN 61184	Bayonet lampholders
BS EN 61347-1	Lamp controlgear. Part 1: General and safety requirements
BS EN 61347-2-1	Lamp controlgear. Part 2-1: Particular requirements for starting devices (other than glow starters)
BS EN 61347-2-2	Lamp controlgear. Part 2-2: Particular requirements for d.c. or a.c. supplied electronic step-down convertors for filament lamps
BS EN 61347-2-7	Lamp controlgear. Part 2-7: Particular requirements for battery supplied electronic controlgear for emergency lighting (self-contained)
BS EN 61347-2-9	Lamp controlgear. Part 2-9: Particular requirements for electromagnetic controlgear for discharge lamps (excluding fluorescent lamps)
BS EN 61347-2-10	Lamp controlgear. Part 2-10: Particular requirements for electronic invertors and convertors for high-frequency operation of cold tubular discharge lamps (neon tubes)

BS EN 61347-2-11	Lamp controlgear. Part 2-11: Particular requirements for miscellaneous electronic circuits used with luminaires
BS EN 61347-2-12	Lamp controlgear. Part 2-12: Particular requirements for d.c. or a.c. supplied electronic ballasts for discharge lamps (excluding fluorescent lamps)
BS EN 61386	Conduit systems for cable management
BS EN 61439-1	Low-voltage switchgear and control assemblies. General rules and design verifications
BS EN 61439-2	Low-voltage switchgear and control assemblies. Power switchgear and control gear assemblies
BS EN 61439-3	Low-voltage switchgear and control assemblies. Distribution boards intended to be operated by ordinary persons (DBO)
BS EN 61439-6	Low-voltage switchgear and control assemblies. Busbar trunking systems (busways)
BS EN 61535	Installation couplers intended for permanent connection in fixed installations
BS EN 61547	Equipment for general lighting purposes. EMC immunity requirements
BS EN 61558-2-1	Safety of power transformers, power supplies, reactors and similar products. Particular requirements and tests for separating transformers and power supplies incorporating separating transformers for general applications
BS EN 62031	LED modules for general lighting. Safety specifications
BS EN 62208	Empty enclosures for low-voltage switchgear and control gear assemblies. General requirements
BS EN 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
BS EN 62305-4	Protection against lightning. Electrical and electronic systems within structures
BS EN 62384	DC or AC supplied electronic control gear for LED modules. Performance requirements
BS EN 62471	Photo biological safety of lamps and lamp systems
BS EN 62504	General lighting. Light emitting diode (LED) products and related equipment. Terms and definitions.
BS EN 62560	Self-ballasted LED-lamps for general lighting services by voltage > 50V. Safety specifications
BS EN 62612	Self-ballasted LED lamps for general lighting services with supply voltages > 50V. Performance requirements
BS EN 62676-1-1	Video surveillance systems for use in security applications. System requirements. General
BS EN 62676-3	Video surveillance systems for use in security applications. Analog and digital video interfaces
BS EN 62676-4	Video surveillance systems for use in security applications. Application guidelines

BS EN 62707-1	LED-binning. General requirements and white colour grid
BS EN 62717	LED modules for general lighting. Performance requirements.
BS EN 62722-2-1	Luminaire performance. Particular requirements for LED luminaires
BS EN 62776	Double-capped LED lamps designed to retrofit linear fluorescent lamps. Safety specifications.
BS EN 62931	GX16t-5 capped tubular LED lamp. Safety specifications
BS EN IEC 62442-3	Energy performance of lamp controlgear. Controlgear for tungsten-halogen lamps and LED light sources. Method of measurement to determine the efficiency of controlgear
BS EN ISO 1182	Reaction to fire tests for products. Non combustibility test
BS EN ISO 3382-1	Acoustics. Measurement of room acoustic parameters. Performance spaces
BS EN ISO 3382-3	Acoustics. Measurement of room acoustic parameters. Open plan offices
BS EN ISO 3740	Acoustics. Determination of sound power levels of noise sources. Guidelines for the use of basic standards
BS EN ISO 5136	Acoustics. Determination of sound power radiated into a duct by fans and other air-moving devices. In-duct method
BS EN ISO 7010	Graphical symbols. Safety colours and safety signs. Registered safety signs.
BS EN ISO 9001	Quality management systems. Requirements
BS EN ISO 16890-1	Air filters for general ventilation. Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM)
BS EN ISO 17672	Brazing. Filler metals
BS EN ISO/IEC 27002	Information technology. Security techniques. Code of practice for information security controls
BS ISO 10294-1	Fire resistance tests. Fire dampers for air distribution systems. Test method
BS ISO/IEC 27001	Information technology. Security techniques. Information security management systems. Requirements
DD CLC/TS 50131-7	Alarm systems. Intrusion and hold-up systems. Application guidelines
Open Network Video Interface Forum (ONVIF) specifications and protocols	
ISO 11801-6	Information technology. Generic cabling for customer premises. Distributed building services
BS 416-1	Discharge and ventilating pipes and fittings, sand-cast or spun in cast iron
BS 476	Fire tests on building materials and structures
BS EN 681	Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications
BS 1710	Specification for identification of pipelines and services
BS 3868	Specification for prefabricated drainage stack units in galvanised steel
BS 4514	Unplasticized PVC soil and ventilating pipes of 82.4 mm minimum mean outside diameter, and fittings and accessories of 82.4 mm and of other sizes. Specification

BS 6465-1	Sanitary installations. Code of practice for the design of sanitary facilities and scales of provision of sanitary and associated appliances
BS 6465-3	Sanitary installations. Code of practice for the selection, installation and maintenance of sanitary and associated appliances
BS 7671	Requirements for electrical installations. IET Wiring Regulations.
BS 8000-13	Workmanship on building sites. Code of practice for above ground drainage and sanitary appliances
BS EN 752	Drain and sewer systems outside buildings. Sewer system management
BS EN 877	Cast iron pipes and fittings, their joints and accessories for the evacuation of water from buildings. Requirements, test methods and quality assurance
BS EN 1254-1	Copper and copper alloys. Plumbing fittings. Fittings with ends for capillary soldering or capillary brazing to copper tubes
BS EN 1329-1	Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure. Unplasticized poly(vinyl chloride) (PVC-U). Specifications for pipes, fittings and the systems
BS EN 12056-1	Gravity drainage systems inside buildings. General and performance requirements
BS EN 12056-2	Gravity drainage systems inside buildings. Sanitary pipework, layout and calculation
BS EN 12056-5	Gravity drainage systems inside buildings. Installation and testing, instructions for operation, maintenance and use
BS EN 12380	Air admittance valves for drainage systems. Requirements, test methods and evaluation of conformity
BS EN 13501-1	Fire classification of construction products and building elements. Classification using data from reaction to fire tests
BS EN ISO 1452-2	Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure. Unplasticized poly(vinyl chloride) (PVC U). Pipes
BS EN ISO 1452-3	Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure. Unplasticized poly(vinyl chloride) (PVC-U).Fittings

9.4 Guidance and other reference documents.

AFSP	Fire and smoke resisting dampers (Grey book)
ASFP	Fire stopping and penetration seals for the construction industry (Red book)
ASTM D1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM F438	Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

BBA	British Board of Agrément Certificate, as appropriate.
BESA DW/143	Guide to good practice. Ductwork air leakage testing
BESA DW/144	Specification for sheet metal ductwork
BESA DW/145	Guide to good practice for the installation of fire and smoke dampers
BESA TR 19	Guide to good practice. Internal cleanliness of ventilation systems
BESA TR/20	Installation and testing of pipework systems
BSI BES 6001	Responsible sourcing of construction products
BSRIA BG 29/2021	Pre-commission cleaning of pipework systems
BSRIA BG 49/2015	Commissioning air systems
BSRIA BG 50/2013	Water treatment for closed heating and cooling systems
BSRIA BG 57/2015	Legionnaires' disease. Risk assessment
BSRIA BG 58/2015	Legionnaires' disease. Operation and maintenance logbook
BSRIA TN 10/97	VRF based air conditioning systems - performance, installation and operation notes
BSRIA TN 12/2000	Location of fresh air intakes
CIBSE AM 10	Natural ventilation in non-domestic buildings
CIBSE AM 14	Non-domestic hot water heating systems
CIBSE Guide G	Public health and plumbing engineering
CIBSE	Design Guides
CIBSE	Code for Lighting
CIBSE	SLL Lighting Guides
CIBSE	Technical Memoranda
CIBSE	Commissioning Codes
CIPHE	Plumbing engineering services design guide
DCSF BB 100	Design for fire safety in schools
HM Government	Approved Documents to the Building Regulations
HSE ACoP L8	Legionnaires' disease – The control of Legionella bacteria in water systems
HSE HSG274	Part 2: Legionnaires' disease – The control of legionella bacteria in hot and cold-water systems
ICEL 1001	Scheme of product and authenticated photometric data registration for emergency lighting luminaires and conversion modules
IoR	Code of practice for the minimisation of refrigerant emissions from refrigerating systems
IoR	Safety code of refrigerating systems utilising A1 refrigerants
IoR	Safety code of refrigerating systems utilising A2 & A3 refrigerants
RISC Authority Recommendations (RC) documents	
Mandatory Fire Suppression for Wales – A Technical Guide, Approved Document B Volumes 1 and 2	

REHVA, Guidebook 1	Displacement ventilation in non-industrial premises
WRAS	Water Fittings and Materials Directory
WRAS	Water Regulations Guide
Water Industry	Approved Installation Method (AIM) 08 01 Type BA Device – Verifiable backflow preventer with Reduced Pressure Zone (RPZ Valve)
University of Manchester EPM documents	

9.5 Related specification sections.

The specification should be read as a whole, and this section should be read in conjunction with all the other sections.

End of section.

P Building fabric sundries.

- P10 Sundry insulation/proofing work/fire stops
- P31 Holes/chases/covers/bunds/supports for engineering services

Audit sheet.

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1. Performance objectives.

- 1.1 To maintain the fire resistance of all fire-rated partitions (including, but not limited to, fire compartment walls, fire compartment floors and cavity barriers) where services (including, but not limited to, pipes, ducts, cables, busbars and associated insulation and containment) pass through.
- 1.2 To make service penetrations through the building envelope watertight.

2. Submittals.

- 2.1 Submit the following documentation at the appropriate time during the contract period for the Contract Administrator's comment:
 - method statements and risk assessment for firestopping and other proofing works
 - manufacturers' technical specifications and information for all proposed proprietary products and materials
 - all necessary amendments to builder's work or associated work of other contractors to accommodate firestopping and proofing works
 - equipment samples
 - material safety data sheets (MSDSs) for mastics, solvents, etc
 - test and commissioning certificates
- 2.2 Submit operating and maintenance instructions for all items of equipment and products required by this specification including:
 - Record logs of each firestop including unique reference numbers, photographic evidence and associated details.
 - Details of all products required to maintain the fire performance of compartments crossed by ventilation system components.

3. References.

3.1 General.

- 3.1.1 Comply fully with the edition (including amendments, replacements and associated normative references) of each of the documents listed below, current at the time of tender.
- 3.1.2 Where a standard referred to in this section conflicts with a standard referred to in the associated 'products' section of this specification, the standard referred to in this 'system' specification section takes precedence.

3.2 Legislation.

The Building Regulations

3.3 Standards.

BS 476-20	Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction (general principles)
BS 2750-3	Measurement of sound insulation in buildings and of building elements. Laboratory measurements of airborne sound insulation of building elements
BS EN 1366-2	Fire resistance tests for service installations. Fire dampers
BS EN 1366-3	Fire resistance tests for service installations. Penetration seals

BS EN 13501 Fire classification of construction products and building element

3.4 Guidance and other reference documents.

BSRIA	Firestopping of Service Penetrations. Best Practice in Design and Installation
HM Government	Approved Document B: Fire safety. Volume 2: Buildings other than dwellings

3.5 Related specification sections.

3.5.1 The specification should be read as a whole, and this section should be read in conjunction with all the other sections.

4. Design parameters.

- 4.1 Determine the scope and extent of all sundry insulation, proofing work and firestopping. Refer to the relevant engineering service specification section and the main contract preliminaries for the definition and demarcation of work to be undertaken by the specialist firestopping contractor, other installers and the Main Contractor.
- 4.2 Determine whether it is required to make provision for services to be removed and replaced or future services to be added.
- 4.3 Take responsibility for coordinating the design of the sundry insulation, proofing work and firestopping in accordance with the specification and drawings, including verification of design dimensions, co-ordination with other contractors, and development of the design to installation level detail.
- 4.4 Refer to the fire strategy drawings for details of fire-rated walls and partitions, ceiling and floor barriers, including locations, fire ratings, construction materials and dimensions. Refer to the mechanical, electrical and public health drawings and specifications for details of services including locations, pipe/duct/cable sizes, materials, insulation levels, supports and operating temperatures.
- 4.5 Ensure that all firestopping assemblies are third-party certified by an accredited organisation such as FIRAS, LPCB, IFC, BM TRADA, etc.

5. System description.

- 5.1 Appoint a specialist firestopping contractor to design and provide the necessary firestopping including verification of the design, coordination with other contractors and development of design to installation level detail.
- 5.2 Coordinate the works with other disciplines including, but not limited to:
 - Mechanical, electrical and public health designers/contractors
 - Architect
 - Structural engineer
 - General contractor
 - Fire engineer
 - Specialist dry lining/partitioning contractors

5.3 Design Requirements

- 5.3.1 Design each individual firestop taking account of the following considerations:

- Type of service(s) passing through
- Pipe, duct or cable materials of services
- Sizes of services (actual rather than nominal external dimensions or diameters)
- Whether the service is insulated
- Whether supports and containment such as cable trays pass through the partition
- Whether movement of the service needs to be allowed
- Clearances between services and openings in partitions
- Proximity of services to one another and whether multiple services can be accommodated in a single opening
- Chemical compatibility of firestopping materials such as mastics with services materials such as cable insulation
- Compatibility of hot works with intumescent materials
- Whether the partition is a wall or a floor
- The type of construction of the partition
- The fire resistance of the partition
- Other (non-fire) functions of the partition including (but not limited to) architectural, aesthetic, structural, acoustic, watertightness and airtightness functions
- Whether the partition has access for installation of firestopping from one or both sides at the location of the service passing through
- Sequencing of firestopping in coordination with other works

5.3.2 Where possible design standard, repeatable solutions.

5.3.3 Ensure access is provided for inspection and maintenance of firestops throughout the life of the building.

5.4 Ductwork

5.4.1 Maintain the fire resistance of the fire-rated elements of all enclosures through which ventilation systems penetrate.

5.4.2 Fit fire dampers, as detailed in specification section *Ductwork accessories* (Pr_65_65_23), in all ductwork penetrating fire barriers, including barriers that are present in floor voids and ceiling voids, and penetrations through concrete floors between fire compartments.

5.4.3 Take responsibility for ensuring that fire dampers and installation frames are built in entirely in accordance with the controlling documentation.

5.4.4 Sleeve all ductwork as it passes through non-fire-rated dividing walls as described in section *Ductwork and fittings* (Pr_65_65_25).

5.5 Pipework

5.5.1 Maintain the fire resistance of the fire-rated elements of all enclosures through which pipework systems penetrate.

5.5.2 Ensure that pipes passing through fire barriers are fitted with the appropriate sleeves, packing of the annulus between the sleeve and the pipework, insulated and sealed to meet the requirements of the certified assembly details.

5.6 Cable containment

5.6.1 Maintain the fire resistance of the fire-rated elements of all enclosures through which cable containment systems penetrate.

5.6.2 Ensure that cable tray, cable trunking, cable ladder and cable basket passing through fire barriers are fitted with the appropriate sleeves, packing between the sleeve and the cable containment and internal "bungs" to meet the requirements of the certified assembly details.

- 5.6.3 Treat plastic trunking or conduits as pipework penetrations and use a metal sleeve.

6. Responsibilities and interfaces.

6.1 Responsibilities.

- 6.1.1 The Main Contractor is responsible for determining the split of responsibilities between various sub-Contract packages and their specialist suppliers.
- 6.1.2 Elements of the work to be considered will include:
- drilling holes in floors, walls, ceilings; forming chases
 - fire barriers, fire sleeves, fire seals
 - waterproof below-ground entries through the structure of buildings
 - painting (specification should refer to Section *Services insulation and protection products* (Pr_80_77_76))
 - warning signs and notices

6.2 Detail Coordination

- 6.2.1 Agree all proposed methods of fixing the system(s) to structure, roof, cladding, chimneys, equipment, etc with the Contract Administrator.
- 6.2.2 Agree the colours and finishes of all exposed materials of the system(s) with the Contract Administrator.

7. System components and equipment.

7.1 Service penetrations

- 7.1.1 Comply with the provisions of BS EN 1366-2 which includes the following dimensional requirements concerning penetrations through fire barriers, or alternatively as incorporated in the certified assembly details:
- Do not incorporate fire dampers exceeding 1250 mm x 1000 mm. Where larger ducts are installed sub-divide these where passing through fire barriers to comply with the maximum dimensions noted above.
 - Incorporate a minimum space of 200 mm between fire dampers.
 - Incorporate a minimum space of 50 mm between combustible pipework fire sleeves.
 - Incorporate a minimum space between non-combustible pipework and/or cable containment appropriate for their installation and maintenance.

8. Painting.

- 8.1 Paint all steel piping, fittings, supports and brackets in accordance with specification section *Services and protection products* (Pr_80_77_76).

9. Fixing to the building 'fabric'.

- 9.1 Comply with specification section *Fastener products* (Pr_20_29).

10. Identification of mechanical and electrical services.

- 10.1 Comply with specification section *Notices, identification and labels* (Pr_40_10_57).

11. Installation.

11.1 Site inspections.

- 11.1.1 Arrange for the specialist firestopping contractor to carry out a suitable regime of site inspections and to permit inspections by the Contract Administrator, Main Contractor and their appointees.
- 11.1.2 Photograph each firestop (from both sides where possible).

11.2 Mock-ups

- 11.2.1 Where identified and as requested by the Contract Administrator and/or Main Contractor, arrange for the specialist firestopping contractor to provide construction mock-ups of key firestopping assemblies.

11.2.2 Records

- 11.2.3 Assign each firestop a unique reference number, and log these with the following details:
- Location (room number, high or low level, wall/floor etc.)
 - Size of opening
 - Type, size and material of service
 - Type of construction
 - Name of designer
 - Name of installer
 - Photographs
- 11.2.4 Note all reference numbers on drawings or BIM model.
- 11.2.5 Include third-party certification documents in the building's O&M manual.

End of section.

Audit sheet.

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P01	05/08/25	Stage 4i Issue	EJG	CW	EJG

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1. Performance objectives.

- 1.1 To identify all builder's work as required to complete the Contract Works.
- 1.2 To provide all secondary steelwork and supports as required to complete the Contract Works.

2. Submittals.

- 2.1 Submit the following for the Contractor Administrator's comment:
 - builder's work details for holes and chases
 - builder's work details for trench covers
 - builder's work details for bunds
 - technical submittal details for covers
 - technical submittal details for puddle flanges
- 2.2 Submit operating and maintenance instructions for all items of equipment including:
 - test certificates for bund integrity
 - lifting details for trench covers
 - test certificates for puddle flanges
 - method statement for emptying the bund after a release of fluid into it
 - method statement for removal of rain water from external bunds in external locations

3. References.

3.1 General.

- 3.1.1 Comply fully with the edition (including amendments, replacements and associated normative references) of each of the documents listed below, current at the time of tender.
- 3.1.2 Where a standard referred to in this section conflicts with a standard referred to in the associated 'products' section of this specification, the standard referred to in this 'system' specification section takes precedence.

3.2 Standards.

BS 8313 Code of practice for accommodation of building services in ducts

3.3 Related specification sections.

- 3.3.1 The specification should be read as a whole, and this section should be read in conjunction with all the other sections.

4. Design parameters.

- 4.1 Determine the scope and extent of all builder's work and secondary steelwork. Refer to the relevant engineering service specification section and the main contract preliminaries for the definition and demarcation of builder's work to be undertaken by the Installer and the main contractor.
- 4.2 Take responsibility for coordinating the design of the builder's work and secondary steelwork in accordance with the specification and drawings, including verification of design dimensions, co-ordination with other contractors, and development of the design to installation level detail.
- 4.3 Liaise as required with the structural engineer.

- 4.4 Refer to Architect's drawings for partition type details, including fire rating and acoustic criteria for those elements.
- 4.5 Refer to Architects drawings for final positions of passive fire protection elements such as fire barriers, fire stopping, ceiling and/or floor barriers, and for final positions of acoustic barriers and other acoustic treatments.

5. System description.

- 5.1 New builder's work holes to be created to allow proposed MEP services to penetrate through internal walls to serve designated rooms and spaces. These systems include but are not limited to HVAC, piped services, cabling, and containment.

6. Responsibilities and interfaces.

6.1 Responsibilities.

- 6.1.1 The Main Contractor is responsible for determining the split of responsibilities between various sub-Contract packages and their specialist suppliers.
- 6.2 Elements of the work to be considered will include:
- drilling holes in floors, walls, ceilings
 - forming chases for services
 - forming bunds around water cisterns and oil tanks
 - provision of supports for services
 - painting (specification should refer to *Services insulation and protection products* (Pr_80_77_76))
 - warning signs and notices

6.3 Detail Coordination

- 6.3.1 Agree all proposed methods of fixing the system(s) to structure, roof, cladding, chimneys, equipment, etc with the Contract Administrator.
- 6.3.2 Agree the colours and finishes of all exposed materials of the system(s) with the Contract Administrator.

7. Builder's work.

7.1 Information.

- 7.1.1 Prepare detailed builder's work schedules and detailed builder's work setting-out information for all major items of builder's works, holes, chases, bunds and support structures for engineering services within the project scope.
- 7.1.2 Fully co-ordinated all internal and external services, service entry points, and primary services and secondary distribution routes with all other trades. Provide setting out and final position details for all builder's work holes to ensure co-ordination with service entry points.
- 7.1.3 Identify holes and fixing requirements for all items of equipment that require apertures to be formed in walls, ceilings and floors such as switches, luminaries and floor outlet boxes.

- 7.1.4 Detail all builder's work holes, secondary steelwork, service entry points, and access for the engineering services on dedicated drawings suitable for the purpose. Prepare method statements for the construction of all builder's work holes, support systems, and fixings.
- 7.1.5 Size apertures to accommodate the requirements of fire barriers, smoke and/or fire dampers, and with due regard to the necessary installation tolerances for successful installation.
- 7.1.6 Identify areas not to be disturbed by any penetration or permanent fixings. These areas could include, but not limited to, items of significant importance either architecturally or historically, listed and/or protected items, items known or suspected of containing asbestos or any other hazardous materials.
- 7.1.7 Forward all information to the Contractor Administrator in good time to enable the Main Contractor to identify the requirements and programme implications for all builder's work and secondary steelwork not specifically carried out by the Installer.

7.2 Scope

- 7.2.1 Identify all builder's work holes, chases, bunds and support structure requirements to the appointed Main Contractor who shall provide all necessary materials, labour and attendance.
- 7.2.2 Include the following within the builder's work scope for the project:
 - External underground services excavations for new and diverted supplies
 - Services entries to buildings
 - Plant and equipment plinths
 - Services support structures
 - Major holes within the structure for engineering services equipment and distribution systems, through walls, floors and roof slabs
 - Containment bunds around water or oil cisterns and other storage vessels
 - Raised plinths at plant room entries and at service riser penetrations through floors, where plant rooms or risers contain water services
 - Builder's work details for all access holes and supports
 - Builder's work associated with lightning protection systems
 - All cable and pipework containment chases
 - Holes for pipes/trays/ducts through walls/floors/roofs
 - Building in of all services passing through these holes
 - External lighting, column bases and excavations
 - Supports for luminaries at suspended ceilings
 - Sealing of all underground builder's work access pits, and building penetrations
 - Internal holes and openings for general services routes through walls and slabs
 - Cable markers and tapes to all external services routes

7.3 Sealing of services penetrations

- 7.3.1 Seal all services passing between zones that have a pressure differential to ensure an airtight seal including, but not limited to, sealing of:
 - all open-ended conduits serving back boxes etc,
 - cable trunking/tray/basket, pipework and ductwork penetrations through partitions
 - aperture through the external envelop of the building
- 7.3.2 Seal all service apertures through the external envelope of the building to ensure an airtight seal that does not compromise the airtightness criteria of the building, as defined by Building Regulations Approved Document L.

8. Painting

- 8.1 Paint all steel piping, fittings, supports and brackets in accordance with specification section *Services insulation and protection products* (Pr_80_77_76).

9. Fixing to the building ‘fabric’.

- 9.1 Comply with specification section *Fastener products* (Pr_20_29).

10. Identification of services.

- 10.1 Comply with specification section *Notices, identification and labels* (Pr_40_10_57).

End of section.

V Electrical supply/power/lighting systems.

V90 Electrical services - small scale

Audit sheet.

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1. Introduction.

The specifications in the parts below are applied to the supply and installation of electrical services over refurbishment areas of Eddie Newcombe. The works will cover all refurbishment areas but included carry out works on non-refurbishment areas in order to complete the installation and achieving specification requirements.

1.1 Detail coordination.

- 1.1.1 Agree all proposed methods of fixing the system(s) to structure, roof, cladding, chimneys, equipment, etc with the Contract Administrator and UofM heritage officer.
- 1.1.2 Agree all new openings and builder works against existing building structure required for electrical services distribution with the Contract Administrator and UofM heritage officer.
- 1.1.3 Agree the colours and finishes of all exposed materials of the system(s) with the Contract Administrator.

1.2 General project design parameters

- 1.2.1 The proposed design criteria for electrical engineering systems will be in accordance with the following:
 - All current British Standards;
 - All current CIBSE Guides and commissioning codes;
 - Building Services Research and Information Association (BSRIA) guidelines;
 - BS7671 – Electrical Regulations (IEE Wiring Regulations);
 - Statutory Authority Regulations;
 - Health & Safety Executive (HSE) Guidance;
 - Construction Design & Management Regulations;
 - Building Regulations;
 - The requirements of Building Control (including Fire Officer);
 - Local Authority Rules and Regulations;
 - The DDA (Disability Discrimination Act) requirements;
 - Hoare Lea Reference specifications;
 - The University of Manchester EPM documentation and guidance.

2. Low-voltage distribution systems (Ss_70_30_45_45)

2.1 Performance objectives

- 2.1.1 The contractor shall supply and install the complete electrical systems as described below in this document and supplement documents, appendices, and schedules.
- 2.1.2 To distribute low voltage (LV) electrical power, safely and reliably, around the site starting with the cables connecting the existing main LV switchboard(s) situated in the ground floor plant room to the mains intake, and finishing at the output terminals of all site distribution boards, power distribution units, mechanical systems' supply points and/or the main switch input terminals of all items of equipment that have their own integral isolator.

- 2.1.3 To ensure that none of the electricity supplies to the existing buildings on the site are interrupted at any time during the Works except where planned well in advance and agreed in writing with the Contract Administrator.
- 2.1.4 To co-ordinate the installation with the other professional team members, including the Structural and Architectural requirements. Attend all coordination meetings as required and undertake all detailed calculations to ensure that the proposed plant and equipment is correctly sized to meet the building loads. Use the latest version of industry recognised software and provide confirmation of the proposed package to the Contract Administrator for comment prior to undertaking building load calculations.
- 2.1.5 To allow for all necessary costs, resources and programme implications to discharge these installation obligations.
- 2.1.6 To provide fire barriers within all new electrical LV distribution networks.
- 2.1.7 To coordinate and investigate the possibility of using existing containments at existing buildings for the new LV distribution to the new refurbishment area and provide additional containments on existing building areas if necessary.
- 2.1.8 To coordinate and investigate the possibility of using the spare ways available on existing distribution board at existing buildings for the new LV distribution to the new refurbishment area and provide additional containments on existing building areas if necessary.
- 2.1.9 To ensure that full selectivity is achieved using devices supplied by your chosen manufacturer and between the existing protective devices on the downstream of the system.
- 2.1.10 Strip out and terminate on the existing wiring or installation as per the area and installation that the strip-out drawings indicate.
- 2.1.11 To validate all existing electrical installations and replace all the damaged and non-functional installations within the building as per the testing results.

2.2 Design parameters

2.2.1 Electric supply characteristics

- 2.2.2 Electrical supply characteristic, are as follows:
- Supply Three-phase 4-wire / Single-phase 2-wire
 - Nominal voltage: $U/U_o = 400 \text{ V} / 230 \text{ V}$
 - Permitted variation: +10%-6%
 - Nominal frequency: $f = 50 \text{ Hz}$
 - Permitted variation: $\pm 1\%$ unless agreed with the supplier/distributor
 - Metering position: LV switchroom on the ground floor of Eddie Newcombe
 - Over current protection device: HRC Fuse
Over current protection device rating: 200 A
 - Prospective fault current: $I_{pf} = \text{TBC by UoM(3 phase), TBC by UoM(1 phase)}$
 - The DNO's disconnection time at this current: $t = \text{TBC by UoM (seconds)}$
 - External loop impedance: $Z_e = \text{TBC by UoM(ohms)}$

2.2.3 Earthing installation

- 2.2.3.1 Provide earthing for the project in accordance with the requirements of a:
- TN-C-S system - with the neutral and protective functions combined in a single conductor as far as the consumer's terminals. Normally referred to as protective multiple earthing (PME), the supply itself is TN-C and the arrangement within the building installation is TN-S.

- 2.2.3.2 Provide LV earth network for compliance with BS 7430 and BS 7671 and separate earth connection to the LV Switchboards main earth bars, single-phase isolation transformer star points etc. (as applicable)
- 2.2.3.3 Connect IT equipment to an existing separate earth bonding network in accordance with BS EN 50310.
- 2.2.3.4 Comply with performance specification section Earthing and bonding systems (Ss_70_30_25_25) and the project earthing schematics for details.

2.3 System description

- 2.3.1 Note that the LV distribution system for this installation extends from the existing LV switchboards, final distribution boards. The LV main switch room to the outgoing terminals of all final distribution boards, power distribution units and local isolating switches in the building. Refer to the existing LV Schematic drawing.
- 2.3.2 Subsequent distribution and sub distribution boards and final isolation switches are located as shown on the layouts, LV schematics and as described further in this section.

2.4 System components

2.4.1 General distribution system

- 2.4.2 Ensure all LV distribution equipment, built-in components and circuits within distribution assemblies are fully rated at the following service conditions:
 - Maximum ambient daily temperature 40°C
 - Minimum ambient daily temperature 5°C
- 2.4.3 Provide only equipment and components not foreseeably identified for withdrawal from either manufacture or continuing manufacturer support with a view to maintaining a supported operational life of twenty five years. Do not use any equipment or components identified as end of line or otherwise not expected to have manufacturer continuing support and spares availability.
- 2.4.4 Fit each assembly with a durable legible label located in a clearly visible place. Provide the following information:
 - manufacturer's name or trademark
 - type designation or identification number or other means of identification
 - date of manufacture
 - IEC 61439-X (the specific part "X" shall be identified)
- 2.4.5 Provide all multi-sectional assemblies with a supplementary protective conductor (earth bar) running the entire length of the complete assembly and connect all earth bonds, cable glands, etc within the assembly to it as necessary.
- 2.4.6 Provide all doors, covers and lids with robust earth tags with an expected life equivalent to that of the assembly or enclosure to which it attaches.
 - 2.4.6.1 Ensure all power and control cables are low smoke zero halogen (LSZH).
 - 2.4.6.2 Ensure all threaded electrical conductor terminations are tightened to the correct torque in accordance with the equipment manufacturer's recommendations. Provide all torqued connections with a torque mark seal. Provide details of all torque settings in the O&M manual and inside all panels.
 - 2.4.6.3 **Rated diversity factor**
 - 2.4.6.4 Provide all distribution assemblies with rated diversity factor (assumed loading) in accordance with BS EN 61439-2. Ensure each individual circuit is capable of carrying the full rated current assigned to them.

- Assembly name/reference 1 x.x
- Assembly name/reference 2 x.x

2.4.6.5 Panel labels for information and warning

2.4.6.6 Fix permanent engraved labels to all panels to provide information and warning to suitably qualified persons carrying out operation and maintenance: Include the following:

- a label indicating the function of each switch and indicator lamp
- a label on each openable panel door reading: "WARNING - ISOLATE PANEL BEFORE MAINTENANCE"
- a self-adhesive warning label to each door giving access to 400-Volt circuits
- a key diagram showing the source and identification of all power supplies entering a panel, their function and means of isolation

2.4.6.7 Device locking

2.4.6.8 Provide all protection devices complete with all necessary lockable fittings and padlocks and supply complete with a minimum of three keys for each padlock.

2.4.7 Wiring systems

2.4.7.1 Support all wiring systems in accordance BS 7671 such that they are not liable to premature collapse in the event of fire. Do not use non-metallic cable clips, cable ties or cable trunking as the sole means of support. Use fire-resistant means of support designed to prevent cables from falling out into escape routes in the event of fire.

2.4.8 Sub mains distribution

2.4.8.1 Sub mains cable

2.4.8.2 Supply, install and connect sub mains cables from the main switchboard to the distribution boards, isolating switches and other plant as detailed on the drawings or in the cable schedules.

2.4.8.3 Containment and support for sub mains cable

2.4.8.4 Supply and install sub mains cable containment and support as detailed on the drawings or in the schedules.

2.4.8.5 Provide all necessary top boxes for all cable ways unless otherwise specified.

2.4.9 Final distribution boards, isolating switches, motor control panel and power distribution units

2.4.9.1 Supply and install the following components in accordance with specification sections *Distribution boards* (Pr_60_70_22_22), *Control and indicator panels* (Pr_75_50_18) and *Motor starters, variable frequency drives and contactors* Pr_75_51_52, and the following requirements:

2.4.9.2 Distribution boards

2.4.9.3 Supply and install new distribution boards as detailed in the distribution board schedule. Unless otherwise specified on the drawings, reuse the existing distribution boards with available spare ways.

2.4.9.4 Reuse the existing distribution board as indicated in the drawing and schedules.

2.4.9.5 **Isolating switches** – Supply and install isolating switches for large plant as specified in the distribution board schedules or shown on the drawings.

2.4.9.6 **Motor control panels** - Connect, in accordance with specification section *Low-voltage cables* (Pr_65_70_48), the sub mains cable direct into the main switch of every such panel where a separate isolating switch is not specified.

2.4.9.7 **Manufacturers** - Unless agreed otherwise by the Contract Administrator in writing ensure that all switchgear is made and supplied by one manufacturer.

2.4.10 Conduit and cable trunking

- 2.4.10.1 Provide conduit and cable trunking complying with specification section *Cable management and accessories* (Pr_65_70_11).
- 2.4.10.2 Provide conduit that is galvanised metallic/non-metallic and the trunking that is galvanised metallic/non-metallic in accordance with specification section *Cable management and accessories* (Pr_65_70_11).
- 2.4.10.3 Ensure that the conduit meets the performance classification 3 (Medium) in accordance with BS 61386-1 and the trunking performance as defined in BS EN 50085 as General High Performance, with the exception of specific requirements designated on drawings or schedules.
- 2.4.10.4 Reuse existing cable containments if the capacity is still available; otherwise, provide new installation to suit.

2.4.11 Cable support and management systems

- 2.4.11.1 Provide cable support and management systems complying with specification section *Cable management and accessories* (Pr_65_70_11).
- 2.4.11.2 Provide metallic cable support systems as shown on drawings or specified, with Class 2 corrosion protection in accordance with BS EN 61537 Table 1.

3. General lighting systems (Ss_70_80_33)

3.1 Performance objectives

- 3.1.1 To provide a complete internal artificial lighting system throughout the refurbishment part of building(s), that will meet the design criteria and reflect the architectural and aesthetic requirements of each area and location respectively.
- 3.1.2 To ensure the internal lighting system solution and installation provides a safe, comfortable, balanced and interesting visual environment. To consider the vertical illuminance of surfaces within an environment, in conjunction with the recommended horizontal working plane illuminance.
- 3.1.3 To achieve good quality colour appearance and colour rendering by ensuring that LED light source colour is within a range of three MacAdam ellipses or less and has a minimum colour rendering index of 80.
- 3.1.4 To achieve the recommended levels of illuminance, luminance, uniformity and glare control by selection of particular luminaire, LED light source for all new luminaires and optical control, together with the selection and recommendation of the associated environmental reflectance properties.
- 3.1.5 To ensure that all luminaires and ancillary controls are suitably selected to be compatible with the environment in which they are installed.
- 3.1.6 The Contractor shall consult the Project Engineer, together with the Building Officer/Project Surveyor, prior to installation of luminaires, to determine the method of fixing and termination to be employed, unless specified in the Particular Specification.
- 3.1.7 To provide general lighting from the university's preferred manufacturers, such as Thorlux.
- 3.1.8 Strip out and terminate on the existing wiring or installation as per the area and installation that the strip-out drawings indicate.
- 3.1.9 To validate all existing electrical installations that are intended to be retained as per the lighting layout showing, and replace all the damaged and non-functional installations with new LED installations.

3.2 Design parameters

3.2.1 Design criteria

3.2.1.1 Illumination levels

3.2.1.2 Achieve the average maintained illuminance values for the particular areas of the building, as specified below:

3.2.1.3 Luminaire cleaning interval:

- 1 year (assuming a typical operation of 14 hours/day for 6 days/week within a clean office environment)

3.2.1.4 Final lighting circuit ratings:

- 230 V 50 Hz SP&N – 6 A/10 A/16 A circuit protective device (CPD) dedicated radial circuits.

3.2.1.5 Ensure the lighting system provides a uniformity of illuminance of not less than 0.8, over the task area and a diversity of illuminance, over the core area, not exceeding 5:1.

3.2.1.6 Where lighting systems are installed for areas with display screen use, ensure the luminance limitation of luminaires and bright room surfaces comply with the following CIBSE SLL Lighting Guide 7 recommendations:

Screen high state luminance	High luminance screen (L > 200 cd/m ²)	Medium luminance screen (L < 200 cd/m ²)
Positive polarity and normal requirements concerning colour and detail of the displayed information	<3000 cd/m ²	<1500 cd/m ²
Negative polarity and/or higher requirements concerning colour and detail of the displayed information as used for CAD, colour inspection, etc.	<1500 cd/m ²	<1000 cd/m ²

3.2.1.7 For lighting system installations complying with CIBSE SLL Lighting Guide 7, ensure the lighting supplier duly completes the Certificate of Conformity to Lighting Guide 7.

3.2.1.8 Ensure that all luminaires are fully compliant with the Ecodesign for Energy-Related Products and Energy Information (Lighting Products) Regulations, and suitably labelled to indicate compliance.

3.2.1.9 Ensure that the luminaires have a lifetime and output of L80/B10 at 50 000 hours.

3.3 System description

3.3.1 General

3.3.1.1 The University preferred manufacturer is Thorlux Lighting, accommodating their Smartscan range shall be utilised, which is currently incorporated on the site. Utilise their preferred manufacturer / range to allow compatibility with the site wide installations.

3.3.1.2 Arrange lighting systems according to the area served as described in clauses 3.3.2 to **Error! Reference source not found.** of this specification.

3.3.1.3 All replaced luminaries should be provided with LED light sources with similar lumen output and luminaire arrangement as the existing.

3.3.2 Circulation areas

3.3.2.1 Circulation area lighting (including reception, main entrance and lobbies) generally comprises recessed decorative downlighters and accent lighting luminaires.

- 3.3.2.2 Unless the lighting is not functional or damaged or specified replacement with new lighting fittings on the drawings, retain all the lighting installation at the areas.

3.3.3 Office areas

- 3.3.3.1 Office area lighting comprises linear recessed/suspended direct/ and surfaced LED luminaires, each with an involuted matt white reflector, combined with either or both a perforated metal opal diffuser and a CIBSE SLL Lighting Guide 7 luminance limiting optical louvre of the appropriate type.
- 3.3.3.2 Unless the lighting is not functional or damaged or specified replacement with new lighting fittings on the drawings, retain all the lighting installation at the areas.

3.3.4 Meeting room

- 3.3.4.1 The Meeting Room lighting comprises linear recessed/suspended direct/ and surfaced LED luminaires, in the meeting rooms to suit meetings and presentations.

3.3.5 Plant rooms and stores

- 3.3.5.1 Plant room and store lighting comprises surface mounted / suspended luminaires each with diffuser or controller attachments and, where applicable, IP rated corrosion resistant and/or vandal-proof luminaires.
- 3.3.5.2 Unless the lighting is not functional or damaged or specified replacement with new lighting fittings on the drawings, retain all the lighting installation at the areas.

3.4 Control requirements

3.4.1 General

- 3.4.1.1 Supply and install the lighting system controls and control equipment of the type and manufacture as indicated on the Schedule of Symbols drawing and as particularly detailed under the Schedule of Manufacturers.
- 3.4.1.2 Install lighting controls and equipment within the locations and at the positions indicated on the drawings.
- 3.4.1.3 Ensure the lighting control system(s) provide(s) selective and variable switching via manual or automatic means to enable illuminance and luminance levels to be adjusted, to facilitate an energy efficient mode of control and operation and to enable luminaires to be systematically switched off during periods of non-occupancy of the space(s) or during periods outside of the normal core operating hours of the building.
- 3.4.1.4 Provide new lighting control for the refurbishment area with new lighting installation only.
- 3.4.1.5 Provide the complete lighting control system in accordance with the following requirements:

3.4.2 Open Plan Office areas

- 3.4.2.1 Retain the existing lighting control arrangement.
- 3.4.2.2 Supply and install ceiling-mounted absent detectors, at the positions indicated on the drawings, to automatically turn off the luminaires upon movement of occupants no longer detected within the space, and to de-energise the luminaires after a pre-determined time delay period, unless reset upon detection of continuing or further movement of occupants in the circulation areas.

3.4.3 Cellular Office

- 3.4.3.1 Supply and install a new dedicated lighting control system to provide scene-set dimming control from wall-mounted manual control switch locations.
- 3.4.3.2 At the locations indicated on the drawings install momentary action 'push-to-make' switches to control the dimmable luminaires. Connect such switches to provide the following modes of operation:

- Scene 1 all on
- Scene 2 only linear suspended direct/indirect luminaires on
- Scene 3 only recessed downlights on
- Scene 4 all off

3.4.3.3 Supply and install ceiling-mounted absent detectors, at the positions indicated on the drawings, to automatically turn off the luminaires upon movement of occupants no longer detected within the space, and to de-energise the luminaires after a pre-determined time delay period, unless reset upon detection of continuing or further movement of occupants in the circulation areas.

3.4.4 Meeting Room

3.4.4.1 Supply and install local wall-mounted manually-operated lighting control switches at the positions indicated on the drawings.

3.4.4.2 Supply and install ceiling-mounted absent detectors, at the positions indicated on the drawings, to automatically turn off the luminaires upon movement of occupants no longer detected within the space, and to de-energise the luminaires after a pre-determined time delay period, unless reset upon detection of continuing or further movement of occupants in the circulation areas.

3.4.5 Workshops/other users 'areas

3.4.5.1 Supply and install local wall-mounted manually-operated lighting control switches at the positions indicated on the drawings.

3.4.5.2 Ensure that all such switches are located at every entry and exit door of such rooms, and wired and connected as one-way, two-way or intermediate lighting control circuits as appropriate.

3.4.5.3 At the locations indicated on the drawings install momentary action 'push-to-make' switches to control the dimmable luminaires. Connect such switches to provide the following modes of operation:

- Scene 1 all on
- Scene 2 only linear suspended direct/indirect luminaires on
- Scene 3 only recessed downlights on
- Scene 4 all off

3.4.5.4 Supply and install ceiling-mounted absent detectors, at the positions indicated on the drawings, to automatically turn off the luminaires upon movement of occupants no longer detected within the space, and to de-energise the luminaires after a pre-determined time delay period, unless reset upon detection of continuing or further movement of occupants in the circulation areas.

3.5 System components

3.5.1 General

3.5.1.1 Install all components in accordance with the relevant clauses of the appropriate product specification sections of this specification.

3.5.2 Conduit system

3.5.2.1 Comply with section *Cable management and accessories* (Pr_65_70_11) of this specification.

3.5.2.2 Install a conduit cable containment system for all unarmoured insulated lighting final circuit cables and where applicable for the fixing of luminaires.

3.5.2.3 Provide throughout the various areas of the building a surface or concealed, class 4 galvanised steel for wiring passing through the wall direct up to the final point of connection or white plastic high impact PVC conduit containment system fixed to walls if it feed from the non-metallic trunking, to soffits of structural slabs, within service ducts and shafts, within ceiling voids, and in prepared chases as applicable.

- 3.5.2.4 Install sections of conduit from the lighting distribution cable trunking and extend to luminaire outlet positions or wall accessory outlet positions and terminate at a conduit outlet box of the appropriate type.

3.5.3 Cable trunking system

- 3.5.3.1 Comply with section *Cable management and accessories* (Pr_65_70_11) of this specification.
- 3.5.3.2 Install a trunking cable containment system for all unarmoured insulated, and all insulated and sheathed, lighting final circuit cables.
- 3.5.3.3 Supply and install, as indicated on the drawings, a surface, or concealed cable trunking containment system for the lighting final circuit cables and where applicable for the fixing of luminaires.
- 3.5.3.4 Provide the distribution cable trunking comprising galvanised steel, single compartment distribution, or multiple compartment distribution sized in multiples of 50 mm x 50 mm, and as particularly detailed on the drawings.
- 3.5.3.5 Install a cable trunking containment system to avoid multiple runs of conduit, comprising either a dedicated or shared (ie lighting and small power supplies) single compartment system, or a multi-compartment trunking for the distribution of various cable supplies and cable systems.
- 3.5.3.6 Install the cable trunking containment system concealed throughout the office building, run within ceiling voids and rising ducts.

3.5.4 Cable tray/basket system

- 3.5.4.1 Comply with section *Cable management and accessories* (Pr_65_70_11) of this specification.
- 3.5.4.2 Install cable tray/basket systems for fixing all single and multi-core insulated and sheathed, armoured and screened soft skin lighting final circuit cables.
- 3.5.4.3 Provide the cable tray/basket comprising steel galvanised finish, medium duty, with a 50 mm return flange or as particularly indicated on the drawings.
- 3.5.4.4 Install the cable tray/basket containment system, concealed within suspended ceiling voids, along the routes indicated on the drawings.

3.5.5 Wiring system

- 3.5.5.1 Comply with section *Low-voltage cables* (Pr_65_70_48) of this specification.
- 3.5.5.2 Wire and connect all luminaires to final radial circuits emanating from local distribution boards in accordance with the lighting circuits references detailed in the schedules and indicated on the drawings.
- 3.5.5.3 Use single core 6491B (XLPE-LSZH) insulated cables with stranded copper conductors to BS 7211, rated at 450/750 V, with minimum conductor size of 1.5 mm².
- 3.5.5.4 Run cables enclosed within a ceiling void mounted galvanised cable trunking with conduit extending to luminaire, controls and switch locations.
- 3.5.5.5 Make final connections to luminaires using 6 A (minimum) 3- or 4-pin plug-in ceiling roses, with self-retaining plug and socket as appropriate, with 3- or 4-core 1.5 mm² insulated and sheathed LSF/LSZH heat resisting high-temperature flexible cable.
- 3.5.5.6 Mount such plug-in ceiling roses direct to the associated trunking or conduit box.
- 3.5.5.7 Ensure all cables and cores of cables connected within a luminaire or passing through will not suffer damage or deterioration due to heat or UV radiation generated by the luminaire or its lamps.
- 3.5.5.8 Locate every such ceiling rose above the associated luminaire position, within the suspended ceiling void, and provide sufficient length of flexible cable over and above the nominal length, to enable the luminaires to be relocated up to 1500 mm horizontally from its installed position.

- 3.5.5.9 Ensure containment and accessories are installed at a suitable height, within the ceiling void, to facilitate future access for maintenance, from the office floor.
- 3.5.5.10 Ensure the wiring installation to all luminaires within the fire-fighting access corridor, staircase and lift lobbies, is carried out using fire-resistant cables in accordance with BS 9999 and BS 6387, category CWZ and fixed using metal supporting system that will not allow the cables to fall during a fire.

3.6 Equipment

3.6.1 General

- 3.6.1.1 Ensure that unless specified otherwise that all the luminaires are of the LED type and are the most recent generation available.

3.6.2 Luminaires

- 3.6.2.1 Comply with specification section *Luminaires, lighting track and lighting accessories* (Pr_70_70_48) of this specification.
- 3.6.2.2 Install recessed luminaires fixed to the suspended ceiling grid or direct to the structure using purpose incorporated fixing positions, together with conduit accessories, suspension rods, side frame brackets, clamps, clips or other equal method.

3.6.3 Electronic control gear and LED drivers

- 3.6.3.1 Comply with section Luminaires, lighting track and lighting accessories (Pr_70_70_48) of this specification, and the luminaire schedule.
- 3.6.3.2 Provide all lamp drivers with digital (DALI) addressable capability, suitable for dimming and daylight regulation where particularly specified.
- 3.6.3.3 Ensure luminaire ballasts comply with BS EN 62384 and the following criteria:
- | | |
|--------------------------|---|
| – efficiency | 90% or better |
| – power factor | 0.9 or better |
| – harmonics | compliance with BS EN 61000-3-2 |
| – mean time to failure - | 50,000 hrs at max ambient temperature, operating 24 hours per day |
| – lamp failure | L80/B10 at 50 000 hours |
| – over voltage | provide protection to BS EN 61000-4-5 |

3.6.4 LED light sources

- 3.6.4.1 Comply with section Luminaires, lighting track and lighting accessories (Pr_70_70_48) of this specification.
- 3.6.4.2 Ensure that all LED light sources provided on the project are of the same colour temperature and have a stable colour over the lamp life.

3.7 Control devices

- 3.7.1 Ensure that each and every control device is suitably rated with regard to the circuit protective device and the load being switched taking account of the load type (e.g. inductive loads), and the in-rush current characteristic of the load.
- 3.7.2 Only install control devices with a minimum in-rush current withstand-capability greater than 125% of the cumulative in-rush current of the connected loads.

3.7.3 Switches

- 3.7.3.1 Comply with section *Wiring accessories* (Pr_65_72_97) of this specification.

- 3.7.3.2 Supply and install all lighting control switches, including wall-mounted type and ceiling-mounted pull-cord type, at the positions shown and connect to the lighting switch control circuits shown on the drawings.
- 3.7.3.3 Ensure switches are of the appropriate 'way' type and grouped into ganged switch plates.
- 3.7.3.4 Install flush-mounted switches throughout the main internal areas of the building. Within plant rooms, stores and semi-exposed locations install surface-mounted switches.
- 3.7.3.5 Install all lighting control switches at a height between 900 mm to the bottom edge and 1200 mm to the top edge as measured from finished floor level, unless otherwise indicated on the drawings, or as particularly detailed elsewhere in this specification.
- 3.7.3.6 Ensure local manually-operated switches are positioned adjacent to all respective access doors to and from each area.
- 3.7.3.7 Supply and install manually operated lighting control switches, rated at 20 A per pole, of the grid switch assembly construction, surface or flush mounting to suit, of the appropriate 'way' type, and complete with rocker or key-pattern switch inserts.
- 3.7.3.8 Install white moulded finish faceplates within flush-mounted installations and metal-clad style switches for surface-mounted installations within plant rooms, etc.
- 3.7.3.9 Provide each switch complete with white insert, cover plate, pressed steel box and earth fly lead, together with neon indicator insert where particularly detailed. Use pressed steel / PVC / pressed steel and PVC boxes as specified elsewhere.
- 3.7.3.10 Provide 16 A single-pole pull-cord switches, of the appropriate 'way' type, complete with neon indicator and of white moulded finish.
- 3.7.3.11 Where different supply phases are present within multi-gang switches, provide voltage warning labels (eg "Danger 400V"). Ensure warning labels are permanently fixed internally and externally to every such switch.
- 3.7.3.12 Select lighting control switches from the manufacturers' ranges to match socket outlets and other accessories.

3.7.4 Time switches

- 3.7.4.1 Ensure that all time switches comply with BS EN 60730.
- 3.7.4.2 Provide time switches with the following minimum functions:
 - ~ Type: electronic digital
 - ~ Display: liquid crystal display
 - ~ programme capability: 4 on and 4 off operations per day
 - ~ number of switching channels: 8
 - ~ inductive switching capacity: 10A
 - ~ cable termination capacity: 4mm²
 - ~ override facility
 - ~ automatic GMT/BST daylight saving
 - ~ minimum degree of ingress protection to BS EN 60529: IP55

3.7.5 Photoelectric control units

- 3.7.5.1 Ensure that all photoelectric control units comply with BS 5972 and are located to ensure that they are not affected by other lighting in the area.

3.7.5.2 Supply and install photoelectric control units with the following:

- ~ inductive switching capacity, 10 Amps
- ~ cable termination capacity, 4mm² and 2*2.5mm²
- ~ minimum degree of ingress protection to BS EN 60529 - IP55
- ~ switching settings; eg adjustable switching time-delay required, on lighting level 20 lux, off lighting level 70 lux. Timed on; programmable 7-day 24-hour clock. Timed off; programmable 7-day 24-hour clock
- ~ remote setup/override - by infrared controller

3.7.6 Presence detectors and daylight linking control

- 3.7.6.1 The presence detector must detect presence in the room and switch the lights on / off – no manual switching to be provided (unless stated otherwise on the drawings).
- 3.7.6.2 Supply and install presence detectors of the ceiling mounted flush or recessed type, with 3600, 6m diameter range and integrally mounted 16A single pole switching relay unit, for direct switching of lighting control circuits.
- 3.7.6.3 All presence detectors are to be of the microwave linked sensor type and located within the infill piece of the lighting system, where this is not possible the presence detectors are to be installed into the fabric of the ceiling.
- 3.7.6.4 Supply and install all presence detectors, including ceiling mounted surface or flush units, to optimise the functionality.
- 3.7.6.5 Locate final positions of presence detectors to provide optimum detection coverage within the respective space.
- 3.7.6.6 Ensure that every such presence detector incorporates an adjustable delay timer, of between 0 – 60 minutes, before de-energising the controlled luminaires, and to re-set upon further movement/ occupancy detection.

3.7.7 Absence detectors and daylight linking control

- 3.7.7.1 The absence detector must detect the “absences” of people in the room and switch the lights off, provided retractable manual switching to switch the lights on.
- 3.7.7.2 Supply and install absence detectors of the ceiling mounted flush or recessed type, with 3600, 6m diameter range and integrally mounted 16A single pole switching relay unit, for direct switching of lighting control circuits.
- 3.7.7.3 All absence detectors are to be of the microwave linked sensor type and located within the infill piece of the lighting system, where this is not possible the absence detectors are to be installed into the fabric of the ceiling.
- 3.7.7.4 Supply and install all absence detector, including ceiling mounted surface or flush units, to optimise the functionality.
- 3.7.7.5 Locate final positions of absence detectors to provide optimum detection coverage within the respective space.
- 3.7.7.6 Ensure that every such absence detector incorporates an adjustable delay timer, of between 0 – 60 minutes, before de-energising the controlled luminaires, and to re-set upon further movement/ occupancy detection.

3.8 Installation

3.8.1 General

- 3.8.1.1 When interconnecting sensors, controllers and luminaires, only use the manufacturers' recommended cable types.

3.8.2 Installing daylight sensors

- 3.8.2.1 Locate daylight sensors in a position that is representative of the daylight level in the area under control.

3.8.3 Installing occupancy sensors

- 3.8.3.1 Locate occupancy sensors in a position to suit the occupancy pattern and occupant density of the area under control. Shield the sensors from erroneous influences.

3.8.4 Cleaning and cable inspection

- 3.8.4.1 Upon completion of the installation, clean all detector lenses using anti-static cleaning fluid.
3.8.4.2 Check that all cable connections are secure.

3.8.5 Labelling

- 3.8.5.1 Provide identification labels for all equipment and sensors. Label the central controller and its output circuits, describing each item's purpose.

3.9 Testing and commissioning.

- 3.9.1.1 Comply with section B4 of this performance specification.
3.9.1.2 Ensure that the testing and commissioning complies in general with the CIBSE Commissioning Code L: 2018, and the results presented under the following headings.

Lighting and lighting control equipment testing
Lighting quality
Lighting control performance
Emergency lighting

4. Small power systems (Ss_70_30_80)

4.1 Performance objectives

- 4.1.1 To provide supply and installation of distributed power supplies throughout the refurbishment areas of Eddie Newcombe using 400-V three-phase 50-Hz circuits and 230-V single-phase 50-Hz circuits and any other voltages/frequencies within the definition of LV.
4.1.2 To provide a system of sufficient capacity to adequately meet the load characteristics of all individual circuits whilst remaining within equipment voltage and frequency tolerances.
4.1.3 To provide a means of fault clearance and isolation on every circuit and coordinated protection of cables and switchgear.
4.1.4 To provide a system complete selectivity under fault conditions.
4.1.5 To ensure that all new circuits makes allowances for anticipated fault levels, installed cable length, environmental influences, diversity, installation methods, and that circuit disconnection is achieved safely within periods prescribed in BS 7671.
4.1.6 To provide outlets that are suitable for all the new connected equipment and the environment in which they are installed.
4.1.7 To ensure that all appliances are fused for the corresponding load, taking into account the manufacturer's recommendation and any inrush current.

- 4.1.8 To strip out and omit the existing installation as per the strip-out installation drawings.
- 4.1.9 To retain and reuse the existing electrical installation as per the strip-out drawings, provide a proper test on its intended function and provide a like-for-like replacement if it is not functioning or damaged. If necessary, all the replaced installations shall comply with the equipment specification below.

4.2 Design parameters

4.2.1 Design Criteria

- 4.2.1.1 Provide distributed power fully in accordance with BS 7671, taking into consideration, amongst other applicable design criteria, the following in respect of BS 7671:
- 4.2.1.2 Adopt a grouping factor not exceeding 0.8, ambient temperature of 30°C, XLPE insulated conductors, and equally sized phase, neutral and CPC conductors.
- 4.2.1.3 Configure ring and radial final circuit arrangements in accordance with BS 7671 as detailed in Regulation 433.1 and informed in Appendix 15. Ensure main and radial final circuits are installed to minimise disruption on failure of a circuit or operation of a protective device.
- 4.2.1.4 Size circuit components to achieve disconnection times as described in BS 7671.
- 4.2.1.5 Provide RCD protection on power circuits to meet the requirements of BS 7671 and of the rating indicated by the distribution board schedules.
- 4.2.1.6 Space outlets on different phases not less than 2 m / 3 m apart.
- 4.2.1.7 Allow 25% spare capacity in all final containment routes to enable additional outlets to be added.
- 4.2.1.8 Comply with the requirements of Part 7 of BS 7671 for special installations or locations such as swimming pools, saunas and bathrooms.
- 4.2.1.9 Connect power supplies to all equipment associated with life safety and fire protection installations to the essential sections of the distribution systems via dedicated circuits, and compliance in accordance with BS 9999.

4.3 System description

4.3.1 General

4.3.1.1 Wiring types

- 4.3.1.2 Take responsibility for the final cable selection.
- 4.3.1.3 Provide internal cabling in accordance with the following:
 - BS 7211, 6491B LSZH, insulated only, single-core cable, 450/750-volt grade, contained in steel trunking and/or conduit
 - BS 6724, XLPE insulated, LSZH bedded, single wire armoured, LSF or LSOH sheathed cable, 600/1000-volt grade unless otherwise specified. Arrange single-core wire armoured cables in trefoil and provide aluminium wire armour and non-ferrous or insulated gland plates to prevent circulating currents.
- 4.3.1.4 Provide copper/LSZH singles in trunking and/or conduit for the final circuits from the distribution boards.
- 4.3.1.5 Provide external cabling in accordance with the following:
 - BS 5467, XLPE insulated, single wire armoured, pre-sheathed cable, 600/1000-volt grade.

4.3.2 Installation methods and containment

- 4.3.2.1 Use single core cables within conduit to feed final socket outlets, unless otherwise specified, to allow re-wiring.
- 4.3.2.2 Provide final circuit wiring installed in a system of containment throughout its length. Run containment generally within the fabric of the building, within ceiling or raised access floor voids, providing concealed drops to items of equipment and socket outlets. In all areas other than service voids, roof areas, risers and plant rooms, conceal all cabling behind dry-lining, chased into walls etc, and flush-mount all outlets ie switches, socket outlets, connection units, etc.
- 4.3.2.3 Provide galvanized steel cable trays and ladders where several cables are installed in close proximity and in accordance with the layout drawings. Ensure that the tray and ladder are medium-duty grade and post-dipped galvanized unless otherwise specified. Ensure that tray and ladder routes are continuous and arranged to provide horizontal cable ways between panels and distribution boards, and vertical cable ways in risers to interconnect to the floors, switchpanels, basement and rooftop plant rooms.
- 4.3.2.4 Paint exposed threads with rust-resisting paint. Ensure that conduit and trunking installations are completed prior to pulling in any circuit cables.
- 4.3.2.5 Ensure that the trunking is galvanized unless otherwise specified.
- 4.3.2.6 Ensure that the insulation of the cabling system selected is equal to the maximum circuit voltage present within the trunking compartment and that the cable can operate satisfactorily within the electromagnetic environment prevailing in the trunking compartment, ie twisted pair and screened cabling, to provide maximum immunity and to minimise emissions.
- 4.3.2.7 Where SWA cabling terminates in enclosures/isolators, provide “banjo” type connections to an earth lug to the respective earth terminal.
- 4.3.2.8 Provide PIN racks in accordance with specification section *Cable management and accessories* (Pr_65_70_11). Wrap cables around these PIN rack to avoid unnecessary stress being exerted onto the cables.
- 4.3.2.9 Support cables located in escape routes in accordance with BS 7671 such that they are not liable to premature collapse in the event of fire. Do not use non-metallic cable clips, cable ties or cable trunking as the sole means of support. Use fire-resistant means of support to prevent cables from falling into escape routes in the event of fire.
- 4.3.2.10 Segregate power and data wiring by spacing the systems apart where they run in parallel, containing power within screened cables or containment. Ensure that power and data cables cross each other at right angles.
- 4.3.2.11 Segregate the containment systems into the following categories, where possible:
 - 230/400 volt
 - extra-low voltage systems, IT systems, security systems, AV & media systems
 - fire alarms
 - utility main supplies
- 4.3.2.12 For data processing applications, segregate cable terminals in distribution boards and /power distribution units.
- 4.3.2.13 Do not use junction boxes as part of the project work; except in situations where it is proven to be wholly unavoidable and only then with the acceptance of the Contract Administrator.
- 4.3.2.14 Provide a multi-compartment dado trunking system (with minimum 50 mm deep back box) for the power data outlets where indicated on the drawings. Ensure that the dado trunking systems are suitable for Cat-6A data structural cabling.
- 4.3.2.15 All general purpose 13 amp power outlets shall be wired in a radial circuit with the circuit protective circuit wired in a ring format. The University standard circuit arrangement is to use 4mm² cables, and

afford protection by a 20A, 30mA RCBO. The number of outlets connected onto each radial circuit shall consider the application but under normal circumstances shall not exceed 8 No. Twin Outlets.

4.3.2.16 Provide each final circuit with 13A double sockets serving not more than 6 workstations.

4.3.3 Mounting heights and accessory finishes

4.3.3.1 Be responsible for the layout of the final installed distribution boards/panels, allowing for all extension boxes, control devices etc for the complete installation.

4.3.3.2 As far as practically possible, ensure that all small power accessories are procured from the same manufacturer.

4.3.3.3 Refer to finishes and mounting height schedules, and any wall elevation drawings provided by the architect.

4.3.3.4 Prior to installation of all electrical items, obtain agreement from the architect for the installed locations.

4.3.3.5 Comply with Approved Document M.

4.3.3.6 Provide accessory finishes generally as follows, ensuring coordination between other accessories, eg lighting control switches, within these specific areas:

- plant room: metal clad
- office area: white plastic in floor boxes and white plastic elsewhere
- core areas: white plastic
- general circulation: white plastic
- reception and atrium: white plastic

4.3.4 RCD protection

4.3.4.1 Provide RCD protection on power circuits to all socket-outlets up to 32 A rating to meet the requirements of BS 7671.

4.3.4.2 Provide RCD protection for all mobile equipment not exceeding 32 A rating for use outdoors.

4.3.4.3 Provide RCD protection to all cables concealed in a wall or partition at depth of less than 50 mm unless sufficient mechanical protection is provided as defined by BS 7671.

4.3.4.4 Provide RCD protection to all cables concealed in a wall or partition where construction includes metallic parts other than fixings unless sufficient mechanical protection is provided as defined by BS 7671.

4.3.4.5 Provide mechanical protection / earthed conduit to all circuits as required by BS 7671.

4.3.4.6 Select the RCD and the electrical circuit it serves such that any protective conductor current that may be expected to occur during normal operation of the connected load will be unlikely to cause unnecessary tripping of the RCD.

4.3.4.7 Provide protection at distribution boards in the form of composite MCB/RCDs (RCBOs) with a maximum tripping current rating of 30 mA.

4.3.5 Arc Fault Detection Device (AFDD) protection

4.3.5.1 Provide AFDD protection for the circuits indicated in the distribution board schedules. The AFDD devices must be combined with the overcurrent and residual current protection devices.

4.3.5.2 Ensure that suitable clear labelling is provided adjacent to each group of AFDDs, describing how to interpret the various fault indications displayable on the AFDDs.

4.3.6 Surge Protection Device (SPD)

- 4.3.6.1 Provide SPD protection in the locations indicated on the new distribution boards. Ensure that the device installed is the correct Type (1,2 or 3), rating and the installation method is in accordance with the manufacturer's requirements
- 4.3.6.2 Ensure that the internal wiring of the distribution boards is such that the protected wires do not run near the unprotected wires,
- 4.3.6.3 Ensure that the SPD devices are individually protected with an overcurrent protection device. The protection device must be selected according to the SPD manufacturers recommendations.

4.3.7 Supplies and connections to equipment

- 4.3.7.1 Provide low voltage dedicated power supplies for the following ancillary equipment from local sub-mains switch panels or existing distribution boards :
 - ~ fire detection and alarm systems
 - ~ security systems
 - ~ access control systems
 - ~ kitchen equipment
 - ~ electric heaters
 - ~ fixed network components of automatic control systems
 - ~ alarm and indication panels
 - ~ mechanical equipment
- 4.3.7.2 Wire and connect all items of fixed equipment to a permanent supply, and not into the general service or computer sockets unless otherwise specified.
- 4.3.7.3 Provide surface- or flush-mounted switched fused connection units and/or isolators for ancillary equipment. Provide circuit wiring installed in a system of dedicated containment throughout its length.
- 4.3.7.4 Run containment generally within the fabric of the building, within ceiling or raised access floor voids, providing concealed drops to items of equipment and socket outlets.
- 4.3.7.5 Connect and functionally test all items of equipment supplied and installed under this contract.
- 4.3.7.6 Liaise with other suppliers or installers to ensure the equipment is fully operational and safe.

4.3.8 Area-specific requirements

- 4.3.8.1 **Office or meeting room**
- 4.3.8.2 Provide power distribution for office areas based on direct-wired radial circuits via compartmented Dado trunking distribution system.
- 4.3.8.3 Retain and validate the existing Dado trunking and sockets, as per the strip-out drawing indicates, and replace any damaged and non-functional sockets if necessary.
- 4.3.8.4 Equip each workstation with at least 1 No. 13A double socket outlet and 1 No. of RJ45 double data outlet.
- 4.3.8.5 Provide new wall-mounted cleaner sockets as indicated on the drawings.
- 4.3.8.6 Provide new fused connection units complete with neon indicators for, and located adjacent to, new fan coil/VAV units/indoor units.
- 4.3.8.7 Provide new wall-mounted 13A socket outlets and AV outlets for new AV equipment as per requirements on the AV drawing if available.

4.3.8.8 Each workstation will be provided with desk power modules and power outlets on top of the desk. The client will provide this, and it does not fall under the electrical services scope.

4.3.8.9 Circulation areas

4.3.8.10 Provide new low-voltage power socket outlet installations to circulation areas for cleaning and maintenance purposes as indicated in the drawings.

4.3.8.11 Mount socket outlets on walls around the perimeter of the areas and serve from local power distribution boards.

4.3.8.12 Provide new power supplies to all new fixed equipment within areas which could include, but is not limited to the following:

- ventilation systems
- smoke ventilation system and AOVs (fire rated as per BS 8519)
- telecommunications equipment
- battery chargers and tripping battery supplies
- IRS signal distribution systems
- voice access control systems
- fire detection and alarm systems
- disable refuge alarms
- disable toilet alarm system
- lobby and reception desk
- mechanical plant and dedicated supplies for associated control systems
- lighting control systems
- disabled alarm system
- trace heating
- security equipment
- CCTV equipment
- energy metering system and control panels
- sump pumps
- BMS outstations and control panels
- other equipment as shown on the small power layouts

4.3.9 IT equipment cabinet power supplies

4.3.9.1 Retain all existing small power provisions for existing cabinets.

4.3.9.2 Supply each new individual cabinet with 2 No. 16 A BS EN 60309-2 ('Commando type') plug and socket outlet, installed above the cabinet. Supply the BS EN 60309-2 outlet from an integral 16 A type C single-pole MCB from their corresponding distribution board.

4.3.10 Kitchen

4.3.10.1 Provide new wall-mounted sockets or fused connection unit as per the requirements of the kitchen appliances.

4.3.10.2 Provide new 13A double sockets for general use proposed on the skirt level as per indicated on the drawing.

4.3.11 Circuit control

4.3.11.1 Provide each final circuit with a protective device to allow automatic disconnection of the supply in the event of a downstream fault. This device may also act as a means of manually isolating the circuit. Provide a means of locking-off this device.

4.3.11.2 Select protective devices to suit the load characteristics and the prospective short-circuit current. Use one or more of the following devices:

- Fuses conforming to BS EN 60269

- MCCBs conforming to BS EN 60947-2
- MCBs conforming to BS EN 60898, Type B, C or D, or BS EN 60947-2 as appropriate; minimum fault rating 9 kA
- RCDs – either combined with MCB, or protecting part or whole of a distribution board, or located at the load; 30 mA sensitivity

4.3.12 Local isolation

- 4.3.12.1 Provide local isolation of each LV power supply integral to an outlet or local to equipment positions by:
- unplugging
 - fuse removal
 - isolating switch
 - isolator
 - isolating switch breaking remote control circuit only if the installer complies with BS EN 60947-3 and is suitable and marked with the symbol for isolation.
- 4.3.12.2 Refer to BS 7671 for a full schedule of devices.

4.4 System components

4.4.1 Standard 13 amp socket outlets and fused connection units

- 4.4.1.1 Provide low voltage power socket outlet installations for general service throughout the building. Install twin / single-gang, BS 1363, 13 A switched socket outlets for tasks such as cleaning and maintenance, either wall-mounted or column-mounted or in raised / screeded floors such that:
- 4.4.1.2 Supply these sockets from separate distribution board circuit ways from those for new computer power or fixed equipment.
- 4.4.1.3 Fit socket outlets and connection units into a back-box of sufficient depth to prevent damage to wiring tails.
- 4.4.1.4 Use PVC boxes.
- 4.4.1.5 Where steel back-boxes are used, fit a manufactured fly lead of 1.5mm² with green/yellow PVC insulation between the back-box earthing terminal and the socket outlet's earthing terminal.
- 4.4.1.6 Connect each socket outlet and fused connection unit on the ring or radial principle. Do not spur off ring circuits.
- 4.4.1.7 Configure fused connection units and flexible cable outlets as indicated on layout drawings, or as appropriate to the design intent, from the following options:
- switched / unswitched
 - with or without neon indicator
 - flex outlet through faceplate
 - flex outlet at remote plate
 - remote outlet directly behind wall mounted equipment
- 4.4.1.8 Connect to equipment with white-coloured three-core flexible cable. Use heat-resisting cable with minimum 85°C rating insulated conductors and provide a fixed base terminal block in the outlet plate box if it is located more than 2 m from the fused connection unit.
- 4.4.1.9 For direct fixed wiring connections into equipment use heat-resisting cable with minimum 85°C rating insulated single-core LSF cables between the terminals of the connection unit and the equipment terminals. Do not introduce unnecessary terminal blocks.
- 4.4.1.10 All new socket outlets are to be double pole switched.

4.4.1.11 Surface mount new sockets on the existing or new Dado trunking. If there is no Dado trunking, surface mount all the sockets without damage on the existing block wall.

4.4.1.12 All new recessed sockets would be only allowed for new partition wall.

4.4.1.13 Refer to the schedule of mounting heights and any available wall elevation drawings.

4.4.2 Isolating switches

4.4.2.1 In areas with flush-mounted installations, use flush-mounting, double-pole, 20 A isolating switches, with cable outlets where necessary, and cover plates finished to match lighting switches and socket outlets.

4.4.2.2 In plant rooms and other areas with surface-mounted installations, use surface-mounting cover plates with metal clad finish.

4.4.2.3 Fit isolating switches into a back-box of sufficient depth to prevent damage to wiring tails.

4.4.2.4 Use pressed steel/PVC/pressed steel and PVC boxes.

4.4.2.5 Where steel back-boxes are used, fit a manufactured fly lead of 1.5mm² with green/yellow PVC insulation between the back-box earthing terminal and the isolating switch's earthing terminal.

4.4.2.6 Connect each isolating switch on the ring or radial principle. Do not spur off ring circuits.

4.4.2.7 Connect to equipment with white-coloured three-core flexible cable. Use heat-resisting cable with minimum 85°C rating insulated conductors, and provide a fixed base terminal block in outlet plate box if it is located more than 2 m from the isolating switch.

4.4.2.8 For direct fixed wiring connections into equipment use heat-resisting with minimum 85°C rating insulated single-core LSF cables between the terminals of the isolating switch and the equipment terminals. Do not introduce unnecessary terminal blocks.

4.4.2.9 Refer to the schedule of mounting heights and any available wall elevation drawings.

4.4.3 Isolators

4.4.3.1 Provide new isolators for three-phase power supplies to new MEP equipment within the building.

4.4.3.2 Generally, make final connections to the items of equipment with rigid steel conduit installed either flush or surface, as appropriate, to a position adjacent to the equipment terminal box terminating in a standard conduit box with fixed connector block. Make final connections to the equipment with multicore heat-resistant cable enclosed in flexible conduit, terminating directly on to the terminal box of the equipment.

4.4.3.3 Fit a label to the front cover of each isolator. Use melamine identification labels, having a white background with 3.5 mm high uppercase black engraved lettering, to identify the item of equipment served.

4.4.3.4 Refer to the schedule of mounting heights and any available wall elevation drawings.

4.4.4 Industrial plugs and socket outlets

4.4.4.1 Provide surface-mounted industrial plugs and sockets outlets.

4.4.4.2 Connect each socket outlet on the radial principle.

4.4.4.3 Configure socket outlets as indicated on layout drawings, or as appropriate to the design intent, from the following options:

- switched / unswitched
- with or without neon indicator
- minimum IP44 ingress protection rating (indoor use)
- minimum IP67 ingress protection rating (outdoor use)

- 4.4.4.4 Use heat-resisting cable with minimum 85°C rating insulated conductors and provide a fixed base terminal block in outlet plate box if it is located more than 2 m from the isolator.
- 4.4.4.5 For direct fixed wiring connections into equipment use heat-resisting cable of minimum 85°C rating insulated single-core LSF cables between the terminals of the isolator and the equipment terminals. Do not introduce unnecessary terminal blocks.

5. General lighting systems - emergency lighting systems (Ss_70_80_33)

5.1 Performance objectives

- 5.1.1 The intention of the system is to provide sufficient illumination to allow people to evacuate a building safely when the normal lighting has failed in an emergency situation.
- 5.1.2 To provide supply and installation throughout all areas within the scope of works, as detailed on the drawings and in the specification, a complete emergency lighting installation to allow safe egress from the building and provide anti-panic lighting in the event of circuit(s) failure or total mains failure.
- 5.1.3 To provide supply and installation of emergency lighting in areas where the use of the space creates an inherent hazard to safe and easy escape.
- 5.1.4 To provide an emergency lighting system that clearly and unambiguously indicates all escape routes, internally and externally as required; and provides illumination along such routes and the immediate external areas of escape routes, so as to allow safe movement towards and through all exits.
- 5.1.5 To provide supply and installation of emergency lighting coverage to all fire alarm call-points and firefighting equipment provided along escape routes in order they can be located when the normal lighting has failed.
- 5.1.6 To provide supply and installation of escape route directional signs, where a direct line of sight to an exit is not possible, to direct persons towards a final escape exit.
- 5.1.7 To retain the existing emergency light fittings where applicable, assess their condition via the compliance tests, and provide new fittings if needed.

5.2 Design parameters

- 5.2.1 For the purpose of this specification the following emergency luminaire definitions apply:
 - a. Defined escape route lighting
 - This enables the safe exit by the occupants from buildings and immediate external areas by providing them with appropriate visual conditions and direction-finding on escape routes and special locations. It ensures that the fire alarm call-points, firefighting equipment and safety equipment can be located and used.
 - Design standard: 1 lux (min), operation in 5 seconds.
 - b. Open area (anti-panic area) lighting
 - This is provided to reduce the chances of panic and enable the building occupants to move safely towards exit routes by providing them with appropriate visual conditions and direction-finding.
 - Design standard: 0.5 lux (min), to defined areas, which excludes a border of 0.5m, operation in 5 seconds.
 - c. Specific locations lighting
 - Emergency illumination in specific positions to enable normal activities to be terminated safely.

- Kitchens: 15 lux (min), operation in 0.5 seconds
 - Refuges: 5 lux (min), operation in 5 seconds
 - Plant rooms, switch rooms and emergency winding facilities for lifts: 15 lux (min), operation in 5 seconds
 - Fire alarm control and indicating equipment: 15 lux (min), operation in 5 seconds
 - Reception areas: 15 lux (min), operation in 5 seconds
 - Panic bars and pads or security devices: 5 lux (min), operation in 5 seconds
- d. High risk task area lighting
- This is provided to ensure the safety of those involved in possibly dangerous situations and processes and to allow the correct shut-down procedures to be affected.
 - Design standard: 10% of the required maintained illuminance for the task, but not less than 15 lux (min), operation in 0.5 second.

5.3 System description

5.3.1 General

- 5.3.1.1 Supply and install the complete emergency lighting installation including all wiring, manual and automatic controls, luminaires, LED light sources and emergency supply equipment as detailed on the drawings, in this specification and in the equipment schedules.
- 5.3.1.2 Ensure that all luminaires notated as emergency are Industry Committee on Emergency Lighting (ICEL) approved whether detailed in the luminaire schedule or not.
- 5.3.1.3 Ensure that all luminaires are fully compliant with the Ecodesign for Energy-Related Products and Energy Information (Lighting Products) Regulations, and suitably labelled to indicate compliance.
1. Ensure the emergency lighting system provides the following coverage: Illumination of all defined escape routes within the building
 2. Illumination of escape route immediately adjacent to the building
 3. Illumination of open areas
- 5.3.1.4 For the purposes of this specification the following emergency luminaire definitions apply:
- **Non-maintained** – luminaire in which the emergency lighting light sources are only in operation when the supply to the normal lighting fails
 - **Maintained** – luminaire in which emergency lighting light sources are energized at all times when normal or emergency lighting is required
 - **Combined** – luminaire containing two or more light sources, at least one of which is energised from the emergency lighting supply and the others from the normal lighting supply. A combined luminaire is either maintained or non-maintained
 - **Standby lighting** – that part of emergency lighting provided to enable normal activities to continue substantially unchanged
- 5.3.1.5 Provide an emergency lighting system, classified in accordance with BS EN 60598-2-22 Annex B comprising: Self-contained battery luminaires:

X	0 or 1	B	180
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- 5.3.1.6 Maintained / Non-maintained / Combined luminaire operation:

X	0 or 1	B	180
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5.3.1.7 Maintained / Non-maintained / Combined illuminated exit signage operation:

X	1	B	180
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5.3.1.8 Ensure the minimum duration in emergency mode is not less than 180 minutes.

5.3.1.9 Provide the facility for periodic testing via a integral automatic self-test and monitoring facilities for each luminaire (Smartscan wireless lighting management system).

5.3.1.10 Co-ordinate the complete system installation, including planning cable routes, access requirements and equipment locations, to provide a neat and tidy installation.

5.3.1.11 Ensure that the emergency lighting system is supplied and installed complete with lamps and control gear, and emergency supply as detailed in this section to form a compliant, complete and fully functioning emergency lighting system.

5.3.1.12 Ensure that the emergency lighting installation is independent of all other systems' wiring in accordance with BS 7671 and as set out in this specification.

5.3.1.13 Unless detailed elsewhere install a "flush" installation. Utilise flush-mounted accessories with cabling systems generally concealed within the walls, ceiling voids and primary main service ducts.

5.3.1.14 In plant rooms and external to buildings, except in hazardous areas, ensure the installation is surface-mounted in galvanised conduit or designated cable types together with metal-clad accessories. In hazardous areas, install appropriate services commensurate with the hazard.

5.3.1.15 Refer to the layout drawings and this specification for wiring types, system operation, location of emergency lighting test switches, and automatic testing and monitoring systems.

5.3.1.16 Provide during the course of the contract works, samples of luminaires with the choice of louvres and LED light source types for demonstration and final selection at site, generally in line with the luminaire schedule.

5.3.1.17 Where alternative luminaires to those listed in the luminaire schedule are proposed, provide full calculations for the emergency lighting installation to all affected areas, including an assessment of any load adjustment to the central battery system and associated electrical distribution system (where applicable).

5.3.2 Luminaires

5.3.2.1 Provide luminaires as specified in the luminaire schedule.

5.3.2.2 Equip LED emergency luminaires with a combined converter/interface module for operation and communication.

5.3.2.3 Provide emergency lighting luminaires complete with EC Directive 92/58/EEC or BS ISO 3864-1 and BS EN ISO 7010 standard exit legend (running man) at designated exit doors and changes in direction, as agreed with the relevant authorities.

5.3.3 Self-contained systems

5.3.3.1 Ensure that self-contained luminaires automatically switch over to their secondary supply on failure of Unless specified otherwise use only luminaires whose emergency output duration under emergency conditions is 3 hours.

5.3.3.2 Provide self-contained luminaires:

- 1. in the form of standalone luminaires only used in emergency conditions
- 2. contained as part of normal use luminaires forming part of the general lighting installation
- 3. in the form of emergency exit signs

5.4 Control requirements

5.4.1 Self-contained systems

- 5.4.1.1 Ensure that self-contained luminaires automatically switch over to their secondary supply on failure of the primary unswitched supply.
- 5.4.1.2 Ensure that upon return of the unswitched supply the luminaire automatically switches back to the primary supply and recharges the battery.
- 5.4.1.3 Except where the design of the lighting control system includes the function to initiate an 'Emergency lighting test mode', prevent the lighting control system from effecting the operation and charging of the emergency lighting system. Do not dim circuits feeding battery chargers.

5.4.2 Periodic testing

- 5.4.2.1 Install the emergency lighting to enable testing by one or a combination of the following methods:
 - a) Type of testing: automatic emergency lighting systems monitoring and testing system
 - a) Install the equipment for the testing of the emergency lighting system comprising: specialist emergency lighting automatic monitoring and testing system and installation (Smartscan wireless lighting management system)

5.4.3 Electronic test logbook:

- 5.4.3.1 Log and store, for at least three years, service life and annual systems tests in the electronic test logbook of the controller. Ensure that the test logbook is capable of being downloaded at any time via an infrared or RS232 interface.

5.4.4 Programmable test cycles:

- 5.4.4.1 In order to prevent tests being carried out at inconvenient times arrange for the date and time of day of all function and annual system tests to be user programmable.

5.5 System components

5.5.1 General

- 5.5.1.1 Install the system according to BS 5266, the appropriate product standards, and manufacturer's guidance.

5.5.2 Hazardous areas

- 5.5.2.1 Where the layout drawings identify areas that have particular requirements for electrical apparatus and installation practice, comply with BS EN 60079 and any other associated standards or applicable guidelines/statutory instruments.

5.5.3 Luminaires

5.5.3.1 General

- 5.5.3.2 Supply and install all luminaires for emergency lighting systems complete with diffusers, reflectors, light sources, control gear and necessary support and fixing brackets etc in the positions indicated on the drawings, as detailed in the luminaire schedule, and in accordance with specification section *Luminaires, lighting track and lighting accessories* (Pr_70_70_48).

5.5.4 Self-contained luminaires

- 5.5.4.1 Install local self-contained 3-hour duration-maintained battery/inverter units to provide a secondary power source to illuminate LED light sources of luminaires at a reduced output in the locations indicated on the layout drawings.

- 5.5.4.2 Provide the units complete with self-contained sealed Lithium-ion or Nickel Metal Hydride (NiMH) batteries, inverter and changeover module housed within the body of the luminaire or within a separate proprietary sheet steel ventilated box type enclosure fixed to the rear of the respective luminaire.
- 5.5.4.3 Ensure that each luminaire/unit is complete with indicating LED to indicate the correct operation of the emergency lighting system.
- 5.5.4.4 Ensure that the luminaires are factory-converted by the emergency lighting/luminaire manufacturer to ensure correct operation and compliance with all other relevant standards.
- 5.5.4.5 **Batteries**
- 5.5.4.6 Ensure that the complete system is ready for test and adequate ventilation is available before the batteries are delivered to site.
- 5.5.4.7 Use only new batteries. Ensure that the batteries do not degrade during the construction stage of the Works.
- 5.5.4.8 **Chargers**
- 5.5.4.9 Ensure that each unit includes solid state switching and recharge equipment to enable a fully discharged battery to be fully recharged within 24 hours automatically and under mains healthy conditions.

5.5.5 LED light sources

- 5.5.5.1 Supply and install all LED light sources for luminaires as detailed in the luminaire schedule and in specification section *Luminaires, lighting track and lighting accessories* (Pr_70_70_48).
- 5.5.5.2 Ensure all luminaires are complete with matched LED light source and driver/electronic control gear.
- 5.5.5.3 Ensure all luminaires operate within the operating voltage range as set out in the European Standard at a nominal voltage of 230 V.
- 5.5.5.4 Ensure that there is no striation of light sources present in any operating conditions on mains or battery.

5.5.6 Switches

- 5.5.6.1 Supply and install all lighting switches, key test switches and, where specified, control contactors, for emergency lighting system testing, in the positions as indicated on the layout drawings, and connect to the lighting final sub-circuit, also as indicated on the layout drawings and in accordance with the distribution board schedules.
- 5.5.6.2 Provide accessories from the same manufacturer and with the same finishes as detailed in section *Small power systems* (Ss_70_30_80) of this specification.
- 5.5.6.3 Ensure that the cover plates are suitably engraved to indicate their function. Ensure that operation of the emergency lighting test switch switches off the normal circuit live supply and operates the respective emergency lighting luminaires for test.

5.5.7 Wiring

- 5.5.7.1 **Wiring for self-contained systems**
- 5.5.7.2 Supply and install emergency lighting final circuit wiring to the same standard as the normal luminaires.

6. Data distribution systems (Ss_75_10_21_21)

6.1 Performance objectives

- 6.1.1 Provide a complete structured cabling installation to support the data, video and ancillary systems installation to be provided for (The University of Manchester).
- 6.1.2 Ensure that the performance of the cabling meets the following requirements:
- based on internationally recognised standards for performance and component type and quality.
 - supports a wide range of current and future data and voice communications techniques with any outlet being able to be used for any service type.
 - correctly structured and fully documented.
 - has a minimum of a 25-year life, warranted by the manufacturer.
 - Complies fully with the University of Manchester EPM documentation and standards

6.2 System description

- 6.2.1 Provide all new structured cabling from the new cabinets. Where necessary, coordinate with UofM IT department, and they will provide new patch panels, patch wiring and active switches to support the new structured cabling installation. Ensure all new equipment is fully compatible with the existing installation and in full compliance with the UoM EPM standards.
- 6.2.2 Provide sufficient wall-mounted data outlets as per UofM IT advice on the new Wi-Fi access panel location.
- 6.2.3 Provide fibre backbone connection from the main ICT cabinets to the relocated existing or new cabinets if necessary.

6.2.4 Building description

- 6.2.4.1 The project involves the provision of structured cabling, for the existing university building: Eddie Newcombe.
- 6.2.4.2 The building is located in Manchester. The refurbishment consists of 2 floors and is anticipated to accommodate 128 occupants. The building will be used as an educational building.

6.2.5 Communication Room

- 6.2.6 Use the ICT cabinets for:
- termination of horizontal Category 6A cabling from RJ45 outlets.
 - patching between backbone and horizontal cabling.
 - accommodation of active network equipment e.g. core and edge Ethernet switches, firewall appliances, etc.
 - patching between horizontal cabling and active network equipment.
 - accommodation of servers and storage equipment.
 - accommodation of UPS equipment.
 - accommodation of security system equipment.
- 6.2.7 Sub-ICT cabinets will be located close to their serving area, and new cabinets will be provided for the refurbishment area. Before terminating the cable, the contractor should confirm with UofM IT regarding the assigned data zoning arrangement.

6.2.8 General scope

- 6.2.8.1 Provide a structured cabling system for the distribution of voice, data, video, and other services, including horizontal cabling, outlet sockets, patch panels, etc. including but not be limited to the following:
- provision of equipment racks and cabinets
 - provision of copper cabling outlets, within the refurbishments area, utilising the raised/screeded floor using Grid Outlet Point (GOP) boxes and grommets/floor boxes / utilising dado trunking

- cable, outlet and patch panel labels
- provision of patch leads and fly leads
- local earthing and bonding to equipment
- the provision of drawings, documents and computer records
- testing and commissioning of the cabling system

6.2.8.2 Source all cabling, outlets, patch panels, cable management and associated accessories from a single manufacturer.

6.3 Scope of works

6.3.1 Responsibilities

6.3.1.1 The following associated works will be carried out separately from the structured cabling package. These works will include, but not be limited to:

- installation of all wide area networking circuits
- installation of IPTV and audio-visual services
- installation of local area networking equipment

6.3.2 Detail coordination

6.3.2.1 Agree all proposed methods of fixing the system(s) to structure, roof, cladding, chimneys, equipment, etc with the Contract Administrator and UofM heritage officer.

6.3.2.2 Agree the colours and finishes of all exposed materials of the system(s) with the Contract Administrator.

6.3.2.3 Agree all new openings and builder works against existing building structure required for electrical services distribution with the Contract Administrator and UofM heritage officer.

6.4 System components

6.4.1 General system architecture

6.4.1.1 Retain the existing system architecture including the backbone cabling to each cabinet position.

6.4.1.2 Supply and install cabling from the existing cabinet(s) to terminate in RJ45 outlets in the approximate locations shown on the data layouts.

6.4.1.3 Supply, install and select from the list below cabling from the proper ICT cabinet to terminate in RJ45 outlets in the approximate locations shown on the data layouts.

6.4.2 Horizontal cabling

6.4.2.1 Ensure that the Category 6 cabling adheres to the following specification:

6.4.2.2 Cabling type,

- Cat 6a U/FTP Low Smoke Zero Halogen (LSOH) Cca-s1a,d1,a1
- Each connection between patch panel and room outlet shall use a single 4-pair twisted pair cable meeting the requirements of ISO/IEC 11801.
- Each connection between patch panel and room outlet shall use a single 4-pair twisted pair cable meeting the requirements of ISO/IEC 11801.
- The length of cable from patch panel to room outlet shall not exceed 90m.
- There shall be no junctions, splices or other connections in the cable between the patch panel and the room outlet.
- There shall be no twists or kinks along the length of the cable.

- All 4 pairs shall be terminated at each end of the cable.
- Each end of the horizontal cable shall be labelled with machine printed labels (before and after termination)
- The correct twists in each 4pair cable shall be maintained up to the point of termination as per the
- manufacturer's guidelines
- The cable sheath shall not be stripped back more than the manufacturer's guidelines.
- The manufacturer's recommended fixings shall be used to secure the cables at the termination points and as installed.
- All structured cabling should enter the cabinets at high level unless installed within a floor void.

6.4.3 Outlets and installation

6.4.3.1 RJ45 outlets

6.4.3.2 Provide RJ45 outlets in each of the floor-, wall- and ceiling-mounted backboxes in the approximate locations shown on the drawings. Wire the RJ45 outlets with Category 6A cabling.

6.4.3.3 Ensure all RJ45 outlets conform to the requirement of Category 6A as defined by ANSI/TIA.

6.4.3.4 Ensure all RJ45 outlets are fitted with spring-loaded sliding shutters to prevent the ingress of dirt and dust.

6.4.3.5 Wall mounted outlets

6.4.3.6 Provide RJ45 outlets in wall-mounted back-boxes provided under the electrical contract package.

6.4.3.7 Ceiling-mounted outlets

6.4.3.8 Provide RJ45 outlets on ceilings and in the ceiling voids, in back-boxes provided under the electrical contract package.

6.4.3.9 Cable containment

6.4.3.10 Route cables via cable baskets and/or tray installed at high level in the general areas as indicated on the electrical containment drawings. Provide conduits from the main cable basket/trunking runs, to route cables to their termination points in back-boxes in the wall and ceiling.

6.4.3.11 Supply and install any required flexible conduits or cable socks.

6.4.3.12 With the exception of flexible conduits and cable socks, all cable containment comprising cable baskets, tray, trunking, rigid conduit, back-boxes, etc., complete with all accessories, will be provided under the electrical contract package. Refer to the electrical containment drawings and the electrical specification for details.

6.4.4 Cable installation

6.4.4.1 Ensure that cable ties secure all cables at intervals of not more than 600mm horizontally and not more than 300mm vertically. Use only the soft cable tie systems such as Velcro, to ensure maximum cable protection.

6.4.4.2 Ensure that where power and information technology cables are installed in parallel, the separation requirements detailed in BS EN 50174-2 are complied with.

6.4.4.3 Ensure that individual bundles of cable do not contain more than 24 cables.

6.4.4.4 Provide strain relief for all cables at their termination to patch panels or outlets, to avoid stress on individual conductors or fibre optic elements.

- 6.4.4.5 Take care to avoid kinking cables or bending them at sharp angles (i.e. less than the minimum bend radius for the cable).
- 6.4.4.6 Do not install cables on cable baskets/trunking to a depth greater than 75mm.
- 6.4.4.7 Install cables with a minimum of 200mm slack in the cabinet in the form of a gooseneck, to allow for re-termination.

6.4.5 Cabinet

- 6.4.5.1 Unless otherwise specified in the drawing or requested by the university's IT manager for new cabinet, use existing cabinets.
- 6.4.5.2 If new cabinet is required, ensure fully compliance with the requirements in the EPM PM19.

6.4.6 Cabinet installation

- 6.4.6.1 Ensure full-height cabinets are free-standing but not fixed to the floor.
- 6.4.6.2 Ensure cabinets are located as per the layout drawings.
- 6.4.6.3 Provide a minimum clearance of 1.2 m on all faces where access is required to the cabinets.
- 6.4.6.4 Connect each cabinet to a safety earth bar using a 10mm² green/yellow PVC-insulated earth conductor.
- 6.4.6.5 Provide earth bonding to the cabinets in accordance with BS 7671.
- 6.4.6.6 Provide a separate functional earth bar system for each cabinet to allow the clean earth bonding of equipment within each cabinet. Insulate the functional earth bar from the body of the cabinet and earth back to the main building earth bar provided under the electrical package.
- 6.4.6.7 Ensure the functional earth is segregated from the dirty earth.
- 6.4.6.8 Ensure that cabinets, patch panels etc. and the MER/MCR are properly cleaned and free of dust prior to handover.
- 6.4.6.9 Refer to the schedule and rack elevations for the list of active and passive equipment to be installed in the cabinets.

6.5 Labelling

- 6.5.1 Labelling to be in line with the university labelling requirements.
- 6.5.2 Provide labelling to identify all the components of the structured cabling installation.
- 6.5.3 Ensure all patch panels, cabinets, outlets, cables etc. are labelled using black lettering on a white background.
- 6.5.4 Provide typewritten cable labels that are the wrap-round, self-laminating types and are printed with the identifier for the cable.
- 6.5.5 Provide labels for outlets, patch panels and cabinets, that are made of traffolite or similar approved sandwich type material. Fasten the labels with a permanent adhesive or mechanical fixing.
- 6.5.6 Ensure that the labelling is in accordance with a labelling regime, which will be confirmed by the Contract Administrator. For the purposes of this tender, allow for a labelling scheme based on the format described below.

6.5.7 Label elements

- 6.5.7.1 The label type, location and format are described below and employ the following elements as required.
 - <comms room> (comms room which an outlet is wired back to)

6.5.7.2 MER/MCR:

- <cabinet ID> CAB1, CAB2, etc.
- <patch panel ID> U1, U2, etc. ('U' position of a patch panel within a cabinet)
- <port ID> 01, 02, etc. (port number on a FTP patch panel)
- <pair ID> 01, 02, etc. (port number (for fibre pair) on a fibre patch panel)
- <box ID> (identifier for floor, wall and ceiling boxes)
- F001, F002, etc. (for floor boxes)
- W001, W002, etc. (for wall boxes)
- C001, C002, etc. (for ceiling boxes)
- <outlet ID> A, B, etc. (for horizontal outlets)
- <cable type> C6 (for Category 6 FTP)
- <QTY> Quantity of cables or cable cores

6.5.8 Horizontal cable labels

6.5.8.1 Ensure all horizontal cables are labelled at both ends using the following label format:

- <cable type>/<outlet floor>/<box ID>/<outlet ID>/<comms room>/<cabinet ID>/<patch panel ID>/<port ID>

6.5.9 Horizontal outlet labels

6.5.9.1 Ensure that each outlet label is approximately 15mm x 5mm in size with engraved lettering.

6.5.9.2 Fix the label to the blanking plate or faceplate above the outlet.

6.5.9.3 Use the following format:

- <comms room>/<outlet floor>/<box ID>/<outlet ID>

6.5.10 Cabinet labels

6.5.10.1 Ensure that each cabinet is provided with two labels, fastened to the centre of the top of the front and rear of the cabinet frame.

6.5.10.2 Provide a label approximately 40mm x 40mm in size with engraved 9mm black lettering, in the following format:

- <comms room>/<cabinet ID>

6.5.10.3 Ensure that each patch field within each patch panel commences with a 1U blanking panel, labelled with the identity of the field that follows it.

6.5.11 Cable containment

6.5.11.1 Reuse existing cable containment for any new data cables within the refurbishment areas if possible. If the capacity of the existing cable containment cannot be managed, provide new containment systems and agree on the routing with the University IT and heritage officer.

6.5.11.2 Route cables via cable baskets and/or tray installed at high level in the general areas as indicated on the electrical containment drawings. Provide conduits from the main cable basket/trunking runs, to route cables to their termination points in back-boxes in the wall and ceiling.

6.5.11.3 Supply and install any required flexible conduits or cable socks.

6.5.11.4 With the exception of flexible conduits and cable socks, all cable containment comprising cable baskets, tray, trunking, rigid conduit, back-boxes, etc., complete with all accessories, will be provided under the electrical contract package. Refer to the electrical containment drawings and the electrical specification for details.

6.5.11.5 All new containment systems shall have a usable space that allows for 50% extra to the initial quantity of cables installed unless an alternative containment has been specified by the Network & Telecomms

planning officer. This means that no more than 66% of the containment should be used on day one leaving 34% spare capacity for future use. Cable calculators should be used when carrying out containment sizing.

- 6.5.11.6 No other services shall share the containment.
- 6.5.11.7 Containment cable dividers should not be used on new builds or major refurbishments.
- 6.5.11.8 White PVC single or multiple compartment trunking or conduit shall be used where the containment will be visible.

6.5.12 Cable installation

- 6.5.12.1 Ensure that cable ties secure all cables at intervals of not more than 600mm horizontally and not more than 300mm vertically. Use only the soft cable tie systems such as Velcro, to ensure maximum cable protection.
- 6.5.12.2 Ensure that where power and information technology cables are installed in parallel, the separation requirements detailed in BS EN 50174-2 are complied with.
- 6.5.12.3 Ensure that individual bundles of cable do not contain more than 24 cables.
- 6.5.12.4 Provide strain relief for all cables at their termination to patch panels or outlets, to avoid stress on individual conductors or fibre optic elements.
- 6.5.12.5 Take care to avoid kinking cables or bending them at sharp angles (i.e. less than the minimum bend radius for the cable).
- 6.5.12.6 Do not install cables on cable baskets/trunking to a depth greater than 75mm.
Install cables with a minimum of 200mm slack in the cabinet in the form of a gooseneck, to allow for re-termination.

6.6 Testing and commissioning

6.6.1 General

- 6.6.1.1 Ensure that the testing conforms to:
 - test results are submitted in the tester manufacturer's format.
 - full graph data is included in the results
 - the tester is set to the correct cable characteristics as per the product's published specifications
 - the latest tester software and firmware is installed
 - the warranty is issued against the standard tested to (EN 50173 or other)
- 6.6.1.2 Test and commission all components of the structured cabling system.
- 6.6.1.3 Thoroughly test the cabling installation to confirm that the components and installation practices meet the defined standards.
- 6.6.1.4 Carry out all tests in accordance with an agreed methodology.
- 6.6.1.5 Maintain full records of all testing carried out and the results of the tests.
- 6.6.1.6 Provide paper and CD/DVD copies of the complete test results in the O&M manuals.

6.6.2 Method statement

- 6.6.2.1 Provide a method statement to describe how the testing will be carried out.
- 6.6.2.2 Ensure that the statement includes the following:
 - the procedures to be employed for carrying out the tests
 - the format of test results produced by the test procedure
 - the manufacturer, type and model of all test equipment to be used

- how the test results will be incorporated into the cable record/audit software package.

6.6.3 FTP/UTP cable tests

6.6.3.1 Test all FTP/UTP cables, following installation, for:

- pair polarity
- crossed pairs
- continuity
- short circuits
- length
- attenuation
- crosstalk (near and far end)
- PS-NEXT
- ACRF
- PSACRF
- propagation delay
- delay skew.

6.6.3.2 Check the results against declared published results for the types of cable used.

6.6.3.3 Ensure each pair in each link is tested from both ends and the worst pair results used as the test result.

6.6.4 Test equipment

6.6.4.1 Provide a valid calibration certificate, that is less than six months old, for each item of test equipment that is brought to site to measure performance data. Make the calibration certificate available for inspection on site.

6.6.4.2 Ensure FTP test equipment can provide accuracy for both channel and permanent link in accordance with the requirements of ANSI/TIA.

6.6.4.3 Ensure all fibre optic test equipment complies with BS EN 50174.

6.6.4.4 Ensure the light source and power meter pair provide attenuation accuracy better than 0.02dB.

6.6.4.5 Provide microscope(s), for inspection of terminated fibre optic connectors, that conform to the following:

- magnification of 200X minimum
- allow connection of LC connectors
- built-in front illumination
- built-in infra-red blocking filter.

6.6.5 Test failures

6.6.5.1 Rectify each failure identified during testing by replacing the faulty cable or component.

6.6.5.2 If either in-line cable joints or flexibility points outside cabinets are detected during testing, replace the affected cable(s).

6.6.5.3 Remove all damaged cables and components from site.

6.6.6 Test notification

6.6.6.1 Inform the Contract Administrator at least ten working days before commencing any tests.

6.6.6.2 Provide a programme for testing and agree the programme with the Contract Administrator and his agents.

6.6.7 Witnessing

- 6.6.7.1 Offer for witnessing any testing requested by the Contract Administrator. The extent of the witness testing will be at the discretion of the Contract Administrator and could be all cables and components, or a random selection.

6.6.8 Test personnel

- 6.6.8.1 Ensure that all personnel who carry out any testing are demonstrably qualified, either by experience or by training, for the test equipment to be employed.
- 6.6.8.2 Provide sample signatures for all authorised test signatories.

6.6.9 Warranty

- 6.6.9.1 Ensure that the cabling installation carries a manufacturer's warranty for at least 25 years from the date of acceptance, for all permanent copper cabling, outlets, jacks, cabinets and cabinet equipment.
- 6.6.9.2 Provide a warranty that covers components and system performance, to the required standard for all elements of the cabling system.
- 6.6.9.3 Identify any exclusions from the warranty at tender stage. Any exclusions not declared at tender stage will not be accepted.
- 6.6.9.4 Describe the repair service, including reporting methods, repair times and escalation procedures in the warranty documentation.

7. Security systems - small scale (Ss_75_40)

7.1 Performance objectives

7.1.1 Access control system

- 7.1.1.1 To provide, install, commission, and demonstrate additional access control devices extended from the existing access control system designed for use in a professional security environment, which will allow an operator to manage and control pedestrian access to specified areas and in accordance with operator-defined access authorisation levels.
- 7.1.1.2 To provide a system that allows authorised operators to easily add, suspend, cancel, or change the access control information and authorisations of any person or groups of people.
- 7.1.1.3 To provide additional door access control management that continues to function normally when mains power and communication links to the central controller are lost.
- 7.1.1.4 To provide additional door access control management that does not prevent persons from escaping in the event of a fire.
- 7.1.1.5 To provide re-programmable on the existing access control system by a university authorised operator; to allow the addition, suspension, removal of individuals or groups of users; and to allow the changing of rules associated with physical areas and new access points.

7.1.2 Surveillance system

- 7.1.2.1 To design, provide, install, commission, and demonstrate a video surveillance system designed for use in a professional security environment, which will allow an operator viewing images from standard resolution cameras to:
- monitor the number, direction and speed of movement of people when a person's figure occupies 5% of the vertical dimension of the screen (more than 80 mm per pixel)
 - detect the presence of a person when the figure occupies 10% of the vertical dimension of the screen (more than 40 mm per pixel)
 - observe and distinguish some characteristic details of a person when the figure occupies 25% of the vertical dimension of the screen (more than 16 mm per pixel)

- recognise a known person or determine that a person is not known when the figure occupies 50% of the vertical dimension of the screen; and (more than 8 mm per pixel)
- identify a person beyond reasonable doubt when the figure occupies 100% of the vertical dimension of the screen (more than 4 mm per pixel) To provide a system of hardware and software that is fully compliant with the latest ONVIF standards and is easy to customise, adjust and control by the user without the need for specialist input.

7.1.2.2 To provide a system that is IP-addressable and transmits all surveillance and control data signals over a standard Ethernet local area network (LAN).

7.1.2.3 To provide a system that uses power over Ethernet to power all cameras.

7.1.2.4 To provide surveillance system to all cover all new communication room if available.

7.2 Design parameters

7.2.1 Access control system requirements

7.2.1.1 Use an electronic access control system that is fully compliant with the requirements for a Grade 3 system as specified in BS EN 60839-11-1, except where these requirements are exceeded or modified in this specification.

7.2.2 Surveillance system requirements

7.2.2.1 Use a video surveillance system that is fully compliant with the requirements for a Grade 2 system as specified in BS EN 62676-1, except where these requirements are exceeded or modified in this specification.

7.3 System description

7.4 System functions

7.4.1 General

7.4.1.1 Provide video management software to perform all setting up, configuration, control and monitoring functions simultaneously without affecting the performance of the system.

7.4.1.2 Ensure that the system is based on an open protocol to allow easy interface and integration with third party systems, equipment and devices.

7.4.1.3 Use a system that will continue to operate normally based on the last system settings when communication between the central equipment and field devices are lost.

7.4.1.4 Provide a minimum of four levels of password protection to limit the software functions available to various users.

7.4.1.5 Ensure that all current and recurrent software licence fees are included within the tender return and transfer the licences to the Client at Practical Completion.

7.4.2 User interface

7.4.2.1 Provide intuitive user interfaces for the access control system and for the surveillance system to allow an authorised operator to set up, monitor and control the relevant system.

7.4.2.2 Ensure that the system is capable of supporting multiple operator stations and multiple users, each interacting in real-time mode with the system via the interface.

7.4.2.3 Provide sitewide interface with the university security office.

7.4.3 Access control system functions

7.4.3.1 Operator functions

7.4.3.2 Ensure that operators are able to perform the following control functions, depending on each operator's individual authorisation:

- enrol, change and cancel users and authorisation details
- set up and change system and device settings
- create, set up and change icons
- enter search criteria to retrieve recorded event data
- monitor and acknowledge alarms
- produce reports based on user-definable criteria

7.4.3.3 User database

7.4.3.4 Provide a central, searchable ODBC-compliant database of users and user groups.

7.4.3.5 Set up the system to include a minimum of 5,000 users and 15 user groups.

7.4.3.6 Include at least the following details for each user:

- first name
- surname
- credentials
- access level (authorised access points set per user and per user group)
- time validity (authorised time periods set per user group)
- authorisation expiry date

7.4.3.7 Set up the system so that an authorised operator can easily add, remove and modify database entries via a standard personal computer (PC) through the use of authorisation codes.

7.4.4 Surveillance system functions

7.4.4.1 Operator functions

7.4.4.2 Ensure that operators are able to perform the following functions, depending on each operator's individual authorisation:

- select and view live images
- search for, view and export recorded images
- display images in full screen or in multiple screens of 2x2, 3x3 or 4x4 windows
- add privacy masks to live or recorded images
- print reports of live or recorded images
- add, change and delete operator and administrator authorisations

7.4.4.3 Text

7.4.4.4 Provide a system that allows the user to generate and modify alphanumeric text to uniquely identify and describe each camera, server and recorder.

7.4.4.5 Ensure that the camera text is recorded as metadata associated with the video images and that it cannot be changed once the images have been recorded.

7.4.4.6 Take responsibility for liaising with the end user to agree on a camera numbering and labelling protocol. Draw up a proposed schedule of all camera numbers and text and submit it to the end user for acceptance. Set up the system in accordance with the accepted schedule.

7.4.4.7 Recording

7.4.4.8 Ensure that the system automatically records images in response to video motion detection (VMD) and when an operator clicks an on-screen button. Set up the system to provide a minimum of 5 seconds of pre-event and post-event recording on all images recorded in response to VMD.

7.4.4.9 Retrieval and playback

- 7.4.4.10 Provide a search facility to enable an authorised user to easily find any recorded surveillance images. Ensure that the metadata recorded with the images can be used as search criteria to find recorded data, including:
- start and end date
 - start and end time
 - movement within the camera's field of view
 - movement within a user-definable area in the camera's field of view
- 7.4.4.11 Ensure that all recorded surveillance data retain its integrity during search and retrieval, so that no surveillance or authentication data is corrupted, and the quality of the image is not affected.
- 7.4.4.12 **Exporting**
- 7.4.4.13 Provide a system for exporting copies of any video or still image in its native format, without any conversion and with metadata and authentication intact. Ensure that the exported images can be viewed on a standard PC using licence-free viewing software.
- 7.4.4.14 Use a system to allow an operator to export any video clip with or without the following:
- password protection
 - operator-defined annotation
 - time and date displayed on the image
 - privacy masks on one or more areas of the image
- 7.4.4.15 Ensure that the system allows exporting to standard CDs, DVDs, external hard drives and operator-defined network locations.

7.5 Components

7.5.1 Location

- 7.5.1.1 Install all visible equipment and devices in accordance with the architectural setting-out details. Ensure that all central equipment, power outlets, data outlets and cables are installed in secure locations.

7.5.2 Cable and containment

7.5.2.1 Cables

- 7.5.2.2 Install all cables between power and data outlets and security equipment.
- 7.5.2.3 Install all network cables between data outlets and security equipment. Use Cat 6A unshielded twisted pair (UTP) network cables. All network cables shall be Cat 6A unshielded twisted pair (UTP).
- 7.5.2.4 Comply with specification section *Low-voltage cables* (Pr_65_70_48).

7.5.2.5 Containment

- 7.5.2.6 Install all cables in rigid electrical conduit throughout its length. Ensure that all conduit is concealed in walls, floors or soffits, and that no cable or containment is visible after the works are complete.
- 7.5.2.7 In each instance where containment cannot be concealed, take responsibility for obtaining written acceptance from the Contract Administrator to install the relevant cables in rigid surface-mounted galvanized steel or stainless-steel conduit throughout its length before commencing any work.
- 7.5.2.8 Take responsibility for liaising with the Main Contractor, the Electrical Installer and the IT Installer to coordinate final location and installation methods of all containment.
- 7.5.2.9 Comply with specification section *Cable management and accessories* (Pr_65_70_11).

7.5.3 Access control equipment

7.5.3.1 Tokens

- 7.5.3.2 Provide an access control system that uses contactless proximity radio frequency identification (RFID) technology operating at 125 kHz. Provide key fob type and access card type tokens for use in a professional security environment. Ensure that any single credential will be able to operate any reader on the system, subject to authorisation level.
- 7.5.3.3 Provide the following quantities of tokens as part of the security installation:
- access cards: 150
- 7.5.3.4 **Token readers**
- 7.5.3.5 Provide close proximity non-contact readers to read proximity cards and fobs.
- 7.5.3.6 Ensure that every reader provides visual and audible indication that a token has been read and access granted or denied.
- 7.5.3.7 Provide a desktop enrolment reader with USB connection at each access control PC.
- 7.5.3.8 **Access controllers**
- 7.5.3.9 Provide IP-addressable access controllers to control all transactions relating to networked access-controlled points. Install the controllers in a secure location within easy reach for maintenance.
- 7.5.3.10 Ensure that all controllers are fully intelligent and capable of operating in a standalone mode when communication with the central control computer is lost.
- 7.5.3.11 Ensure that failure of any individual controller does not compromise communication with, or operation of, any other controller within the system.
- 7.5.3.12 Ensure that there is no noticeable delay between the time when access is requested and the release of the relevant lock.
- 7.5.3.13 Provide a rechargeable battery for each controller to ensure normal operation of all hardwired access points for at least four hours when mains power is disconnected.
- 7.5.3.14 Ensure the batteries are no older than six months from date of manufacture at the time of installation and mark the date of installation on each battery in indelible ink. Install the batteries with the relevant access controller in the same enclosure, or where that is not possible in a separate lockable powder coated steel enclosure adjacent to the controller.
- 7.5.3.15 Connect all hardwired access control devices to the access controllers.
- 7.5.3.16 **Pushbuttons**
- 7.5.3.17 Provide flush mounted momentary pushbuttons to temporarily release the locks.
- 7.5.3.18 Use round stainless-steel pushbuttons with bevelled collars, mounted in stainless steel face plates. Engrave the face plates with the words “PRESS TO EXIT” in clear green letters.
- 7.5.3.19 Ensure that all pushbuttons can be upgraded to readers at any time in the future without the need for builders work or changes to containment.
- 7.5.3.20 **Break glass units**
- 7.5.3.21 Provide semi-flush mounted, resettable, 3-pole break glass units (BGUs) to allow people to escape through access points in the event of an emergency. Use green-coloured BGUs engraved with the words “EMERGENCY DOOR RELEASE” in clear white letters.
- 7.5.3.22 Ensure that both conductors of the cable between the access controller and the lock are disconnected when the BGU is operated, and that the access point unlocks and remains unlocked until the BGU is reset.
- 7.5.3.23 Set up the system to generate an alarm signal when a BGU is operated.

- 7.5.3.24 Ensure that the BGUs can be reset by means of a reset key without the need to open the unit or replace any element. Provide three reset keys.
- 7.5.3.25 Weatherproof BGUs where installed in areas that are located externally or open to the elements.
- 7.5.3.26 **Fire alarm interfaces**
- 7.5.3.27 Provide fire alarm interfaces (FAIs) to automatically unlock access-controlled points in the event of a fire.
- 7.5.3.28 Provide 3-pole, normally open contacts held in closed position by a healthy signal from the fire alarm system.
- 7.5.3.29 Ensure that both conductors of the cable between the access controller and the lock are disconnected when the FAI is operated, and that the access point unlocks and remains unlocked until the fire alarm signal is restored.
- 7.5.3.30 Set up the system to generate an alarm signal when a FAI is operated.
- 7.5.3.31 **Status monitors**
- 7.5.3.32 Provide concealed magnetic reed switch type monitors to detect the closed or open status of all access-controlled doors or gates.
- 7.5.3.33 Provide magnetic reed switch type monitors to detect the closed or open status of all non-access-controlled doors and gates as indicated on the drawings, to allow monitoring of the door or gate status via the access control system.
- 7.5.3.34 Install concealed monitors in doors. On gates and garage doors provide weatherproof, rugged, aluminium clad, surface mounted monitors fitted with stainless steel armoured cables. Ensure that the detectors generate an alarm when the door or gate is opened by no more than 50 mm.
- 7.5.3.35 Ensure that the monitors cannot be defeated by the use of external magnets.

7.5.4 Surveillance equipment

7.5.4.1 Cameras

- 7.5.4.2 Use cameras complying with the following minimum specification:
- IP-addressable and compliant with the latest ONVIF standards
 - powered by power over Ethernet (PoE) via Cat 6A unshielded twisted pair (UTP) cable
 - H.264 video compression format
- 7.5.4.3 Where cameras require the use of ancillary heaters or fans for the control of condensation, provide power supplies to support these ancillary systems through the same POE supply.
- 7.5.4.4 In areas where temperatures are well maintained, use internal cameras or enclosure for normal operation in environmental conditions between 0°C and 40°C and between 20% and 80% relative humidity.
- 7.5.4.5 In areas where temperatures are not well maintained or where areas are unheated, use internal cameras or enclosures for normal operation in environmental conditions of between -10°C and 40°C and between 20% and 80% relative humidity.
- 7.5.4.6 Semi-recess static dome cameras into ceilings or wall cladding, or surface-mount cameras where no suitable ceiling or wall cladding exists.
- 7.5.4.7 Semi-recess pan, tilt, zoom (PTZ) dome cameras into ceilings, or surface-mount cameras where no suitable ceiling exists. Use brackets where cameras are wall mounted.
- 7.5.4.8 Use video motion detection (VMD) for all cameras.
- 7.5.4.9 Use electronic privacy masking of multiple user-defined areas for each camera's field of view.

- 7.5.4.10 Use cameras that produce clear colour video images without visible artefacts in all lighting levels, including low light conditions below 1 lux at 80% reflectivity and at an aperture setting of f1.2.
- 7.5.4.11 Include effective measures on each camera to ensure clear images of a target are produced when the target is viewed against strong backlight and to eliminate the effects of flare or silhouette. As a minimum, use wide dynamic range capability on all cameras.
- 7.5.4.12 Use high optical quality glass lenses that provide sharp focus, accurate colour and distortion-free images across the entire image.
- 7.5.4.13 Equip each lens with an automatic iris.
- 7.5.4.14 Fit static cameras with a varifocal lens.
- 7.5.4.15 Fit PTZ cameras with an autofocus lens.
- 7.5.4.16 Ensure that PTZ cameras are capable of:
 - 360° endless pan and 180° tilt at a rate of 300 degrees per second
 - automatic image flip
 - touring between 20 user-definable pre-set positions, including a home position
- 7.5.4.17 Set up each camera to ensure that the image is not affected by any of the electrical or electronic equipment located near the camera.
- 7.5.4.18 **Enclosures**
- 7.5.4.19 Manufacture dome bubbles and flat windows from optically pure, distortion free, impact-resistant polycarbonate or glass.
- 7.5.4.20 Limit the light attenuation factor of each dome bubble or flat window to no more than 1 f-stop.
- 7.5.4.21 Use vandal-resistant enclosures where mounted outdoors, and where shown on the drawings.
- 7.5.4.22 Equip external enclosures with an automatic heater or other provisions to stop condensation.
- 7.5.4.23 Equip flat window external cameras and enclosure with an operator-controlled wiper.
- 7.5.4.24 **Camera mounting**
- 7.5.4.25 Provide rigid camera mounts specific to each camera and mounting surface to ensure the camera remains static in all three dimensions at all times, and that external cameras can withstand gusts of winds of up to 160 km/h.
- 7.5.4.26 Ensure that all camera mounts are fixed directly onto a solid surface such as masonry or concrete and not onto cladding or suspended ceilings. Trim and make good any openings in ceilings and cladding.
- 7.5.4.27 Use corrosion-resistant camera mounts and weatherproof all external elements.
- 7.5.4.28 **Recording**
- 7.5.4.29 Provide network video recorders (NVRs) complete with software for 24/7/365 operation in a professional security environment. Ensure that the system is capable of recording video from all surveillance cameras at full camera resolution and at 25 frames per second.
- 7.5.4.30 Ensure that all NVRs are compliant with the latest ONVIF standards.
- 7.5.4.31 Use video compression format H.264.
- 7.5.4.32 Set up the system to ensure that images and data are recorded for 31 days and are automatically overwritten or deleted after that time. Ensure that operators cannot manually overwrite or delete recorded images or data.
- 7.5.4.33 Use a system for providing authentication, such as digital signature, check marking, and invisible watermarking, and encryption of all recorded surveillance data, suitable for use in legal proceedings in a court of law.

- 7.5.4.34 Ensure that no recorded surveillance data or system settings are affected by power supply interruptions or power surges.
- 7.5.4.35 Take responsibility for calculating and providing the hard drive capacity required to record all video as described in this specification and on the drawings.
- 7.5.4.36 Ensure that the hard drive capacity provides not less than 10 TB

7.6 Equipment

7.6.1 Electromagnetic locks

- 7.6.1.1 Provide electromagnetic locks consisting of pull magnets and armature plates to provide effective locking of access-controlled points. On double doors where both leaves are electronically locked provide a single unit with two integral electromagnetic locks.
- 7.6.1.2 Ensure that the pull strength of each individual lock is to be no less than 5,000 N, except on low security internal doors, where the pull strength of each individual lock may be no less than 2,500 N.
- 7.6.1.3 Take responsibility for liaising with the Main Contractor to coordinate the installation of each lock to ensure that the required clear head height of the door opening is maintained.
- 7.6.1.4 Provide all brackets, trims and mounting hardware to suit the specific requirements of each door.
- 7.6.1.5 Install all locks on the secure side of the door.
- 7.6.1.6 Ensure that the lock engages automatically when the door is returned to the closed position.

7.7 Security system installer's responsibilities

- 7.7.1 Employ a specialist Security System Installer registered with the National Security Inspectorate as a NSI Gold installer to install, test, commission and demonstrate the security systems. Ensure the Security System Installer has the necessary expertise and capacity to provide professional and timely maintenance and emergency repair services of all systems during the design life of the systems.
- 7.7.2 Provide all central equipment, recording equipment, signal transmission, monitoring and control hardware and software complete with licences.
- 7.7.3 Provide all access point hardware, controllers, devices and interfaces.
- 7.7.4 Provide all access control tokens and associated accessories.
- 7.7.5 Provide all cable and containment from data and power outlets to all security equipment.
- 7.7.6 Provide all control equipment, power supplies, detectors, hold-up devices, alarm confirmation devices, setting and un-setting equipment and portable devices, remote input and output devices, warning devices, alarm transmission equipment, cabling and containment.
- 7.7.7 Provide all camera, camera movement, signal transmission, recording, display, monitoring and control hardware and software complete with licences.
- 7.7.8 Provide all enclosures, mounts, brackets and supports for all security equipment.
- 7.7.9 Provide all statutory warning signage.
- 7.7.10 Take responsibility for liaising with the Contract Administrator to agree on the positioning, colour and style of all visible parts of the installation before placing orders or commencing installation.
- 7.7.11 Take responsibility for liaising with all other trades, including the Main Contractor, Electrical Installer, IT Installer, Lighting Installer and Lift Installer to coordinate the location and installation of all containment, cables, outlets, devices and equipment.
- 7.7.12 Take responsibility for ensuring that the selected equipment and installation locations meet all performance requirements and are fully compatible with the building elements on which it is installed.

8. Fire and smoke detection and alarm systems (Ss_75_50_28)

8.1 Performance objectives

- 8.1.1 Provide supply, installation and commissioning of a refurbished automatic fire detection and alarm system to satisfy the area coverage, operational and performance criteria as outlined elsewhere in this section. Ensure that the fire alarm system complies with the recommendations of BS 5839-1 for non-domestic premises as applicable to the system category as specified in this specification.
- 8.1.2 Extend from the existing Fire alarm system to satisfy the area coverage, and operational and performance criteria as outlined elsewhere in this section. Ensure that the fire alarm system complies with the recommendations of BS 5839-1 as applicable to the system category as specified in this specification.
- 8.1.3 Reconfigure and add new detectors to suit the rearranged layout. The works include providing all wiring, containment, and any necessary components. Refer to the drawings for the exact arrangement.
- 8.1.4 Provide audible alarms and combined audible/visual alarms of the nature and type indicated, to achieve the required sound levels and intelligibility specified, and the remote information criteria, in compliance with all relevant British Standards.
- 8.1.5 Ensure all control and indicating equipment, standard power supply units and standard repeater units comply with the EMC requirements described in BS EN 54 part 2 and BS EN 54 part 4.
- 8.1.6 Retain existing fire alarm installation as per indicate on the drawings.
- 8.1.7 Reconnect any new fire alarm installation back to the existing fire alarm panels and provide reprogramming on the system for any modification.

8.2 Design parameters

8.2.1 System parameters

- 8.2.1.1 Provide a non-domestic system to the following BS 5839-1 category of protection:

System Category (L):	L2
System Category (P):	P2

- 8.2.1.2 Provide a system to the following arrangement:

Arrangement:	Addressable system (existing)
Approx. no. of devices (used):	nn / refer to layout drawings
No. of spare loop cards (for future use):	refer to existing installation
Spare capacity per loop:	refer to existing installation

8.2.2 Status of Tender drawings

- 8.2.2.1 The fire detection and alarm system schematic and layout drawings are indicative only.
- 8.2.2.2 The position of all detectors, call points, visual alarm devices, and sounders / beacons are shown on the drawings for tender purposes only. At an early stage in the contract, determine the exact

locations of all components on site and inform the Contract Administrator of any required position change(s) and obtain approval to such change(s) prior to installation.

8.3 System description

8.3.1 General

8.3.1.1 Arrange for the fire detection and alarm system to include the following items:

- Retain and reconnect to existing main control and indication panel(s) located at the ground floor entrance lobby
- Retain existing smoke detectors as indicated on the areas without changes on the ceiling, room arrangement
- Retain all existing manual call points
- Provide new wiring, containment and all necessary components for the refurbishment works.
- Extension and modification of the existing fire alarm circuits or loops to incorporate changes as indicated on the drawings.
- Discrete visual indications for all new key functions
- Alarm circuits connected to audible, visual or combined alarms
- Provision of new devices, interfaces, audio and visual alarm devices as indicated on the drawings.
- Update software system and programming as necessary

8.3.1.2 Ensure that call-points are of type A (direct operation) to comply with BS EN 54-11 and all other components are to the relevant part/s of BS EN 54.

8.3.1.3 Provide all central control and indication equipment, and, where specified, distributed and repeat indication facilities.

8.3.1.4 Provide voice alarms to BS 5839-8, alarm devices for hearing impaired to BS 5389-1 and visual alarm devices to BS EN 54-23.

8.3.1.5 Provide software system and programming, including security of stored information, and re-programming capability. Ensure that all devices use open-protocol communications unless an alternative is agreed and accepted by the Contract Administrator.

8.3.1.6 Provide all system components from a single manufacturer's standard product range. Ensure that all components of the fire detection and alarm system are compatible and connectable to BS EN 54-13, and fully capable of delivering the requirements of this specification.

8.3.1.7 Do not use any equipment or components identified as end-of-line or otherwise not expected to have manufacturer continuing support and spares availability.

8.3.1.8 Ensure that all requirements of the chosen manufacturer's equipment are included for in the tender. Provide all ancillary components and items such as separate power supplies for bells, interface units, zone isolators etc. Provide for the manner in which the system is to be wired, which varies from one manufacturer to another. Determine the requirement for additional items by reference to architectural, mechanical and electrical drawings.

8.3.1.9 Arrange that the fire detection and alarm system is not susceptible to nor causes electromagnetic interference. Install the fire detection and alarm system such that it complies with the Electromagnetic Compatibility Regulations.

8.3.1.10 Installer certification

8.3.1.11 Use a LPCB LPS 1014 (Requirements for certificated fire detection and alarm system firms) certificated firm for the installation and commissioning of the fire detection and alarm system specified herein. Ensure that the LPS 1014 certificated firm issues a signed LPS 1014 Certificate of Conformity in respect of the specified alarm system.

- 8.3.1.12 Use a BAFE scheme SP203-1 certificated firm for the installation, and commissioning of the fire detection and alarm system specified herein. Ensure that a BAFE certificated firm issues a signed BAFE SP203-1 Certificate of Compliance in respect of the specified alarm system.

8.3.2 System arrangement and detection

- 8.3.2.1 Ensure that all equipment connected to the fire detection and alarm system, either directly or via interfaces, is resistant to electrical noise and electromagnetic interference from other equipment.
- 8.3.2.2 Provide fire detection and alarm system of the following arrangement, or combination of arrangements.
- 8.3.2.3 **Addressable system**
- 8.3.2.4 Install and configure an addressable system in which all individual automatic detectors, manual call points, alarm devices and other field and interface devices have unique address identifications.
- 8.3.2.5 Use devices of the two-state type providing a 'fire' or 'normal' condition status.
- 8.3.2.6 Loop all detectors back to the existing main control and indicating panel. Ensure the control and indicating panel is microprocessor-based and pre-programmed with software that allows identification of both the condition and location of all devices in the system. Provide operating programs and configuration data capable of being updated.

8.3.3 Existing system

- 8.3.3.1 Provide extensions and enhancements to, and reconfiguration of, the existing fire detection and alarm system, ensuring that all components provided are fully compatible with the existing system's operation including software protocol.

8.4 Control requirements

8.4.1 System operation

- 8.4.1.1 Ensure that the fire detection and alarm systems can be used to:
- initiate shutting down ventilation systems
 - initiate operation of fire suppression and smoke control systems
 - release passive control measures such as automatic closing fire doors
 - interface with voice alarm system
 - interface with the access control system to release the door lock

8.4.2 Control interfaces

8.4.2.1 Fire protection system interfaces

- 8.4.2.2 Ensure that the fire detection and alarm system provides signals and interfaces with the operation of other fire protection systems and equipment including:
- BMS
 - ventilation plant
 - smoke fire curtains
 - security access control system
 - door release units
 - smoke ventilation system
 - aspirating smoke detection systems
 - sprinkler system
 - lighting control
 - lifts
 - other fire protection and fire suppression systems
 - voice alarm systems

- fire telephone systems / disabled refuge

8.4.2.3 **Auxiliary systems control and mounting**

- 8.4.2.4 Provide all necessary relay and termination facilities within the respective control and indication panels to achieve the requirements specified.
- 8.4.2.5 Ensure that the fire alarm system contains a sufficient number of volt-free contacts suitable for monitoring the fire protection interfaces listed in the Performance Objectives (clause 8.1) section above.
- 8.4.2.6 Provide five spare volt-free contact sets for future connection.
- 8.4.2.7 Arrange for the other systems to initiate the appropriate action in the event of fire or fault signals being initiated, as indicated by the cause and effect schedule.
- 8.4.2.8 Ensure that the volt-free contacts are capable of switching the current and voltage of the auxiliary systems input.
- 8.4.2.9 Wire all fire protection interfaces and BMS interfaces directly from the fire alarm panel, using cabling sized appropriately to the switching system operation requirements, and liaise fully with the specialist installers of those systems to effect satisfactory connections and operations.
- 8.4.2.10 Power all relays from the fire detection system supply.
- 8.4.2.11 Ensure that the interfaces with other systems do not prejudice the operation of the fire detection and alarm system at any time.
- 8.4.2.12 Ensure that routine testing of the fire detection and alarm system does not have any undesirable effect on other systems interfaced to it.
- 8.4.2.13 **Communication with fire service**
- 8.4.2.14 Provide all the necessary equipment for the connection of the fire detection system via monitored telephone line and other remote fire system monitoring technologies. Configure the equipment to transmit alarm signals automatically to the local authority fire service via a remote manned monitoring centre. Provide the option for dual signal transmission.
- 8.4.2.15 Include details of all necessary rental costs for this facility, together with details of the system and remote manned centre proposed.
- 8.4.2.16 Provide a visual indicator to confirm the activation of this facility.
- 8.4.2.17 Provide, install and commission all necessary interface/indication units required for transmitting and receiving alarm signals to remote situations such as the local fire brigade, remote indicator panels etc. (using British Telecom landlines or similar). Ensure that these components are compatible with the existing system(s) or private network equipment. Include all associated installation costs, charges, etc.

8.5 **System components**

8.5.1 **Wiring arrangement**

- 8.5.1.1 Provide the fire alarm system installation with a totally independent, separated, diverse and segregated wiring system in accordance with BS 5839-1 Paragraphs 24.2 and 26.2 and BS 7671. Ensure that the system uses the same cable type throughout, sourced from a single BASEC approved cable manufacturer. Ensure that the cable type is LPCB approved.
- 8.5.1.2 Connect all system equipment in circuit loop formation as indicated on the schematic drawing, in conjunction with the specialist fire alarm system manufacturer's recommendations.
- 8.5.1.3 Install sufficient short circuit isolation devices in each detector loop to ensure that a single fault does not disable more than 20 manual call points or sensors or one fire zone. Plan the installation of the detector cables accordingly.

- 8.5.1.4 Ensure that the maximum number of addresses allowed to be connected on each loop is not exceeded and allows a minimum of 30% spare capacity.
- 8.5.1.5 Ensure that the routes of each “leg” of each loop cable are segregated from each other, in order to reduce loss of the entire fire alarm loop in the event of short- or open-circuit or earth fault occurring, and that only one cable “leg” can be affected by a fault.
- 8.5.1.6 Do not use four-core loop cables.
- 8.5.1.7 Wire sounder circuits using the ‘A’ and ‘B’ circuit technique to provide two separate circuits for any particular area and allocate sounders to the ‘A’ and ‘B’ circuits as indicated on the drawings.

8.5.2 Cables

- 8.5.2.1 Ensure that ‘standard’ fire resisting cables meet the BS EN 50200 PH 30 classification and the 30 min survival time when tested in accordance with Annex E of BS EN 50200.
- 8.5.2.2 Ensure that ‘enhanced’ fire resisting cables meet the BS EN 50200 PH 120 classification and the 120 min survival time when tested in accordance with BS 8434-2.
- 8.5.2.3 Provide all fire detection, alarm and signalling cabling using fire resistant cabling with red outer sheath.
- 8.5.2.4 Ensure that all cable sizing is in accordance with the manufacturer’s recommendations subject to a minimum size of 1.5 mm² for detection / actuation circuits and 2.5 mm² for sounder circuits.
- 8.5.2.5 Install and terminate all cable in accordance with the manufacturer’s recommendations.
- 8.5.2.6 Provide all cabling for the complete system in 600 / 1000 V mineral insulated copper sheathed (MICS) type. Ensure that the MICS cable and terminations comply with BS EN 60702. Ensure that the MICS cable is of the ‘enhanced’ fire resisting level.
- 8.5.2.7 Adhere to the material standards set down in the product specification sections of this specification for the MICS wiring system.

8.5.3 Cable Installation

- 8.5.3.1 Ensure all new cables are mechanically protected to BS 5839.
- 8.5.3.2 Install the new cables to the FAS cable trays strictly in accordance with the manufacturer’s instructions and recommendations and terminate using proprietary Type A2 brass glands or zero halogen low smoke polymeric red coloured glands. Use only zero halogen low smoke coated copper ‘P’ clips coloured red for direct fixing of cables. Use only fire-resistant cable ties, eg stainless steel, for fastening to the underside of cable trays or similar structures where support is required.
- 8.5.3.3 Install the cabling fixed to walls and on dedicated cable tray systems, to allow a practical means for future re-wiring of the system. Ensure all cable support is non-combustible and capable of withstanding an exposure to temperature at least equal to that of the supported cable. Fix cable supports and terminate cables in accordance with the recommendations of the cable manufacturer and in accordance with BS 7671.
- 8.5.3.4 Clip single or twin runs of cable in ceiling voids direct to the structure only where cable tray is not present. Provide cable trays where two or more cables follow a common route. Fix cable tray spaced off soffit by suitable galvanized brackets.
- 8.5.3.5 Adhere to the installation standards set down in the product specification sections of this specification for the installation of the wiring system.
- 8.5.3.6 Earth all fire alarm system cabling in accordance with the requirements of BS 7671 and the recommendations of the manufacturer. Ensure that the electrical continuity of all electromagnetic screens is maintained throughout the system.

- 8.5.3.7 Install the wiring system concealed/flush other than in plant areas, including the final positioning and installation co-ordination of all system cabling and components together with the marking out of all associated builder's work.
- 8.5.3.8 Install all cables in a manner such that they are physically continuous throughout the length of each circuit other than where connection is made at the terminations of a system component. Do not use any other cable connections or joints.
- 8.5.3.9 In all areas except plant areas, provide the final connections to all the system components via suitable conduit boxes fixed flush with the underside of the ceiling or flush in the wall. In plant areas, use a surface mounted installation.
- 8.5.3.10 Provide all necessary cabling from the main fire alarm panels to the appropriate mechanical control panels, lift control panels, etc, and liaise fully with the installers of those systems to affect satisfactory connections and operation. Either wire these services directly from the fire alarm panels, or utilise the appropriate detector/alarm circuit loops, via suitable interface units, if required. Size cabling appropriate to the switching system's operation requirements.
- 8.5.3.11 Make good all penetrations through walls, floors, partitions or ceilings with fire-stopping material.

8.5.4 Control and Indicating Control Panel (analogue addressable / addressable)

8.5.4.1 General

- 8.5.4.2 Arrange the equipment mounting such that the enclosure can be fixed in position, and outgoing cables terminated, prior to the equipment being installed. Ensure the enclosure incorporates suitable internal cable management such that modular components can be easily replaced.
- 8.5.4.3 Arrange the internal layout to provide adequate free space for cable termination. Ensure access to all outgoing terminals is possible with the panel in an operational state. Provide access to terminals at the back of the enclosure by use of a hinged chassis, if necessary. Include a series of 20mm knockouts or gland plates at the top and bottom of the enclosure for the termination of cables.
- 8.5.4.4 Provide a updated zone plan, identifying the building fire alarm zones, at the main indicating panel and any repeat indicating panels. Mount the zone plan in a glass-fronted hardwood frame and fix adjacent to the panel.

8.5.4.5 Programming

- 8.5.4.6 Carry out the necessary re-programming and configuration of the system without reliance on the system manufacturer. Ensure that the operation of the test feature is indicated on the fire alarm panel. Arrange that test procedures do not release any access-controlled doors nor shut down any mechanical plant unless expressly instructed to do so as part of test.

8.5.4.7 Issue of information

- 8.5.4.8 Issue for comment, prior to programming, all necessary information, eg room names and numbers. Provide a full chart detailing the device numbers, types, loop connected, zone, address and position as part of the user's operating and maintenance instruction manual.

8.5.5 Field devices

8.5.5.1 General

- 8.5.5.2 Confirm all proposed device locations with the Contract Administrator and prepare installation drawings before commencing wiring or other equipment installation. Determine the full quantity of equipment, manual call-points, detectors, interface units, monitors, sounders etc, from layout drawings and specification requirements.
- 8.5.5.3 Keep detectors free of any contamination due to works taking place after installation and commissioning by bagging etc, and replace any detectors contaminated at no extra cost

- 8.5.5.4 Ensure that all field devices are labelled, in the field, with the device address, for easy identification. Ensure the field address is identical to that shown on the system drawings that form part of the completion documentation and is attached to the equipment so that if the device is removed for maintenance or replacement, the label is retained.
- 8.5.5.5 **Mounting heights**
- 8.5.5.6 Mount items of equipment at the following typical centre line heights above floor level (except where indicated otherwise on drawings):
- manual call-points – 1200 mm
 - sounders in offices and other low ceiling rooms – 200 mm below soffit level
 - main control and repeat indicator panels – 1500 mm
 - beam detectors – minimum 3750 mm above finished floor level and maximum 300 mm below soffit level
 - visual alarm devices – minimum 2100 mm.
- 8.5.5.7 Agree all fire alarm equipment heights with the Contract Administrator prior to commencing installation and subject to architects' drawings which may be issued post tender.
- 8.5.5.8 **Remote indicators**
- 8.5.5.9 Provide remote LED indicators to indicate the operation of automatic detectors that are mounted in locations where they cannot readily be seen (eg within all plant rooms, switchrooms, substations, lift motor rooms, ceiling voids, and ducts). Connect the remote LED indicator units to the respective detector back-plate terminals and install flush or surface to ceiling or wall boxes, as required.
- 8.5.5.10 Mount indicators above plant room entrance doors, wired to their associated detector. These indicators are not necessarily detailed on either layout drawings or system schematics. Clearly label all remote indicators.
- 8.5.5.11 **Detectors – general**
- 8.5.5.12 Provide automatic detectors of the type and in the locations as indicated on the drawings and in accordance with BS 5839-1. Ensure each detector is of the analogue type and capable of being individually addressed.
- 8.5.5.13 Ensure all voids greater than 800mm are provided with void detection, including but not limited to ceiling and floor voids, lift shafts, risers; in accordance with BS 5839-1
- 8.5.5.14 Agree the final location of detectors on site with the Contract Administrator and the specialist supplier.
- 8.5.5.15 Incorporate the following facilities in each detector:
- common mounting base for different types, allowing detector heads to be fully interchangeable
 - integral LED alarm indication of operation where directly visible, with remote indication where concealed, ie duct sensors, lift shafts etc, labelled suitably.
 - capability of automatic or manual disablement for maintenance purposes
 - appropriate indication on main control and repeat panel when the sensor is removed from its base
 - ensure removal of the detector head does not render any part of system inoperative.
- 8.5.5.16 Ensure all automatic detectors produce an analogue output that changes with smoke density or temperature, and that detectors change this to digital data for transmission to the processor.
- 8.5.5.17 Ensure all automatic detection devices are individually compensated, at the master control panel, for any degradation in performance due to ageing, dust accumulation, component characteristic change etc.
- 8.5.5.18 Ensure that detectors installed anywhere on any loop are capable of being assigned to any zone.
- 8.5.5.19 **Manual call points**

- 8.5.5.20 Provide manual call-points of the addressable type complying fully with BS EN 54-11, made of polycarbonate/moulded ABS material and finished in red. Ensure all manual call-points are of the same type. Install call-points complete with suitable inscription of operation and provided with suitable proprietary enclosures for surface or flush mounting within internal/external locations.
- 8.5.5.21 Incorporate the following facilities within each manual call-point:
- external test facility to operate contacts without opening manual call-point
 - an LED to indicate operation of manual call-point
 - transparent safety covers to ensure that they are not operated inadvertently.
- 8.5.5.22 **Optical smoke detectors**
- 8.5.5.23 Provide detectors of the obscuration or scatter light type, with sensitivity adjustment via the system control panel.
- 8.5.5.24 Ensure that point detectors comply with BS EN 54-7.
- 8.5.5.25 **Ionisation smoke detectors**
- 8.5.5.26 Provide detectors of the twin-chambered product-of-combustion ionisation type, with sensitivity adjustment via the system control panel.
- 8.5.5.27 Ensure that point detectors comply fully with the requirements of BS EN 54, parts 5 and 7, with regard to performance.
- 8.5.5.28 Ensure that the radioactive source employed has an emission rating of less than 40 kBq.
- 8.5.5.29 **Multi-sensor detectors**
- 8.5.5.30 Provide multi-sensor detectors, with sensitivity adjustment via the system control panel. Ensure that the sensor installed is a combination of the following technologies
1. Optical and heat sensors that comply with BS EN 54-29
 2. Carbon monoxide and heat sensors that comply with BS EN 54-30
 3. Optical, carbon monoxide and heat sensors that comply with BS EN 54-31
- 8.5.5.31 **Optical beam detectors**
- 8.5.5.32 Provide detectors of the infra-red obscuration type, with sensitivity adjustment via the system control panel. Use transmitting and receiving units specifically for operation on the detector loops.
- 8.5.5.33 Ensure that optical beam smoke detectors comply with BS EN 54-12.
- 8.5.5.34 Ensure that access to transmitter and receiver units facilitates maintenance, all as indicated on the drawings.
- 8.5.5.35 Allow for interfacing for connection onto the loop with appropriate interface units.
- 8.5.5.36 Ensure that each detector is addressable. Provide beam detectors with individual isolation at the panel to facilitate maintenance.
- 8.5.5.37 Ensure that transmitter and receiver units are carefully aligned and mounted to establish and maintain maximum beam signal strength.
- 8.5.5.38 Locate interface units discreetly, where appropriate.
- 8.5.5.39 **Fixed temperature/rate of rise type detectors**
- 8.5.5.40 Provide detectors of the electronic type and specifically for analogue operation, with sensitivity adjustment via the system control panel.

8.5.5.41 Ensure that heat detectors respond to either fixed temperature heat detection or fixed temperature heat detection combined with rate-of-rise of temperature. Do not use heat detectors that respond only to rate-of-rise of temperature.

8.5.5.42 Ensure that detectors comply with the sensitivity performance of BS EN 54-5.

8.5.5.43 Fusible link detectors

8.5.5.44 Short circuit (line) isolating modules

8.5.5.45 Provide short circuit isolating modules to BS EN 54-17 and install between zone boundaries.

8.5.5.46 Provide these as proprietary units, capable of isolating the relevant section of the wiring installation either under circuit fault conditions, or whilst alteration/extensions are affected, leaving the remainder of the system unaffected.

8.5.5.47 Interface units

8.5.5.48 Provide interface units of the addressable type connected to the local loop circuit and which provide the required inputs and outputs for control or indication functions.

8.5.5.49 Ensure each input/output way is fully programmable from the control panel and fully monitored for open- and short-circuit conditions.

8.5.6 Audible alarm devices

8.5.6.1 Ensure all audible fire alarm devices conform to BS EN 54-3 and have similar and distinctive sound characteristics. Provide sufficient fire alarm sounders to ensure that sound pressure levels throughout all accessible levels of the building are in accordance with the recommendations of BS 5839-1.

8.5.6.2 Ensure all audible alarm devices and flashing beacons are loop powered and addressable.

8.5.6.3 Electronic sounders

8.5.6.4 Provide sounders with an output frequency of 500 to 1000 Hz, providing a sound pressure level of not less than 104 dBA at 1 metre and having an adjustable volume control. Ensure that the number of sounders on any one circuit does not exceed the manufacturer's recommended maximum.

8.5.6.5 Provide sounders that are electronic two-tone and red coloured. Ensure that sounders are polarised and suppressed as standard. Supply units complete with a centre disc bearing the legend "Fire" in black.

8.5.6.6 Ensure that the number of sounders for circuit A or circuit B does not exceed the current rating of the sounder circuit and allows for 20% spare capacity.

8.5.6.7 Flashing beacons

8.5.6.8 Provide flashing beacons to operate at all times whilst sounder circuits are activated. Do not incorporate mute or isolation switches.

8.5.6.9 Ensure flashing beacon units are electronic Xenon / LED and sensor-base mounted, wall-mounted and where necessary combined with audible alarm devices.

8.5.7 Visual alarm devices

8.5.7.1 Ensure that visual alarm devices conform to BS EN 54-23 and only use in conjunction with audible alarms.

8.5.7.2 Install visual alarm devices in accordance with BS 5839-1 and following the recommendations of the VAD manufacturer on the correct mounting height and orientation of VADs to ensure correct light dispersal and coverage.

8.5.7.3 Comply with the recommendations of the Loss Prevention Council Code of Practice CoP 0001 Issue 1.0 'Code of Practice for visual alarm devices used for fire warning'.

8.5.7.4 Arrange that the visual alarm device flashes at a rate between 30-120 flashes per minute.

8.5.8 Other devices

8.6 Equipment

8.6.1 Power supplies – general

8.6.1.1 Provide separate power supplies to each item of equipment, as required, comprising a primary mains 230 V ac supply, and a secondary/back-up dc power supply unit, incorporating a battery charger, for the specified system operating voltage. Ensure that power supplies comply with BS 5839-1.

8.6.1.2 Provide power supplies for the following items:

- interface units
- other ancillary items requiring power
- all interfaced equipment drawing power from fire detection and alarm system

9. Schedule of installers submissions

9.1 General

9.1.1 For all systems, submit for the Contract Administrators comment:

- Installation and builder's work drawing production schedule.
- Installation drawings, including schematics, wiring diagrams, and details, for all systems to be provided under the contract.
- Associated builder's works drawings.
- Technical submissions encompassing full technical specifications, details, pictures and installation details for the proposed equipment and any software, including manufacturer's details.
- List of samples to be supplied, for agreement and indicated when and where each will be available for review. Samples of all equipment, fittings and devices to be supplied under the contract and as agreed.
- All documentation necessary to comply with the requirements of The Electromagnetic Compatibility Regulations.
- Testing, commissioning and completion documentation.
- Details of instruction and training programme for the employer's staff in accordance with specification section A37.
- Installation and commissioning programme
- Installation method statements and proposals for the supply and installation of all equipment
- Record drawings and record BIM model compliant with BIM level 2.
- Schedule of recommended spares, consumables and special tools and as specified by specification A37. Documents and drawings as otherwise required by the specification.

9.1.2 For the systems listed, submit the following for the Contractor Administrator's comment:

9.2 Low voltage distribution system

9.2.1 At tender submission stage, provide details of the physical dimensions, weights and lifting instructions of all major LV systems components (eg main switchboard whole or split in sections) to the Structural Engineer.

9.2.2 For all LV assemblies provide details of BS EN 61439 verification documentation when panel assembly drawings are submitted for comment.

9.2.3 Provide copies of letters of conformity and test certificates for all equipment supplied as part of the LV distribution system.

9.2.4 Submit the following for the Contract Administrator's comment:

- Cable and containment support system sizing calculations (additionally and specifically refer to BS 8519 annex E where appropriate)
- A copy of the completed supply application forms
- Method statements
- Technical specifications for the proposed equipment, including manufacturer's details of main switchboard, meters, power factor correction equipment, etc
- Schematic drawings
- Wiring diagrams
- Graphical diagrams
- Equipment samples
- Test and commissioning certificates
- Drawing production schedule and drawings of cable basket, ladder, tray, trunking, etc. Systems in accordance with performance specification section a11 schedule of torque settings
- Control fuse schedule
- Spares schedule of recommended consumables
- Copies of record drawings

9.3 Lighting

9.3.1 Submittals during contract

- selected manufacturer's proposals
- manufacturer's technical submissions and proposals for the supply and installation of all items of equipment and associated components
- lighting system samples
- lighting input data and calculation output sheets by using the simulation software, such as Relux or Dialux
- manufacturer's design and installation drawings
- installation and commissioning programme
- installation method statements
- inspection details and certificates
- operating and maintenance manuals for all items of installed components and equipment
- record drawings
- completion certificate(s)
- test and commissioning certificates
- manufacturer's test certificates to verify compliance with Category TP(a) for luminaires specified with thermoplastic diffusers

9.3.2 Emergency lighting

9.3.2.1 Tests

9.3.2.2 Fully test and commission the complete system at Practical Completion and provide all test results and printouts for inclusion in operating and maintenance instruction manuals.

9.3.2.3 Carry out testing including operational and system duration tests.

9.3.2.4 Operate the test functions for the emergency lighting and verify satisfactory operation of the test facility and of the emergency lighting.

9.3.2.5 At such positions and quantum as agreed with the engineer, take suitable measurements of the illuminance level at the initiation of the changeover to emergency lighting and at the end of the rated duration of the system. Record these measurements accurately upon record drawings and present to the Contract Administrator for comment.

9.3.2.6 Verify that all batteries are in a condition of charging prior to and after duration tests. Prior to duration tests, ensure the batteries are fully charged.

9.3.2.7 **Documentation**

9.3.2.8 Complete and provide the installation and verification declarations, system certification and logbook to the Contract Administrator and include copies in the operating and maintenance instruction manuals.

9.3.2.9 Comply fully with the requirements of BS 5266-1 and annexes in respect of ensuring sufficient information is provided upon the testing, commissioning and completion certificates.

9.3.2.10 Ensure the emergency lighting system logbook is compliant with BS 5266-1, BS 5266-8 and annexes thereof.

9.4 Containment system

- Cable and containment support system sizing calculations (additionally and specifically refer to BS 8519 annex E where appropriate)

9.5 Security system

- a copy of the Security System Installer's NSI Gold registration certificate
- technical details of all proposed equipment, devices and software
- detailed schematic drawings of the proposed installation
- full working drawings of all cable and containment routes coordinated with all the other trade packages
- a certificate of compliance for each system that all tests have been completed successfully and that all results comply with the specifications
- full test results
- detailed record drawings / BIM model indicating the final system as installed
- as installed BIM COBie data
- explicit manufacturer's warranties for all equipment
- all software media and relevant software licences
- complete operating and maintenance documentation

9.6 Fire alarm system

9.6.1 Prepare all installation and record drawings, supply proper operating and maintenance instructions, and provide adequate demonstration to and training of the Client's representatives, for the system in accordance with the standards listed in the relevant A and B sections of this specification.

9.6.2 Provide operating and maintenance instructions for all items of equipment including:

- detection devices
- manual alarm devices
- alarm devices
- system testing

9.6.3 Issue the following:

- details of proposed field device locations
- cause and effect diagram or schedule
- Zone diagram

9.6.4 Issue a signed copy of the BS 5839: Installation Certificate / LPS 1014 certificate / SP203-1 certificate immediately on completion of the installation.

- 9.6.5 Issue a commissioning certificate within seven days of completion of commissioning, and ensure that the certificate clearly indicates any requirement for a period of soak testing.

10. Operating and maintenance manuals

- 10.1 In addition to the general requirements in section A37 of this specification, provide the following:

10.2 Low voltage distribution system

- 10.2.1 Submit operating and maintenance instructions manuals for:
- distribution system
 - meters
 - testing and commissioning certificates
 - terminal imaging results
 - inspection details
- 10.2.2 Provide copies of letters of conformity and test certificates for all equipment supplied as part of the LV distribution system.

10.3 Fire alarm system

- 10.3.1 Provide operating and maintenance instructions for all items of equipment if necessary, including:
- control panels
 - monitoring devices
 - autodiallers and modems
 - detection devices
 - manual alarm devices
 - alarm devices
 - amplifiers
 - backup systems
 - fault monitoring systems
 - loudspeakers
 - microphones
 - disc/tape players
 - recording equipment
 - digital message store
 - system software
 - system testing

11. Division of responsibilities

- 11.1 Achieve proper control and function of systems, equipment and components.
- 11.2 Coordinate with other installers to ensure correct provision and inter-operability with other systems. Where required for the operation of the specified systems and in addition to the provisions set out in the service specific specification sections:
- 11.3 Validate all the existing electrical installations that are intended to be retained.
- 11.4 Omit the highlighted existing electrical installations as indicated on the strip-out drawings.
- 11.5 Replace any damaged electrical installations if they are intended to be retained but are considered no longer functional after validation.
- 11.6 The electrical installer shall provide the supply, install and commissioning,

- power supplies as required, for each and every item of equipment, including those items installed by other trades
 - all primary containment
 - all earthing and bonding
- 11.7 The lighting installer shall provide the supply, install and commission a lighting system comprising,
 - final circuits distribution,
 - control devices and equipment,
 - Luminaires and optical accessories as per the schedule of luminaires,
 - complete with lamps,
 - wire and connect all luminaires to final radial circuits emanating from local distribution boards in accordance with the lighting circuit references detailed within the schedules and indicated on the drawings,, throughout all areas and locations of the building(s).
- 11.8 The IT installer shall provide and install,
 - data outlets
 - network cabinets
 - cabling
 - cable containments
 - patching
- 11.9 The IT department of University of Manchester shall provide and install,
 - network switches
 - other network switches
- 11.10 The fire detection and alarm installer shall be responsible for the supply, installation and commissioning of the fire alarm system modifications. This includes all builders' work, making good, fire-stopping, fixings, etc, to make a complete system.
- 11.11 The security installer shall provide the supply, install and commissioning,
 - New surveillance system, with all necessary components, including CCTV recorders, monitors and PCs
 - All necessary components for extending the existing access control system

12. Appendix A – Reference documents

12.1 General

- 12.1.1 This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.
- 12.1.2 Comply fully with the edition (including amendments, replacements and associated normative references) of each of the documents listed below, current at the time of tender.
- 12.1.3 Where a standard referred to in this section conflicts with a standard referred to in the associated 'products' section of this specification, the standard referred to in this 'system' specification section takes precedence.

12.2 Legislation.

Health and Safety (Display Screen Equipment) Regulations
The Building Regulations
The Construction (Design and Management) Regulations
The Construction (Design and Management) Regulations
The Dangerous Substances and Explosive Atmospheres Regulations
General Data Protection Regulations, the Data Protection Act 1998, and any replacement legislation.
The Disability Discrimination Act
The Electrical Equipment (Safety) Regulations
The Electricity Act (As amended by the Utilities Act)
The Electricity at Work Regulations
The Electricity Safety, Quality and Continuity Regulations
The Electromagnetic Compatibility Regulations
The Equality Act
The Equipment and Protective Systems Intended for use in Potentially Explosive Atmospheres Regulations
The Fire Safety and Safety of Places of Sport Act (As amended)
The Health and Safety (Safety Signs and Signals) Regulations
The Health and Safety at Work etc. Act
The Meters (Certification) Regulations
The Offices, Shops and Railway Premises Act
The Supply of Machinery (Safety) Regulations
The Smoke and Carbon Monoxide Alarm (England) Regulations
The Telecommunications Act
Local Authority Acts and Bylaws
Local Authority Standing Orders and Bylaws
Relevant Office of Communications (Ofcom) Regulations
Directive of the European Council - Low Voltage Directive 73/23/EEC and amendment (93/68/EEC)

12.3 Standards

BS 67	Specification for ceiling roses
BS 476-20	Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction (general principles)
BS 764	Specification for automatic change-over contactors for emergency lighting systems
BS 951	Electrical earthing. Clamps for earthing and bonding. Specification
BS 1363-1	13 A plugs, socket-outlets, adaptors and connection units. Specification for rewirable and non-rewirable 13 A fused plugs

BS 1363-2	13 A plugs, socket-outlets, adaptors and connection units. Specification for 13 A switched and unswitched socket-outlets
BS 1363-4	13 A plugs, socket-outlets, adaptors and connection units. Specification for 13 A fused connection units switched and unswitched
BS 1853-2	Tubular fluorescent lamps for general lighting service. Specification for lamps used in the United Kingdom not included in BS EN 60081, BS EN 60901, BS EN 61195 and BS EN 61199
BS 1710	Specification for identification of pipelines and services
BS 4533-102.19	Luminaires. Particular requirements. Specification for air-handling luminaires (safety requirements)
BS 5266-1	Emergency lighting. Code of practice for the emergency lighting of premises
BS 5424-3	Specification for controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c. Additional requirements for contactors subject to certification
BS 5446-2	Fire detection and fire alarm devices for dwellings. Specification for heat alarms
BS 5446-3	Detection and alarm devices for dwellings. Specification for fire alarm and carbon monoxide alarm systems for deaf and hard of hearing people
BS 5467	Electric cables. Thermosetting insulated, armoured cables of rated voltages of 600/1 000 V and 1 900/3 300 V for fixed installations. Specification
BS 5489-1	Design of road lighting. Lighting of roads and public amenity areas. Code of practice
BS 5499-4	Safety signs. Code of practice for escape route signing
BS 5724-2.15	Medical electrical equipment. Particular requirements for safety. Specification for capacitor discharge X-ray generators
BS 5724-3.12	Medical electrical equipment. Particular requirements for performance. Method of declaring parameters for lung ventilators
BS 5724-3.26	Medical electrical equipment. Particular requirements for performance. Method for declaring parameters for ultrasonic diagnostic equipment using test objects
BS 5724-3.129	Medical electrical equipment. Particular requirements for performance. Methods of declaring functional performance characteristics of radiotherapy simulators. Guide to functional performance values
BS 5733	General requirements for electrical accessories. Specification
BS 5839-1	Fire detection and fire alarm systems for buildings. Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises
BS 5839-3	Fire detection and alarm systems for buildings. Specification for automatic release mechanisms for certain fire protection equipment
BS 5839-6	Fire detection and fire alarm systems for buildings. Code of practice for the design, installation, commissioning and maintenance of fire detection and fire alarm systems in domestic premises. Part 6: Code of practice for the

	design, installation, commissioning and maintenance of fire detection and fire alarm systems in domestic buildings
BS 5839-8	Fire detection and fire alarm systems for buildings. Code of practice for the design, installation, commissioning and maintenance of voice alarm systems
BS 5839-9	Fire detection and fire alarm systems for buildings. Code of practice for the design, installation, commissioning and maintenance of emergency voice communication systems
BS 6004	Electric cables. PVC insulated and PVC sheathed cables for voltages up to and including 300/500 V, for electric power and lighting
BS 6231	Electric cables. Single core PVC insulated flexible cables of rated voltage 600/1000 V for switchgear and controlgear wiring
BS 6266	Fire protection for electronic equipment installations. Code of practice
BS 6290-2	Lead-acid stationary cells and batteries. Specification for the high-performance Plante positive type
BS 6290-3	Lead-acid stationary cells and batteries. Specification for the flat positive plate type
BS 6387	Test method for resistance to fire of cables required to maintain circuit integrity under fire conditions
BS 6396	Electrical systems in office furniture and educational furniture. Specification
BS 6513	Wideband cabled distribution systems
BS 6701	Telecommunications equipment and telecommunications cabling. Specification for installation, operation and maintenance. Specification for installation, operation and maintenance
BS 6724	Electric cables. Thermosetting insulated, armoured cables of rated voltages of 600/1 000 V and 1 900/3 300 V for fixed installations, having low emission of smoke and corrosive gases when affected by fire. Specification
BS 6972	Specification for general requirements for luminaire supporting couplers for domestic, light industrial and commercial use
BS 7211	Electric cables. Thermosetting insulated and thermoplastic sheathed cables for voltages up to and including 450/750 V for electric power and lighting and having low emission of smoke and corrosive gases when affected by fire
BS 7273-1	Code of practice for the operation of fire protection measures. Electrical actuation of gaseous total flooding extinguishing systems
BS 7273-3	Code of practice for the operation of fire protection measures. Electrical actuation of pre-action watermist and sprinkler systems
BS 7273-4	Code of practice for the operation of fire protection measures. Part 4: Actuation of release mechanisms for doors. Part 4: Actuation of release mechanisms for doors
BS 7273-5	Code of practice for the operation of fire protection measures. Electrical actuation of watermist systems (except pre-action systems)
BS 7346-4	Components for smoke and heat control systems. Functional recommendations and calculation methods for smoke and heat exhaust ventilation systems, employing steady-state design fires. Code of practice

BS 7346-5	Components for smoke and heat control systems. Functional recommendations and calculation methods for smoke and heat exhaust ventilation systems, employing time-dependent design fires. Code of practice
BS 7346-7	Components for smoke and heat control systems. Code of practice on functional recommendations and calculation methods for smoke and heat control systems for covered car parks
BS 7346-8	Components for smoke control systems. Code of practice for planning, design, installation, commissioning and maintenance
BS 7430	Code of practice for protective earthing of electrical installations
BS 7629-1	Electric cables. Specification for 300/500 V fire resistant, screened, fixed installation cables having low emission of smoke and corrosive gases when affected by fire. Multicore cables
BS 7657	Specification for cut-out assemblies up to 100 A rating, for power supply to buildings
BS 7671	Requirements for Electrical Installations. IET Wiring Regulations
BS 7846	Electric cables. Thermosetting insulated, armoured, fire-resistant cables of rated voltage 600/1 000 V for fixed installations, having low emission of smoke and corrosive gases when affected by fire. Specification
BS 7895	Specification for bayonet lampholders with enhanced safety
BS 8431	Electrical static meters for secondary metering and sub-metering. Specification
BS 8434-2	Methods of test for assessment of the fire integrity of electric cables. Test for unprotected small cables for use in emergency circuits. BS EN 50200 with a 930° flame and with water spray
BS 8492	Telecommunications equipment and telecommunications cabling. Code of practice for fire performance and protection. Code of practice for fire performance and protection
BS 8519	Selection and installation of fire-resistant power and control cable systems for life safety, fire-fighting and other critical applications. Code of practice
BS 8592	Electric cables. Thermosetting insulated, non-armoured, fire-resistant, single core non-sheathed cables of rated voltage 450/750 V, having low emission of smoke and corrosive gases when affected by fire. Specification
BS 9991	Fire safety in the design, management and use of residential buildings. Code of practice
BS 9999	Fire safety in the design, management and use of buildings. Code of practice
BS EN 54-1	Fire detection and fire alarm systems. Introduction
BS EN 54-2	Fire detection and fire alarm systems. Control and indicating equipment
BS EN 54-3	Fire detection and fire alarm systems. Fire alarm devices. Sounders
BS EN 54-4	Fire detection and fire alarm systems. Power supply equipment
BS EN 54-5	Fire detection and fire alarm systems. Heat detectors. Point heat detectors

BS EN 54-7	Fire detection and fire alarm systems. Smoke detectors. Point smoke detectors that operate using scattered light, transmitted light or ionization
BS EN 54-10	Fire detection and fire alarm systems. Flame detectors. Point detectors
BS EN 54-11	Fire detection and fire alarm systems. Manual call points
BS EN 54-12	Fire detection and fire alarm systems. Smoke detectors. Line detectors using an optical beam
BS EN 54-13	Fire detection and fire alarm systems. Compatibility and connectability assessment of system components
BS EN 54-16	Fire detection and fire alarm systems. Voice alarm control and indicating equipment
BS EN 54-17	Fire detection and fire alarm systems. Short-circuit isolators
BS EN 54-18	Fire detection and fire alarm systems. Input/output devices
BS EN 54-20	Fire detection and fire alarm systems. Aspirating smoke detectors
BS EN 54-21	Fire detection and fire alarm systems. Alarm transmission and fault warning routing equipment
BS EN 54-23	Fire detection and fire alarm systems. Fire alarm devices. Visual alarm devices
BS EN 54-24	Fire detection and fire alarm systems. Components of voice alarm systems. Loudspeakers
BS EN 54-25	Fire detection and fire alarm systems. Components using radio links
BS EN 81-71	Safety rules for the construction and installation of lifts. Particular applications to passenger lifts and goods passenger lifts. Vandal resistant lifts
BS EN 179	Building hardware. Emergency exit devices operated by a lever handle or push pad, for use on escape routes. Requirements and test methods
BS EN 1125	Building hardware. Panic exit devices operated by a horizontal bar, for use on escape routes. Requirements and test methods
BS EN 1127-1	Explosive atmospheres. Explosion prevention and protection. Basic concepts and methodology
BS EN 1838	Lighting applications. Emergency lighting
BS EN 12193	Light and lighting. Sports lighting
BS EN 12464-1	Light and lighting. Lighting of workplaces. Indoor workplaces
BS EN 12464-2	Light and lighting. Lighting of workplaces. Outdoor workplaces
BS EN 13032-1	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Measurement and file format
BS EN 13032-2	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Presentation of data for indoor and outdoor workplaces
BS EN 13032-3	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Presentation of data for emergency lighting of workplaces

BS EN 13032-4	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. LED lamps, modules and luminaires
BS EN 13501-6	Fire classification of construction products and building elements. Classification using data from reaction to fire tests on power, control and communication cables
BS EN 14604	Smoke alarm devices
BS EN 50107-3	Product standard covering luminous signs with discharge lamps and/or LED (light emitting diodes) and/or EL (electroluminescent) lightsources with a nominal voltage not exceeding 1000 V, with the exclusion of general lighting, traffic- or emergency related purpose
BS EN 50131-1	Alarm systems. Intrusion and hold-up systems. System requirements
BS EN 50131-3	Alarm systems. Intrusion and hold-up systems. Control and indicating equipment
BS EN 50131-6	Alarm systems. Intrusion and hold-up systems. Power supplies
BS EN 50171	Central safety power supply systems
BS EN 50172	Emergency escape lighting systems
BS EN 50173-1	Information technology. Generic cabling systems. General requirements
BS EN 50173-2	Information technology. Generic cabling systems. Office spaces
BS EN 50173-3	Information technology. Generic cabling systems. Industrial spaces
BS EN 50173-4	Information technology. Generic cabling systems. Homes
BS EN 50173-5	Information technology. Generic cabling systems. Data centre spaces
BS EN 50173-6	Information technology. Generic cabling systems. Distributed building services
BS EN 50174-1	Information technology. Cabling installation. Installation specification and quality assurance
BS EN 50174-2	Information technology. Cabling installation. Installation planning and practices inside buildings
BS EN 50174-3	Information technology. Cabling installation. Installation planning and practices outside buildings
BS EN 50200	Method of test for resistance to fire of unprotected small cables for use in emergency circuits
BS EN 50310	Telecommunications bonding networks for buildings and other structures
BS EN 50346	Information technology. Cabling installation. Testing of installed cabling
BS EN 50525-1	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). General requirements
BS EN 50525-2-11	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750V (U0/U). Cables for general applications. Flexible cables with thermoplastic PVC insulation
BS EN 50525-2-12	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Cables for general applications. Cables with thermoplastic PVC insulation for extensible leads

BS EN 50525-2-21	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Cables for general applications. Flexible cables with crosslinked elastomeric insulation
BS EN 50525-2-31	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Cables for general applications. Single core non-sheathed cables with thermoplastic PVC insulation
BS EN 50525-2-41	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Cables for general applications. Single core cables with crosslinked silicone rubber insulation
BS EN 50525-2-42	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Cables for general applications. Single core non-sheathed cables with crosslinked EVA insulation
BS EN 50525-2-81	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Cables for general applications. Cables with crosslinked elastomeric covering for arc welding
BS EN 50525-3-41	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Cables with special fire performance. Single core non-sheathed cables with halogen-free crosslinked insulation, and low emission of smoke
BS EN 50565-1	Electric cables. Guide to use for cables with a rated voltage not exceeding 450/750 V (U0/U). General guidance
BS EN 50565-2	Electric cables. Guide to use for cables with a rated voltage not exceeding 450/750 V (U0/U). Specific guidance related to EN 50525 cable types
BS EN 50575	Power, control and communication cables. Cables for general applications in construction works subject to reaction to fire requirements
BS EN 50849	Sound systems for emergency purposes
BS EN 60051-1	Direct acting indicating analogue electrical measuring instruments and their accessories. Definitions and general requirements common to all parts
BS EN 60061-1	Lamp caps and holders together with gauges for the control of interchangeability and safety. Lamps caps
BS EN 60061-2	Lamp caps and holders together with gauges for the control of interchangeability and safety. Lampholders
BS EN 60061-3	Lamp caps and holders together with gauges for the control of interchangeability and safety. Gauges
BS EN 60061-4	Lamp caps and holders together with gauges for the control of interchangeability and safety. Guidelines and general information
BS EN 60079-14	Explosive atmospheres. Electrical installations design, selection and erection
BS EN 60079-17	Explosive atmospheres. Electrical installations inspection and maintenance
BS EN 60079-25	Explosive atmospheres. Intrinsically safe electrical systems
BS EN 60079-26	Explosive atmospheres. Equipment with Equipment Protection Level (EPL) Ga
BS EN 60269-1	Low-voltage fuses. General requirements

BS EN 60269-4	Low-voltage fuses. Supplementary requirements for fuse-links for the protection of semiconductor devices
BS EN 60309-1	Plugs, socket-outlets and couplers for industrial purposes. General requirements
BS EN 60309-2	Plugs, socket-outlets and couplers for industrial purposes. Dimensional interchangeability requirements for pin and contact-tube accessories
BS EN 60335-1	Household and similar electrical appliances. Safety. General requirements
BS EN 60529	Degrees of protection provided by enclosures (IP Code)
BS EN 60570	Electrical supply track systems for luminaires
BS EN 60598-2-22	Luminaires. Particular requirements. Luminaires for emergency lighting
BS EN 60601-1	Medical electrical equipment. General requirements for basic safety and essential performance
BS EN 60601-1-8	Medical electrical equipment. General requirements for basic safety and essential performance. Collateral Standard: General requirements, tests and guidance for alarm systems in medical electrical equipment and medical electrical systems
BS EN 60601-1-11	Medical electrical equipment. General requirements for basic safety and essential performance. Collateral Standard: Requirements for medical electrical equipment and medical electrical systems used in the home healthcare environment
BS EN 60601-2-4	Medical electrical equipment. Particular requirements for the basic safety and essential performance of cardiac defibrillators
BS EN 60601-2-5	Medical electrical equipment. Particular requirements for the basic safety and essential performance of ultrasonic physiotherapy equipment
BS EN 60601-2-6	Medical electrical equipment. Particular requirements for the basic safety and essential performance of microwave therapy equipment
BS EN 60601-2-8	Medical electrical equipment. Particular requirements for the basic safety and essential performance of therapeutic X-ray equipment operating in the range 10 kV to 1 MV
BS EN 60601-2-9	Medical electrical equipment. Particular requirements for safety. Specification for patient contact dosimeters used in radiotherapy with electrically connected radiation detectors
BS EN 60601-2-11	Medical electrical equipment. Particular requirements for the basic safety and essential performance of gamma beam therapy equipment
BS EN 60601-2-65	Medical electrical equipment. Particular requirements for the basic safety and essential performance of dental intra-oral X-ray equipment
BS EN 60622	Secondary cells and batteries containing alkaline or other non-acid electrolytes. Sealed nickel-cadmium prismatic rechargeable single cells
BS EN 60630	Maximum lamp outliners for incandescent lamps
BS EN 60702-1	Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V. Cables
BS EN 60702-2	Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V. Terminations

BS EN 60730-2-3	Automatic electrical controls for household and similar use. Particular requirements for thermal protectors for ballasts for tubular fluorescent lamps
BS EN 60754-1	Test on gases evolved during combustion of materials from cables. Determination of the halogen acid gas content
BS EN 60793-1-1	Optical fibres. Measurement methods and test procedures. General and guidance
BS EN 60794-1-1	Optical fibre cables. Generic specification. General
BS EN 60825-2	Safety of laser products. Safety of optical fibre communication systems (OFCS)
BS EN 60838-1	Miscellaneous lampholders. General requirements and tests
BS EN 60838-2-1	Miscellaneous lampholders. Particular requirements. Lampholders S14
BS EN 60838-2-2	Miscellaneous lampholders. Particular requirements. Connectors for LED-modules
BS EN 60838-2-3	Miscellaneous lampholders. Particular requirements. Lampholders for double-capped linear LED lamps
BS EN 60839-11-1	Alarm and electronic security systems. Electronic access control systems. System and components requirements
BS EN 60839-11-2	Alarm and electronic security systems. Electronic access control systems. Application guidelines
BS EN 60896-11	Stationary lead-acid batteries. General requirements and methods of test. Vented types. General requirements and methods of tests
BS EN 60896-21	Stationary lead-acid batteries. Valve regulated types. Methods of test
BS EN 60896-22	Stationary lead-acid batteries. Valve regulated types. Requirements
BS EN 60898-1	Electrical accessories. Circuit-breakers for overcurrent protection for household and similar installations. Circuit-breakers for a.c. operation
BS EN 60898-2	Electrical accessories. Circuit-breakers for overcurrent protection for household and similar installations. Circuit-breakers for a.c. and d.c. operation
BS EN 60909	Short-circuit currents in three-phase a.c. systems. Calculation of currents
BS EN 60927	Auxiliaries for lamps. Starting devices (other than glow starters). Performance requirements
BS EN 60947-2	Low-voltage switchgear and controlgear. Circuit-breakers
BS EN 60947-4-3	Low-voltage switchgear and controlgear. Contactors and motor-starters. AC semiconductor controllers and contactors for non-motor loads
BS EN 60947-6-1	Low-voltage switchgear and controlgear. Multiple function equipment. Transfer switching equipment
BS EN 60969	Self-ballasted lamps for general lighting services. Performance requirements
BS EN 61000-4-5	Electromagnetic compatibility (EMC). - Part 4-5: Testing and measurement techniques - Surge immunity test

BS EN 61047	D.C. or A.C. supplied electronic step-down convertors for filament lamps. Performance requirements
BS EN 61111	Live working. Electrical insulating matting
BS EN 61180	High-voltage test techniques for low-voltage equipment. Definitions, test and procedure requirements, test equipment
BS EN 61184	Bayonet lampholders
BS EN 61340-5-1	Electrostatics. Protection of electronic devices from electrostatic phenomena. General requirements
BS EN 61347-2-13	Lamp controlgear. Particular requirements for d.c. or a.c. supplied electronic controlgear for LED modules
BS EN 61386-1	Conduit systems for cable management. General requirements
BS EN 61386-24	Conduit systems for cable management. Particular requirements. Conduit systems buried underground
BS EN 61386-25	Conduit systems for cable management. Particular requirements. Conduit fixing devices
BS EN 61439-3	Low-voltage switchgear and controlgear assemblies. Distribution boards intended to be operated by ordinary persons (DBO)
BS EN 61439-6	Low-voltage switchgear and controlgear assemblies. Busbar trunking systems (busways)
BS EN 61547	Equipment for general lighting purposes. EMC immunity requirements
BS EN 61557-4	Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. Equipment for testing, measuring or monitoring of protective measures. Resistance of earth connection and equipotential bonding
BS EN 61558-2-1	Safety of power transformers, power supplies, reactors and similar products. Particular requirements and tests for separating transformers and power supplies incorporating separating transformers for general applications
BS EN 61558-2-2	Safety of power transformers, power supplies, reactors and similar products. Particular requirements and tests for control transformers and power supplies incorporating control transformers
BS EN 61558-2-4	Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100 V. Particular requirements and tests for isolating transformers and power supply units incorporating isolating transformers
BS EN 61558-2-5	Safety of transformers, reactors, power supply units and combinations thereof. Particular requirements and tests for transformer for shavers, power supply units for shavers and shaver supply units
BS EN 61558-2-6	Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100 V. Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers
BS EN 61558-2-16	Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V. Particular requirements and tests for

	switch mode power supply units and transformers for switch mode power supply units
BS EN 61643-11	Low-voltage surge protective devices. Surge protective devices connected to low-voltage power systems. Requirements and test methods
BS EN 61643-21	Low voltage surge protective devices. Surge protective devices connected to telecommunications and signalling networks. Performance requirements and testing methods
BS EN 61951-1	Secondary cells and batteries containing alkaline or other non-acid electrolytes. Secondary sealed cells and batteries for portable applications. Nickel-Cadmium
BS EN 61951-2	Secondary cells and batteries containing alkaline or other non acid electrolytes. Secondary sealed cells and batteries for portable applications. Nickel-metal hydride
BS EN 62034	Automatic test systems for battery powered emergency escape lighting
BS EN 62040-4	Uninterruptible power systems (UPS). Environmental aspects. Requirements and reporting
BS EN 62040-5-3	Uninterruptible power systems (UPS). DC output UPS. Performance and test requirements
BS EN 62196-2	Plugs, socket-outlets, vehicle connectors and vehicle inlets. Conductive charging of electric vehicles. Dimensional compatibility and interchangeability requirements for a.c. pin and contact-tube accessories
BS EN 62208	Empty enclosures for low-voltage switchgear and controlgear assemblies. General requirements
BS EN 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
BS EN 62305-1	Protection against lightning. General principles
BS EN 62305-2	Protection against lightning. Risk management
BS EN 62305-3	Protection against lightning. Physical damage to structures and life hazard
BS EN 62305-4	Protection against lightning. Electrical and electronic systems within structures
BS EN 62386-202	Digital addressable lighting interface. Particular requirements for control gear. Self-contained emergency lighting (device type 1)
BS EN 62471	Photobiological safety of lamps and lamp systems
BS EN 62504	General lighting. Light emitting diode (LED) products and related equipment. Terms and definitions
BS EN 62560	Self-ballasted LED-lamps for general lighting services by voltage > 50 V. Safety specifications
BS EN 62561-1	Lightning protection system components (LPSC). Requirements for connection components
BS EN 62561-4	Lightning protection system components (LPSC). Requirements for conductor fasteners
BS EN 62561-5	Lightning protection system components (LPSC). Requirements for earth electrode inspection housings and earth electrode seals

BS EN 62612	Self-ballasted LED lamps for general lighting services with supply voltages > 50 V. Performance requirements
BS EN 62676-1-1	Video surveillance systems for use in security applications. System requirements. General
BS EN 62676-3	Video surveillance systems for use in security applications. Analog and digital video interfaces
BS EN 62676-4	Video surveillance systems for use in security applications. Application guidelines
BS EN 62707-1	LED-binning. General requirements and white colour grid intended for automotive applications
BS EN 62717	LED modules for general lighting. Performance requirements
BS EN 62722-2-1	Luminaire performance. Particular requirements for LED luminaires
BS EN 62733	Programmable components in electronic lamp controlgear. General and safety requirements
BS EN 62776	Double-capped LED lamps designed to retrofit linear fluorescent lamps. Safety specifications
BS EN 62931	GX16t-5 capped tubular LED lamp. Safety specifications
BS EN 62949	Particular safety requirements for equipment to be connected to information and communication technology networks
BS EN IEC 55014-1	Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus. Part 1: Emission
BS EN IEC 55014-2	Electromagnetic compatibility. Requirements for household appliances, electric tools and similar apparatus. Immunity. Product family standard
BS EN IEC 55015	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
BS EN IEC 60051-2	Direct acting indicating analogue electrical measuring instruments and their accessories. Special requirements for ammeters and voltmeters
BS EN IEC 60051-3	Direct acting indicating analogue electrical measuring instruments and their accessories. Special requirements for wattmeters and varmeters
BS EN IEC 60051-4	Direct acting indicating analogue electrical measuring instruments and their accessories title. Special requirements for frequency meters
BS EN IEC 60051-5	Direct acting indicating analogue electrical measuring instruments and their accessories. Special requirements for phase meters, power factor meters and synchroscopes
BS EN IEC 60051-6	Direct acting indicating analogue electrical measuring instruments and their accessories. Special requirements for ohmmeters (impedance meters) and conductance meters
BS EN IEC 60051-7	Direct acting indicating analogue electrical measuring instruments and their accessories. Special requirements for multi-function instruments
BS EN IEC 60051-8	Direct acting indicating analogue electrical measuring instruments and their accessories. Special requirements for accessories
BS EN IEC 60051-9	Direct acting indicating analogue electrical measuring instruments and their accessories. Recommended test methods

BS EN IEC 60079	Explosive atmospheres. Equipment. General requirements
BS EN IEC 60079-10-1	Explosive atmospheres. Classification of areas. Explosive gas atmospheres
BS EN IEC 60079-15	Explosive atmospheres. Equipment protection by type of protection "n"
BS EN IEC 60238	Edison screw lampholders
BS EN IEC 60332-3-10	Tests on electric and optical fibre cables under fire conditions. Test for vertical flame spread of vertically-mounted bunched wires or cables. Apparatus
BS EN IEC 60332-3-21	Tests on electric and optical fibre cables under fire conditions. Test for vertical flame spread of vertically-mounted bunched wires or cables. Category A F/R
BS EN IEC 60332-3-22	Tests on electric and optical fibre cables under fire conditions. Test for vertical flame spread of vertically-mounted bunched wires or cables. Category A
BS EN IEC 60332-3-23	Tests on electric and optical fibre cables under fire conditions. Test for vertical flame spread of vertically-mounted bunched wires or cables. Category B
BS EN IEC 60332-3-24	Tests on electric and optical fibre cables under fire conditions. Test for vertical flame spread of vertically-mounted bunched wires or cables. Category C
BS EN IEC 60332-3-25	Tests on electric and optical fibre cables under fire conditions. Test for vertical flame spread of vertically-mounted bunched wires or cables. Category D
BS EN IEC 60598-1	Luminaires. General requirements and tests
BS EN IEC 60598-2-1	Luminaires. Particular requirements. Fixed general purpose luminaires
BS EN IEC 60601-2-1	Medical electrical equipment. Particular requirements for the basic safety and essential performance of electron accelerators in the range 1 MeV to 50 MeV
BS EN IEC 60601-2-16	Medical electrical equipment. Particular requirements for the basic safety and essential performance of haemodialysis, haemodiafiltration and haemofiltration equipment
BS EN IEC 60601-2-46	Medical electrical equipment. Particular requirements for the basic safety and essential performance of operating tables
BS EN IEC 60793-2	Optical fibres. Product specifications. General
BS EN IEC 60794-1-2	Optical fibre cables. Generic specification. Basic optical cable test procedures. General guidance
BS EN IEC 60947-1	Low-voltage switchgear and controlgear. General rules
BS EN IEC 60947-3	Low-voltage switchgear and controlgear. Switches, disconnectors, switch-disconnectors and fuse-combination units
BS EN IEC 60947-4-1	Low-voltage switchgear and controlgear. Contactors and motor-starters. Electromechanical contactors and motor-starters
BS EN IEC 61000-3-2	Electromagnetic compatibility (EMC). Limits. Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)

BS EN IEC 61386-21	Conduit systems for cable management. Particular requirements. Rigid conduit systems
BS EN IEC 61386-23	Conduit systems for cable management. Particular requirements. Flexible conduit systems
BS EN IEC 61439-1	Low-voltage switchgear and controlgear assemblies. General rules
BS EN IEC 61439-2	Low-voltage switchgear and controlgear assemblies. Power switchgear and controlgear assemblies
BS EN IEC 61535	Installation couplers intended for permanent connection in fixed installations
BS EN IEC 61557-4	Electrical safety in low voltage distribution systems up to 1000 V AC and 1500 V DC – Equipment for testing, measuring or monitoring of protective measures. Resistance of earth connection and equipotential bonding
BS EN IEC 61557-6	Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. Equipment for testing, measuring or monitoring of protective measures. Effectiveness of residual current devices (RCD) in TT, TN and IT systems
BS EN IEC 62031	LED modules for general lighting. Safety specifications
BS EN IEC 62368-1	Audio/video, information and communication technology equipment. Safety requirements
BS EN IEC 62384	DC or AC supplied electronic controlgear for LED modules. Performance requirements
BS EN IEC 62386-207	Digital addressable lighting interface. Particular requirements for control gear. LED modules (device type 6)
BS EN IEC 62442-3	Energy performance of lamp controlgear. Controlgear for tungsten-halogen lamps and LED light sources. Method of measurement to determine the efficiency of controlgear
BS EN IEC 62485-1	Safety requirements for secondary batteries and battery installations. General safety information
BS EN IEC 62485-2	Safety requirements for secondary batteries and battery installations. Stationary batteries
BS EN IEC 62561-1	Lightning protection system components (LPSC). Requirements for connection components
BS EN IEC 62561-2	Lightning protection system components (LPSC). Requirements for conductors and earth electrodes
BS EN IEC 62561-6	Lightning protection system components (LPSC). Requirements for lightning strike counters (LSC)
BS EN IEC 62561-7	Lightning protection system components (LPSC). Requirements for earthing enhancing compounds
BS EN ISO 7010	Graphical symbols. Safety colours and safety signs. Registered safety signs
BS EN ISO 8185	Respiratory tract humidifiers for medical use. Particular requirements for respiratory humidification systems
BS EN ISO 9241-6	Ergonomic requirements for office work with visual display terminals (VDTs). Guidance on the work environment

BS EN ISO 10079-1	Medical suction equipment. Electrically powered suction equipment
BS EN ISO 80601-2-12	Medical electrical equipment. Particular requirements for basic safety and essential performance of critical care ventilators
BS EN ISO 80601-2-13	Medical electrical equipment. Particular requirements for basic safety and essential performance of an anaesthetic workstation
BS EN ISO 80601-2-55	Medical electrical equipment. Particular requirements for the basic safety and essential performance of respiratory gas monitors
BS EN ISO 80601-2-69	Medical electrical equipment. Particular requirements for the basic safety and essential performance of oxygen concentrator equipment
BS ISO 3864-1	Graphical symbols. Safety colours and safety signs. Design principles for safety signs and safety markings
BS ISO 7240-8	Fire detection and alarm systems. Point-type fire detectors using a carbon monoxide sensor in combination with a heat sensor
BS ISO/IEC 14443-1	Cards and security devices for personal identification. Contactless proximity objects. Physical characteristics
BS ISO/IEC 14443-2	Cards and security devices for personal identification. Contactless proximity objects. Radio frequency power and signal interface
BS ISO/IEC 14443-3	Cards and security devices for personal identification. Contactless proximity objects. Initialization and anticollision
BS ISO/IEC 14443-4	Cards and security devices for personal identification. Contactless proximity objects. Transmission protocol
IEC 60364-7-710	Low-voltage electrical installations. Requirements for special installations or locations. Medical locations
ISO/IEC 11801-2	Information technology. Generic cabling for customer premises. Office premises
ISO/IEC 11801-3	Information technology. Generic cabling for customer premises. Industrial premises
ISO/IEC 11801-4	Information technology. Generic cabling for customer premises. Single-tenant homes
ISO/IEC 11801-5	Information technology. Generic cabling for customer premises. Data centres
ISO/IEC 11801-6	Information technology. Generic cabling for customer premises. Distributed building services
PD IEC/TR 60977	Medical electrical equipment. Medical electron accelerators. Guidelines for functional performance characteristics

12.4 Guidance and other reference documents

ANSI/TIA/EIA 568.0-D Generic Telecommunications Cabling for Customer Premises
ANSI/TIA/EIA 568.1-D Commercial Building Telecommunications Cabling
BREEAM Scheme Documents & Requirements
British Approvals for Fire Equipment publications
CAE & RIBA Designing for Accessibility

CAI COP 01	Code of practice. Installation of terrestrial and satellite TV reception systems (MDU and commercial)
CIBSE	Guide E: Fire Safety Engineering
CIBSE / SLL	Lighting Guides and Codes
	Code of practice for the installation of SMTV and MATV systems
Defence Estates Specification 034:	Electrical Installations
DISC PD 1001	Electromagnetic Compatibility and Structured Cabling.
DISC PD 1002	Cabling in Private Telecommunications Systems.
ENA ER G5	Engineering recommendation. Planning levels for harmonic voltage distribution and non-linear equipment for transmission systems and distribution networks in the UK
ENA ER G12	Requirements for the application of protective multiple earthing to low voltage networks
ENA ER G59	Recommendations for the connection of embedded generating plant to the Public Electricity Supplier's distribution systems
ENA ER G83	Recommendations for the connection of small-scale embedded generators [up to 16A per phase] in parallel with public LV distribution networks
ENA ER P20/1	Earthing policy in relation to the customers installations
ENA ER P23/1	Consumer's earth fault protection for compliance with IEE Wiring Regulations for Electrical Installations
ENA ETR 122	Guide to the application of Engineering Recommendation G5/4 in the assessment of harmonic voltage distortion and connection of non-linear equipment to the electricity supply in the UK
ENA TS 43-94	Earth rods and their connectors
FIA	Code of Practice for Design, Installation, Commissioning & Maintenance of Aspirating Smoke Detector (ASD) Systems
HSE L64	Safety signs and signals. The Health and Safety (Safety Signs and Signals) Regulations. Guidance on Regulations
HSE L26	Work with display screen equipment. Health and Safety (Display Screen Equipment) Regulations 1992 as amended by the Health and Safety (Miscellaneous Amendments) Regulations 2002. Guidance on Regulations
ICEL 1001	Scheme of Product and Authenticated Photometric Data Registration for Emergency Luminaires and Conversion Modules
ICEL 1004	Requirements for the Re-Engineering of Luminaires for Emergency Lighting Use
IESNA LM-79-08	IES Approved Method for the Electrical and Photometric Measurement of Solid-State Lighting Products
IESNA LM-80-08	IES Approved Method: Measuring Lumen Maintenance of Light Emitting Diode Light Sources
IESNA TM-21-11	IES Approved Method: Making Useful LED Lifetime Projections
IET	Guidance Notes
ILP GN01	Guidance Notes for the Reduction of Obtrusive Light

Loss Prevention Council publications

NJUG Guidelines on the positioning and colour coding of utilities' apparatus

Open Network Video Interface Forum (ONVIF) specifications and protocols

Park Mark Assessment Guidelines for Parking Facility Owners / Operators

Secure by Design Lighting Against Crime

Secured by Design New Homes

SLL Commissioning Code L

Specified requirements of Client/insurers

Specific requirements of the local Building Control Officer and Fire Officer

TIA-568.0 Generic Telecommunications Cabling for Customer Premises

TIA-568.1 Commercial Building Telecommunications Infrastructure Standard

TIA-568.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards

UofM The University of Manchester EPM documentation and guidance, as follows (check for the latest edition / revision):

EPM 16 - Role of the Project Sponsor

EPM ES02 University of Manchester Green Roof and Wall Policy

EPM FM1 - Maintenance Strategy

EPM GM1 - Records Management Policy (Jan 2021)

EPM GM1 - Records Management Policy (July 2016)

EPM GM4 Space Allocation and Relinquishment Procedure

EPM GM5 CAD & Modelling Standards

EPM GM11 - Room Numbering Procedure

EPM GM13 - Signage Strategy

EPM HS4 - The Management of Water Systems and Control of Legionella

EPM HS5 - Facility A Policy Procedure Cover Sheet

EPM HS12 - Permit to Work and Controlled Access Procedure

EPM HS14 - CDM 2015 Procedure - April 2016

EPM HS14a - CDM 2015 Appendices to Procedures

EPM HS14c Pt1 - H&S File Sign Off

EPM HS14c Pt2 - H&S File Submission

EPM HS15 - Estate Ownership and Occupancy

EPM HS16 - Electrical Shutdown Procedure

EPM HS17 - Gas Safety Management Arrangement

EPM HS18 - Energy and Utility Policy

EPM HS20 - Mercury Guidance 1.03.21

EPM HS20 - Mercury Guidance 5.12.19

EPM HS25 - Asbestos Management Plan

EPM HS25 Asbestos Management Plan 2021 [2205504Final]

EPM HS25A Estates Asbestos Policy 2021

EPM HS25A Estates Asbestos Policy 2021 (Final)

EPM HS30 - Fire Safety Signs

EPM HS31 - Fire Safety Management Policy RJ REV2

EPM HS31 - Fire Safety Management Policy

EPM HS32 - Guidance for New Projects - Fire Strategies

EPM HS34 - Passive Fire Protection FP latest version 2018

EPM HS37 - Management of Fire Alarm Systems

EPM PM2 - Project Allocation and Project Monitoring Process

EPM PM3 - Project Procedures Flowchart

EPM PM4 - University Project Manager Guidelines

EPM PM6 - Code of Practice for Contractors on Campus

EPM PM7 - Code of Practice for Design Teams

EPM PM7 Appendix 1 - Key Personnel

EPM PM7 Appendix 2 - Key Documents

EPM PM7 Appendix 5 - Sign off form

EPM PM7 Appendix 6 - Stage Report Logging Procedure rev 2

EPM PM7 Appendix 7 - RIBA Stage Report Submission form Rev 4

EPM PM7 Appendix 8 - Client Notice

EPM PM8-Standard Electrical Specification

EPM PM9 - Standard Lift Specification

EPM PM10 - University BMS Policy

EPM PM11 - Standard Access Control Specification

EPM PM14- Disabled Access Guidelines

EPM PM15 - Project Sponsor Handbook

EPM PM17 - Project Committees

EPM PM18 - UOM Landscape Masterplan

EPM PM19- Structured Cabling Specification Dec 2018

EPM PM19- Structured Cabling Specification June 2021

EPM PM20 - Project Completion and Handover

EPM PM21 - Energy and Water Metering Specification - AUG19

EPM PM22 - Air Conditioning Policy

EPM PM24 - OEAM Group Data Requirements

EPM PM25 - Employers Information Requirements

EPM PM25 - Employers Information Requirements Appendix C

EPM PM26 - Standard CCTV specification Issue 02

EPM PM27 - Monitoring & Reporting Procedures

EPM PM28 - Design Guide for WC Refurbishments and Installations (Rev 4)

EPM PM28 - Design Guide for WC Refurbishments and Installations (Rev 5)

EPM PM29 - UoM Application of BIM

GM10 Building List Procedure

End of section.



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