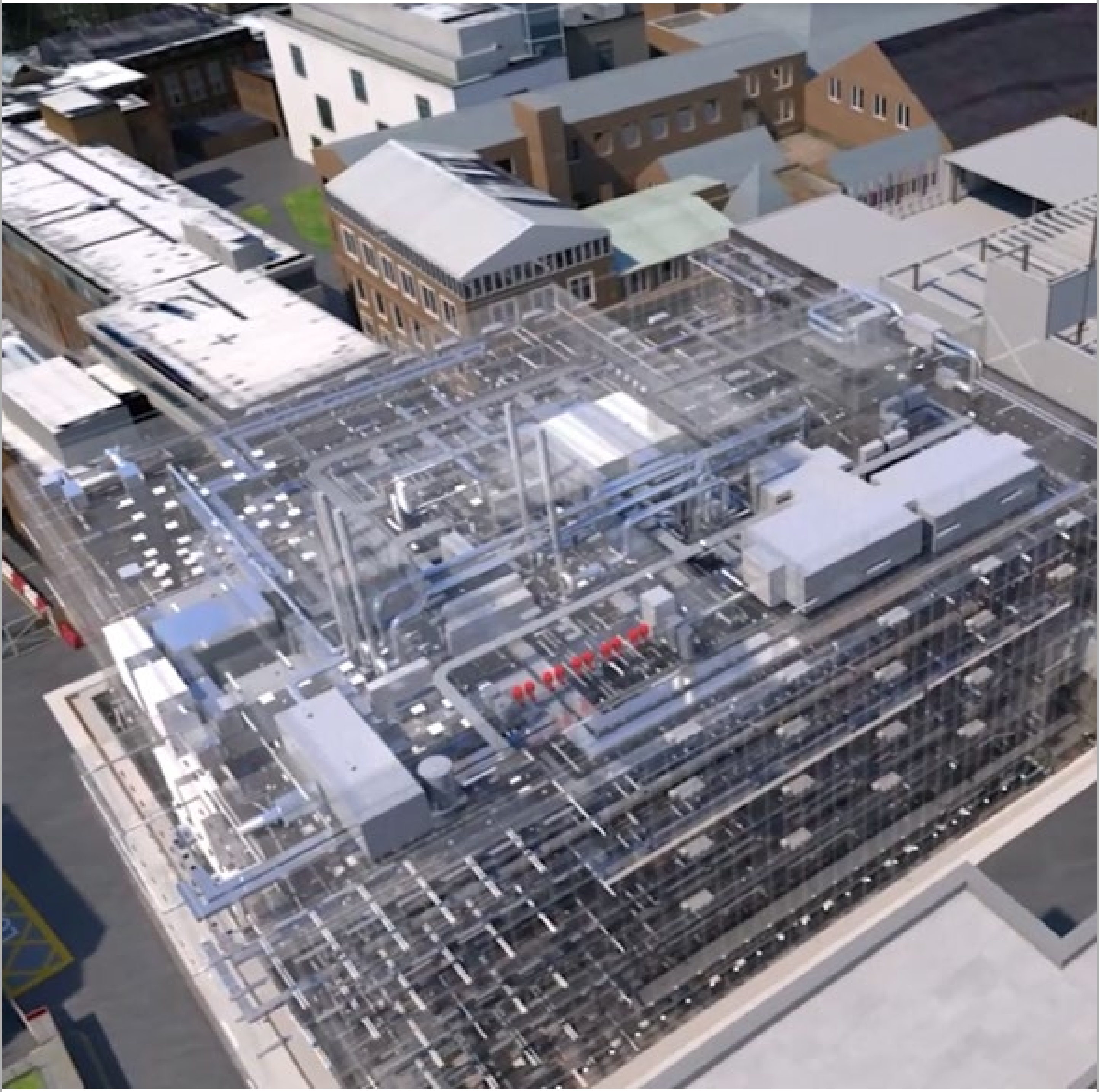
ESTATES SERVICES

UNIVERSITY OF OXFORD

Building Services Design Guide



Version control

Document reference:	Building Services Design Guide
Version/Draft:	1.0
Next review date:	June 2024
Distribution:	Estates Service website
Document owner:	Steven Mearns, Building Services, Estates Services
Document author:	Paul Young, Building Services, Estates Services

Version history:	Previously approved by:	Date:
Not applicable – still using first version.		

Reasons for revision:
Replaced the M&E Philosophy Document 9, adding new information on various subjects, updating the previous content where necessary and reworking the document's structure to improve clarity and make it easier for Estates Services to maintain.

The original document is held by Estates Services, University of Oxford. The most current copy is available on the Estates Services website.

Users of this document should be aware that it will be uncontrolled if saved or printed.

This document may not be edited or changed by anyone except the document owner.

(Cover illustration courtesy of Crown House Technologies. It shows the Biochemistry Completion project, University of Oxford.)

Contents

Introduction

Our building services philosophy

This document sets out what the University expects from the design and installation of building services. It is primarily intended for **consultants and contractors**.

This introduction sets out the **overall principles** the University seeks to apply around its buildings and the systems in them. It is followed by a **series of technical appendices**, each providing detailed guidance on the design and installation of a particular type of building service. If you are unclear on any of the instructions in this document, or on how they apply to your project, consult the Building Services team within Estates Services.

All the rules and instructions here are aimed at ensuring the University receives **high-quality systems** that:

- **perform well over the long term**;
- provide **flexibility to meet changing needs**;
- offer good **value for money**; and
- are **easy and affordable to access and maintain**, without unduly disrupting building occupants.

Staff within the Estates Services department maintain an extremely diverse and complex range of mechanical and electrical equipment, in a complicated organisational environment with many stakeholders and numerous, often conflicting priorities. It is vital that all systems are designed and installed in a consistent way that makes them as robust, simple and easy to maintain as possible.

In many cases in the past, value-engineering decisions intended to reduce a project's cost have ended up costing far more than was saved through increased maintenance expenses over the building's life.

The University aims to operate its buildings for decades; apparently small increases in the annual expense of maintaining one can significantly increase its total lifetime cost.

Core principles

- Plant and equipment should be **robust** – designed and built to last an appropriate time relative to the building type and industry guidelines.
- The University should be **able to access every part of every mechanical and electrical system safely**, to maintain them and, when the time comes, to replace them. Wherever possible these should be accessible by a single person without the need for heavy lifting equipment.
- Systems should be **designed to be repaired and maintained with a minimum of disruption** to building users.
- **Plant rooms** should be safe, secure and readily accessible.
- Systems should be designed to be **simple to operate and maintain,** and should **come from manufacturers agreed in advance with the University**, with preference given to University Framework suppliers. There should be a **proven supply chain** for spare parts.
- **Plant and equipment that will be maintained by Estates Services should be strictly segregated from plant and equipment that will be maintained by building users**. (See 'Understanding the University's structure', below.) In general, the two types of equipment should have their own independently accessible plant rooms.
- Control systems should be based on **open protocols**; the University should not be tied to inflexible proprietary standards, and should not need third-party specialist hardware to access, test or diagnose its equipment.
- Guarantees on plant and equipment **should not tie the University to maintenance contracts** that are controlled by the manufacturer.

Some of the instructions in this document are absolute requirements. In other cases they may be negotiable, but all deviations should be cleared with the appropriate University M&E Project Engineer. Assume all relevant requirements apply to your project unless a specific exemption has been made.

Discuss the proposed design for a project's building services with the University Estates Services M&E Project Engineer as soon as possible after being appointed as a consultant or contractor, to ensure you understand the rules set out in this document and how they apply to the project you are working on.

Without exception, **no work on, or extension of, an existing building system may go ahead without the approval of the Estates Services M&E Project Engineer**. A site visit to inspect a typical existing installation and see the principles outlined in this document put into in practice can be arranged if needed.

To help Estates Services make sure a project design complies with this document, **the designer should complete the checklist in Appendix I** and give it to the Project Manager before the design is signed off. This should include a full explanation of all areas of non-compliance, which should be individually approved by the University M&E Project Engineer.

Once a system's design has been agreed, it should not be changed later to save money. **The time for value engineering is during the design process.**

Understanding the University's structure

Newcomers are often surprised to learn how decentralised Oxford University is. Departments and colleges have a great deal of autonomy compared to their equivalents in most other universities.

It is important to understand that **some building systems are the responsibility of the department that occupies a particular building,** while **others are maintained by the central University via Estates Services.**

For example, a building's heating and ventilation will typically be an Estates Services responsibility, while compressed air systems are maintained by the occupying department.

The two sets of systems need to be **accessed and maintained separately**. Central University staff should never have to request access to departmental space in order to reach equipment they are responsible for maintaining. Conversely, departmental staff should never need to enter an Estates Services plant room to access their own equipment.

The fact that representatives of the department occupying a building are happy with a proposed installation within it does not mean the same is true of Estates Services, which represents the interests of the University as a whole.

This means it is essential to speak regularly with all a project's stakeholders to make sure the design and implementation meet all their needs. As a minimum, this would typically include the project gateway and stage reviews.

Authorisation

All systems should be agreed with the Building Services team and detailed engagement sought **ahead of each project gateway and stage review**. Other teams may need to be consulted as well, depending on the project:

- If the project involves work in or near a building that is listed, within a conservation area or otherwise historically significant, all proposals should be agreed with the **Head of Conservation & Buildings** before anything is done on site. If you are unsure of a building's status, consult the Conservation & Buildings team.
- The **Electrical team** within Building Services **should authorise all work on fixed electrical installations**. No work may be carried out on any fixed existing electrical systems until a **transfer of control** has been issued by the authorising Estates Services Electrical Engineer. Nobody is permitted to work on an existing fixed installation unless they hold a current **University Blue Book**. (The Blue Book provides detailed safety guidance on electrical installations in University buildings. It is issued to individuals who are suitably qualified and have been successfully inducted into the University's electrical code of practice. Blue Books are issued by the Head of Electrical Engineering Services and logged on the University's system.)
- Any works on sprinkler or fire suppression systems and fire alarm systems should be agreed with both the **Estates Compliance Fire Officer** and the **Safety Office Fire Officer**. No work may be carried out on any fixed fire alarm system until a **transfer of control** has been issued by the authorising Estates Compliance Fire Engineer. Where works are carried out on any existing sprinkler or fire-suppression system, the **University's Insurance Office should be notified.**
- The **Environmental Sustainability team** control the University's BEMS and energy metering systems. They should be consulted on related topics.
- The **Direct Labour Organisation (DLO)** within Estates Services should be consulted before any **work on existing mechanical systems**. They will help locate isolation valves, advise on draining and refilling wet systems, etc. The DLO operate and maintain most of the University's mechanical systems and it is essential that they know about any impending work on systems under their control. No contractor may isolate existing mechanical services without consulting the DLO and obtaining a permit to work.

Maintenance philosophy

All systems should be designed to be **repaired, maintained, inspected, extended and removed with the minimum of disruption to the building user**.

The consulting engineer or contractor should submit a **detailed maintenance philosophy document** to Estates Services to demonstrate that these objectives are being met. This should be done as early as possible in the design of the project, and in all cases at the Stage 3 and Stage 4 reviews.

For all capital projects or complex departmental projects, a **formal maintenance review** that addresses all the above requirements should be carried out with representatives of the project team, Estates Services and the occupying department. The output from the review(s) should be documented, and this document should be reviewed with Estates Services at appropriate stages of the project. **The document should form part of the Operation and Maintenance manuals.**

The maintenance review should cover areas including:

- The effects on the building user of **planned maintenance** on the various plant items
- The effect of **periodic test and inspection programmes** of an electrical installation
- The provision of any **standby plant**
- The provision of any **alternative sources of electrical supply** to maintain essential services
- **End-of-life removal**

In the event of a cost-minimising exercise (value engineering), the Project Board and representative of the client department should be **made fully aware of the effects of any changes that may cause disruption or add cost to their activities**, for example through increased plant replacement and running costs.

Design philosophy

It is the University's ambition to **reduce its carbon emissions related to energy consumption to a minimal level**. Buildings are expected to be designed to be **'climate resilient'** with respect to **thermal comfort over their expected lifespan**.

Designers should test the building's performance against future weather files and establish what changes are needed to ensure it can provide thermal comfort under these conditions. Building systems should be designed to be easily **upgradable to accommodate future changes in climate**.

Target room temperatures for heating and cooling systems, and the rationale behind these, are set out in the *Sustainability Design Guide (SDG)*. The architects and lead designers should work closely with, and take guidance from, the MEP consultants to ensure buildings are designed to be **thermally comfortable and stable, avoiding large swings in temperature**.

The *SDG* provides detailed guidance on **energy storage** and **peak load reduction**, **thermal comfort**, and **designing for future climate change**. The strategies set out there are intended to complement the technical details within the *Building Services Design Guide*.

Designers should always carry out detailed thermal modelling of proposed schemes and develop them into a full **operational energy model** using the methodology set out in *CIBSE TM54*, and at handover a *CIBSE TM63* in-use operational energy model which can be used to validate seasonal commissioning energy performance.

Accessibility philosophy

The University aims to provide an **inclusive environment for all staff, students and visitors**. All new University buildings and major refurbishments are required to provide **equal access into and around the building as well as access to, and use of, all services and facilities**. This includes public buildings such as museums and galleries as well as departmental buildings.

Detailed guidance is contained within the *Accessibility Design Philosophy Document*, which is referenced in Appendix H. The **University's Accessibility Advisor** should be consulted throughout the design stages around **any work on building systems that could affect accessibility**.

Equipment selection and value engineering philosophy

Robust whole-life cost analysis should always be undertaken for all decisions around equipment selection.

University projects are often typified by a **tension between capital and operational cost considerations**. While capital savings will be attractive to a cost-challenged project, this can impose onerous long-term costs on the University through increased maintenance requirements and reduced durability. This trade-off should be well understood before any such decisions are taken.

Whenever value engineering or capital cost constraints are advanced as a rationale for derogating from the standards set out in this document, **a detailed analysis of any additional operational or maintenance costs should be presented** setting out the alternative options, using an approach agreed by the Building Services team.

This analysis should demonstrate that **any capital cost reduction does not increase the operational and maintenance costs** over the envisaged life of the asset. This analysis is also valuable when applied to decisions on whether to invest in plant that requires a long-term specialist maintenance contract.

Seasonal commissioning philosophy

M&E services and BEMS on all new or refurbished buildings should be **seasonally commissioned** on a quarterly basis following handover. The rationale behind the University's approach to seasonal commissioning is set out in the University's *Sustainability Design Guide*.

It is essential that accurate and comprehensive metering and sub-metering data is available through the PME metering system. The **BEMS should be fully functional** with all necessary sensors, drivers and other devices logged at appropriate intervals with plots available.

Seasonal commissioning should start **no earlier than six months after practical completion** to ensure that all the main snag items are cleared, that all meters are connected and reading correctly, and that the building has had a chance to settle in. After this there should be **four quarterly visits over the next 12 months**, covering a period of no less than 18 months following practical completion.

Seasonal commissioning should generally follow the requirements of the ***BSRIA BG 44* guide**. The building's **in-use energy should also be collected** from the metering system and **compared against the design model**.

The seasonal commissioning should be **led and chaired by the Project Manager** and include the appropriate team members. As a minimum this should be the **MEP contractor**, **BEMS contractor**, **Estates M&E Engineers**, **Estates Sustainability Carbon Manager**, and the **Building Manager**.

Following each visit a full and detailed report of the commissioning activities undertaken and the analysis of the energy usage of the building should be presented to the Estates Team and Building Users along with recommendations for adjustments to make the systems more energy efficient.

Handover philosophy

It is essential that the Estates Services M&E team are **engaged with in good time** to ensure a smooth handover of the project. Where the project follows the University's soft-landings guide, the team should be engaged at an early stage in this process to assist the project team.

Asset data should be provided to the M&E team so that it can be recorded in the University's maintenance databases. Mechanical asset information should be provided by the project team in a format that enables **upload onto the University's Planon system**, and electrical information to the **ElecFM database**.

Contractors should assist the Estates maintenance team in **identifying and tagging all the installed assets**. On refurbishment projects, they should provide a **list of all assets removed** along with their identification numbers.

The **O&M information, drawings and all test certificates** should be **available at handover** to ensure that Estates Services staff can commence maintenance from day one along with **full training** for the **operation and maintenance** of the installed services. The Estates **M&E handover checklist** should be completed before systems can be accepted for handover.

As-fitted drawings provided as part of the O&M documentation should be provided in both PDF and DWG formats.

Technical Appendices

Appendix A – Mechanical Systems

A1 Piped services

A1.1 Horizontal distribution

Main horizontal distribution **pipework must be at a high level in corridors**, in a single depth and preferably not hidden above ceiling tiles. If ceiling tiles are unavoidable, they must be easily removable and replaceable. The general guidance of *BESA Technical Bulletin TB/56* must be followed for spatial co-ordination of services in corridors

Pipes must not have fixed equipment or cable and data trays positioned directly underneath them, and all valves must be easily accessible from below.

Pipework must be fully **co-ordinated with all other services** and be installed in **horizontal runs** which **naturally vent or drain back to the main risers**. The installation must not rely on automatic air vents or drain cocks to overcome co-ordination issues.

Where high points are unavoidable, **automatic air vents** must be installed. These must be from a supplier with a proven record, such as Spirax Sarco. Hose-union drain cocks must be installed on all low points.

Where pipework passes through walls or fire barriers, it must be **continuously sleeved** in the same material as the main pipe, with certified **fire stopping**.

A1.2 Vertical distribution

Main vertical distribution pipework must rise in a **wide, shallow duct** containing a single depth of pipes. Access must be via **full-height doors at each floor level**. Such vertical ducts must have **solid floors** at every level suitable for maintenance engineers to stand on. Open mesh flooring is not acceptable due to the risk of tools or equipment being dropped down the riser.

A1.3 Pipework supports

Adequate supports must be installed to support the pipework's weight.

Where the contractor choses to use pre-fabricated risers, service modules, plant skids etc, **structural checks must be carried out** for the additional weight frames and self-supporting risers carry. Where off-site manufacture occurs for these systems, the Estates team should be given the **opportunity to inspect and view products before they are delivered to site.**

Bracketry must use **support blocks** to allow insulation to run in a continuous length, in order to avoid moisture ingress when butting insulation lengths. Support blocks must be of the **same material as the insulation**; wooden pipe supports may not be used.

Where support blocks are phenolic foam, they must be of a **suitable density** for the size and weight of the pipework. Phenolic blocks must be **foil lined**.

External vertical pipework must be **supported from below** and must not rely on pipework clips.

Where **expansion devices** are used on long lengths of pipework, proprietary anchors must be used at each end of the section and supported with guides, to allow free movement of the pipework. The **designers must produce an expansion strategy and design**, which must be **developed by the contractors into installation details**.

A1.4 Isolation valves

All piped services must have adequate numbers of **isolation valves** fitted for future maintenance requirements to **minimise drain down**. As a minimum, **each floor must be zoned**.

Isolation valves up to 50mm must be ball valves with lever arms. Valves 65mm and over must be lugged butterfly valves. Those of 100mm or over must be of the geared type.

All items of plant must be fitted with isolation valves. Commissioning valves, regulating valves, thermostatic valves and other throttling or control valves must not be used for equipment or circuit isolation – there must be a **dedicated isolation valve installed upstream**. All strainers, dirt separators, de-aerators and expansion bellows must be provided with **inlet and outlets isolation valves**. Automatic & manual air vents must be provided with isolation valves on the system side which must also be **lever arm ball valves.**

Where pipework tee branches run into laboratories or limited-access research/process rooms, the **isolation valves must be on the corridor side**, or in open plan spaces within a designated corridor area.

A1.5 Thermal insulation

Mechanical services pipework must be **insulated** as necessary to conserve energy and prevent condensation and freezing.

Wherever practicable insulation must have a GWP of <5 and a zero Ozone Depletion Potential (ODP).

Fibreglass insulation must not be used in any form. Where **phenolic foam** is selected to be used on cold piped services, the **pipework must be suitably protected** and not in contact with the surface of the insulation. Where **copper pipework** is used, it must be **PCV-coated**; where **stainless steel** is used, it must be **wrapped with foil tape**.

The insulation's surface finish must be appropriate for its location, but in plant rooms **Isogenopak** sheeting must be used in preference to aluminium cladding for pipework, and **Proclad** or similar must be used for ductwork.

Valves and flanges, plate heat exchangers, control equipment, pump bodies and other serviceable equipment must be insulated with purpose-made, high-quality, easily removable muff covers. Aluminium valve boxes will not be accepted.

Pipework or ductwork that is either in the **open air or in external service ducts** must be insulated with **rigid sectional insulation** backed with **Proclad** sheeting finish (or other approved waterproof material, as agreed with the Mechanical Services Project Engineer). This must form an unbroken surface along the entire length of pipe. Aluminium cladding must not be used externally.

All piped services within plant rooms, service ducts, ceiling voids etc must be clearly identified to *BS 1710* together with the direction of flow.

Where pipework passes though fire walls, an **approved and tested fire stopping detail** incorporating **intumescent pipe wrap** must be used so that the insulation can be left along the full length of the pipe.

A1.6 Flexible connections, expansion bellows and inertia bases

Flexible connections and inertia bases must not be installed on heating, chilled water and domestic hot water pumps unless there is a proven need to provide a completely vibration-free environment for research purposes.

Flexible connections may be used on chillers and heat pumps, but only where **specifically required by the manufacturer**.

Spring hangers must be used if pipework is suspended from structures where vibration transfer may cause issues with scientific equipment.

Expansion loops are preferred to bellows on lengths of pipework where expansion may occur. Pipework loops must be formed from a single length of tube with pulled bends. Where bellows are absolutely required, they must be braided stainless steel and not rubber.

A1.7 Protection from frost and freezing

Appropriate frost protection and measures to prevent freezing must be provided to all plant, equipment and systems. All critical systems or exceptions must be discussed and agreed with the Mechanical Services Project Engineer.

Trace heating must be avoided wherever possible; and the use of passive design measures (eg routing pipework within thermally controlled or thermally frost protected routes within the building, enhanced insulation levels etc) is preferred.

Trace heating may be installed only if agreed with the Mechanical Services Project Engineer. Where its use is unavoidable and has been approved, the system needs to be properly insulated and accessible for routine testing. It must be **installed on a fused spur** – never plugged into a wall socket.

Trace heating must be **monitored for status/fault via BEMS on a zonal basis**. A list of each separate trace heating system must be included in the Operation and Maintenance manual.

A2 Low-pressure hot water, steam, condenser water and chilled water systems

A2.1 Heating systems

All wet heating systems must be designed as **low-pressure hot water systems** and suitable for **heat-recovery air-source heat-pumps.** Medium- and high-pressure systems are not acceptable.

All pipework systems, heat-emitters, fan-coil units and air-heating coils must be **sized to accommodate a future maximum flow temperature of 50°C to allow for the future adoption of heat pumps**. This also applies to those fitted within existing systems, even where the flow temperatures are currently higher.

Boiler house main circuits and weather-compensated circuits must not be used for summer dehumidification.

A2.2 Chilled water systems

Chilled water systems **must not run at a flow temperature of lower than 5°C**. Particular attention must be given to systems with chilled beams where condensation may occur.

Chilled water and heating primary systems must always be **hydraulically separated**.

Critical and process cooling systems must not be fed from, or shared with, the environmental cooling systems.

A2.3 Pipework

Pipework must be **heavy-gauge mild steel**, installed in accordance with *HVCA TR/20*. Pipework up to and including 50mm must have screwed joints, while pipework 65mm and above must have welded joints.

With the agreement of the Mechanical Services Project Engineer, an approved **grooved-jointing system** or **mechanical-pressed system** may be used. This is the preferred methodology where no hot works are allowed.

Adequate **dismantling points**, using unions or flanges as appropriate, must be provided to enable appliances to be disconnected and pipework to be repaired.

Thin-walled **stainless steel or copper pipework may be used as an alternative** if using crimped fittings. **Plastic and carbon-steel pipework must not be used**.

A2.4 Redundant systems

Where buildings or areas are being refurbished, all redundant pipework must be **removed back to the tee** on the live pipework and provided with **plugged isolation valves** on flow and return pipework.

A2.5 Pipework testing

Pipework must be tested in accordance with *BSRIA TR/6*. The testing process in occupied buildings must be agreed in advance with the Mechanical Services Project Engineer.

Where welded pipework and fittings are used, joints must be non-destructively tested as dictated by, and at the discretion of, the Mechanical Services Project Engineer.

A2.6 Radiators & heat emitters

All radiators must be fitted with a Herz non-domestic **thermostatic radiator valve and matching lock shield valve**. Lock shield valves must of the type that can accept live conversion to thermostatic operation. Valve bodies must be of the type that can be maintained with the Herz 'Changefix' tool. Herz proprietary inserts must be used with copper or stainless steel pipework.

Where 'smart' radiator valves are considered, the **valve bodies must be from the Herz range** and the control head **matched correctly to the Herz valve body**.

Radiators must not be boxed in unless specifically designed for the purpose (such as low-surface temperature panels). LST radiators must be selected to allow for Herz valves rather than the radiator manufacturer's proprietary valve set.

Electric underfloor and trench heating must not be used. Where water-based trench heating is proposed, it must be **maintainable via easily removable grilles**. The trench must be wide enough to allow the pipework, fins and casing to be accessed with tools for cleaning.

A2.7 Fan-coil units

Fan-coil units installed in deep ceiling voids must be **directly above the ceiling finish and accessible** from below the finished ceiling level. Fan-coil units must not be installed above fixed furniture or laboratory benching.

In addition to the control valves, all fan-coil units must be provided with flow & return isolation valves and test points, and strainers. Manual air-vents and drain-cocks must be provided on the top and bottom connections to the coils. A normally closed flushing loop prior to the control valves must also be provided. Flexible hose connectors must not be used. Where pipework temperature sensors are installed, the sensor pocket must be fully immersed in the full flow of the fluid stream.

Fan-coil unit **condensate drains** must be in **plastic with solvent-welded fittings** and must **fall naturally to drain**. Dry-traps must be used at the connection to the main. The **need for condensate lift pumps must be designed out wherever possible**. Where condensate pipework runs in voids used as air plenums, it must be thermally insulated.

A2.8 Heating & cooling coils

In addition to the control valves, all heating & cooling coils must be provided with flow & return isolation valves, temperature gauges and pressure gauges, and suction side strainers. Manual air-vents and drain-cocks must be provided on the top and bottom connections to the coils.

A normally closed flushing loop prior to the control-valves must also be provided. Isolation valves and pipework unions or flanges must be positioned so that the coil can be withdrawn without the need to drain excessive pipework. Where pipework temperature sensors are installed, the sensor pocket must be fully immersed in the full flow of the fluid stream.

Balancing valves must be locked off after commissioning.

Where electric trimmer batteries are used in close proximity to a filter bank, or where there is a risk of combustible material 'shedding' and working its way down the duct, appropriate **mesh protection must be provided** to mitigate fire risk.

A2.9 Plate heat-exchangers

Plate heat-exchangers must be provided on a **bolted framework**, so that their capacity can be expanded with additional plates (up to 25%) if necessary.

Heat-exchanger operations must be **controlled from the main University Building Energy Management System (BEMS)**. Any prewired systems must use an **open protocol** allowing for full **two-way communication and control by the BEMS**. Pre-wired control systems based on manufacturers' proprietary closed protocols are not allowed.

In addition to the control valves, all plate heat-exchangers must be provided with flow & return isolation valves, temperature gauges and pressure gauges, and strainers. Manual air-vents and drain-cocks must be provided on the top and bottom connections to the coils. A flushing loop prior to the control-valves must also be provided. Where pipework temperature sensors are installed, the sensor pocket must be fully immersed in the full flow of the fluid stream.

Balancing valves must be locked off after commissioning.

A2.10 Steam systems

Steam must not be used as a primary or secondary form of heating or for humidification. Where steam is necessary, it must be **generated adjacent to the point of use**. Steam plant which serves only departmental equipment such as cage washers or autoclaves will be maintained by departmental personnel, so the proposed design must be discussed with both Estates Services and the building user.

Steam generation systems and their associated operations have a major influence on the performance and **energy consumption of the fabric envelope**. Any **modifications or additions** must include **extensive thermal modelling** to ensure stability of internal conditions and keep energy losses to a minimum.

Where **high-temperature discharges** are installed, they must be **cooled before discharging to drain**. Discharge temperatures from departmental equipment to drain must not exceed 40°C. Where there is any possibility that live steam could be discharged in a fault situation, the safety lines, discharge points and their impact on the drainage materials must be appropriate.

A2.11 Circulation pumps

All pump systems must be installed with **100% redundancy (n+1)**. For dynamic control systems, the minimum flow requirements of the system must be considered, as well as the associated maximum turn-down of the pump which would usually require **duty-assist-standby rather than a single duty** requirement. Ensure the best efficiency point of the pump is based on the unit's expected majority run time.

All pumps must be **fully maintainable without shutting their associated systems down**. Twin-head pumps are only allowed where the systems are confirmed as non-critical, and are not dynamically controlled, and in this case blanking plates must be provided, labelled and stored near the installation.

All pumps must be inverter-driven. All inverters must include communications cards that are compatible with the University's BEMS. **Communication and controls protocols** must be outlined clearly to and approved by the BEMS team before any new installations are agreed. **Energy data** that is available from the drives must be relayed through the BEMS.

All pumps must be provided with suction and discharge side isolation valves and pressure gauges, and suction side strainers. Flexible connectors must not be used.

A2.12 Pressurisation units

Automatic pressurisation units must be fitted to all closed-water systems. Manual top-up systems are not allowed.

All pressurisation units must be fitted with an **analogue water meter on the inlet feed**. These must afford a minimum of **category 4 backflow protection** between the system and inlet water. High- and low-pressure alarms and pump failure alarms must be provided and communicated to the BEMS.

Direct-type mains pressure units are preferred to pumped-type units where possible. Combination dosing/degassing and pressurisation units are not allowed.

A2.13 Boiler installations

Boiler installations must be **hydraulically separated from the main building network.**

Condensing boilers must be fitted with **neutralisers on the condensate discharge** to manufacturers' guidelines and current regulations. These must be easily accessible for routine maintenance. **Condensate pipework must be designed to prevent freezing in cold weather**, for example by providing tundishes within plant rooms. Externally run condensate lines must be insulated. All condensate pipework must be in high-temperature plastic; copper traps must not be used.

Condensate drains and safety valve drains must be piped to discharge over the closest plant room floor gulley.

A2.14 Water treatment

Pre-commissioning cleaning and flushing of pipework must be carried out in accordance with *BSRIA BG29*.

Appropriate water treatment must be provided for all steam plant, heating installations, chilled water installations, heat recovery systems, and humidifiers, as well as for low- and zero-carbon technologies such as solar panels or ground source and air source heat pumps.

The type of **chemicals used for dosing the systems** must be agreed with the Mechanical Services Project Engineer. **Automatic dosing systems must be avoided; combination manual dosing pots are preferred.** Dosing pots must not be located externally. A schedule of the specific type and product reference of any dosing chemicals added to the system, along with the volumes added, must be fully documented in the O&M manuals.

De-gassers must be used on multi-storey buildings above 15m where system temperatures are greater than 60°C.

On all systems that have circulation temperatures less than 60°C, and in all systems with air source heat pumps and all chilled water systems, **vacuum degassers** must be installed. These must use proprietary self-cleaning motorised valves, not solenoid valves.

A3 Potable & non-potable water systems

A3.1 General

All water systems must be designed to comply with the following regulations and guidance:

- *L8: Legionnaires' disease. The control of Legionella bacteria in water systems. Approved Code of Practice and guidance*
- *HSG274: Legionnaires' disease - Technical Guidance*, issued by the Health & Safety Commission
- *The Control of Legionella Bacteria in Water Systems* (Estates Services Policy & Procedures document).

Galvanised mild steel pipework, fittings, storage vessels and tanks must not be installed; **only copper, stainless steel or appropriate plastic materials may be used**.

Any work on water services must receive prior approval by the Mechanical Services Project Engineer with adequate information provided on application. When working on existing systems, the contractor must complete a **Transfer of Control form** and forward it to the Mechanical Services Project Engineer.

A3.2 Water system types

Water systems must have suitable **backflow protections**, appropriate to the systems served. RPZ valves must not be installed without written authorisation from the Mechanical Services Project Engineer, which will not normally be given.

General sanitary appliances, and hot-water feeds to potable hot-water generators, must be **fed directly from the mains water or via a dedicated potable water tank**. All cold water pipework serving urinals must have an electronic presence-automated flushing system.

No laboratory equipment, laboratory sinks, heating/cooling system feeds, irrigation systems or wash-down bib taps must be fed from this system.

Laboratory & process equipment (such as general sinks, fume cupboards, process equipment, RO equipment, and laboratory hot water-generating equipment) must be fed from a dedicated **non-potable water tank with category 5 backflow protection**.

Laboratory hand-wash basins, eye-wash stations and emergency drench showers must be fed from the potable water systems.

Feed connections to heating & cooling systems must have **category 4 backflow protection**.

External irrigation systems and external bib taps must be fed from a **dedicated non-potable irrigation water tank with category 5 backflow protection**. All external bib taps must have lockable covers.

Drinking water points must be provided for all kitchen areas, water fountains, drinks vending machines and water-bottle filling stations. All **drinking water outlets must be supplied directly from the mains supply pipe**. Each piece of equipment must be provided with a **category 3 backflow protection** valve.

A3.3 Pipework installations

All fittings must be **mechanically crimped**. Soldered fittings must not be used on domestic water services without express written authorisation from the Mechanical Services Project Engineer, which will not normally be given.

Pipework must be installed in **horizontal runs that naturally vent back to the main risers**. The installation **must not rely on mains pressure or booster pump pressure to force-vent the system**. Automatic and manual air vents must not be used on domestic water services.

Flexible connections to terminal fittings and faucets are not permitted; **final connections must be copper or stainless steel**. The only exception will be mixer taps which have an integral flexible connection, but these are limited to specific installations (such as height-adjustable benches for accessibility purposes, de-ionised water outlets and fume hood connections) and even then, may only be used with written permission from the Mechanical Services Project Engineer. **Local isolation valves** must be provided on all faucets and terminal fittings, and must be full-bore type with a quarter-turn handle.

Access to maintainable components on faucets, cisterns and local isolation valves must be from **removable IPS panels**. The components must be located immediately behind these panels.

Underground pipework must be in **blue PE with electro-fusion joints**. Detectable underground marker tape must be installed over all buried water pipework. This must be high-strength plastic tape, incorporating two stainless steel wires as tracers, and must carry a repeated printed warning of black text on a yellow background, reading “CAUTION BURIED WATER MAIN”.

A3.4 Redundant systems

Where buildings or areas are being refurbished, all **redundant pipework and dead legs must be removed** back to the live pipework. The redundant tee connection on the live pipework must be removed and replaced with a through joint.

Any **historic dead legs or redundant potable water systems** encountered within the demised space of the project must also be removed.

A3.5 Water metering

A water meter must be fitted in the **mains cold water supply pipework to all cold water storage tanks**. The tank water temperatures must be monitored by the BEMS and alarm when out of range.

The **main meter on the incoming cold water supply** to the building, and any **sub-meters**, must be **monitored by the PME metering system**. Water metering requirements are set out in Appendix E of this document.

A3.6 Water storage tanks

Two separate cold water storage tanks must be provided, so that supplies can be maintained while one tank is taken out of service for inspection or cleaning. If a tank with an internal divider is specified, it must be designed so that it can operate for long periods with only one side in use. It must be possible to clean the tank from outside to avoid confined space entries.

The tank must be on a **raised platform** with the main water outlet, or alternatively a 25mm valved drain, provided on the underside in an accessible location so that it can be **fully drained**. **Inlet and outlet positions** must be located to achieve **optimum circulation of water** within the tank/cistern, including use of sparge pipes etc as necessary to achieve this.

Tank fill-valves must be fully adjustable, so that stored water capacities can be changed if necessary.

Cold water tanks must be externally flanged multi-sectional. One-piece tanks may be used if authorised by the Mechanical Services Project Engineer. This permission will only be given where it can be demonstrated that the tank can be removed and replaced through the designed access routes, hatches and doorways.

Water tanks must not be installed in any plant room with heat-generating equipment, nor in any area where ambient heat gain could cause increases in the stored water temperature.

Consideration must be given to the type of building and turnover time of any stored water. Storage must be agreed with the Mechanical Services Project Engineer on a case-by-case basis, but a **maximum storage period of four hours** would normally be expected.

A3.7 Cold water booster pumps

Cold water booster sets must have the following minimum features:

- Duty/assist pumps
- Inverter control on each pump
- Stainless steel or copper manifolds for potable water applications
- Control panel with system monitoring
- Autorotation of pumps
- Monitoring by the BEMS

A3.8 Hot water systems

Hot water with central plant and associated pipework distribution systems must only be used if it is impractical to use **point-of-use electric hot water heaters**.

Where central plant is used, it must be via **air- or ground- source heat pumps**. Plate heat exchangers fed via a boiler or direct gas-fired hot water heaters may be used on refurbishment projects with the authorisation of the Mechanical Services Project Engineer. High turnover buffer vessels must be used in preference to storage calorifiers.

Unless high temp heat-pumps systems are used, a secondary heat source must be provided to elevate the domestic hot water flow / storage temperature to the required levels that minimise risk of pseudomonas proliferation.

Where un-vented equipment is used, it must be WRAS-approved. Connection tees for expansion vessels must be via a **three-way anti-Legionella valve**, in order to maintain a flow through the expansion vessel and avoid stagnation. **All expansion vessels must be mounted vertically.**

Trace-heated hot water flow pipework must not be used in place of a pumped hot water return.

Pumped hot water return connections must be taken to within 300mm of the outlet. Where thermal balancing valves (TBVs) are used on hot water returns, they must not be used for circuit isolation purposes. An additional separate isolation valve must be provided on the upstream side of all TBVs. Where **hot-water circulation pumps** are installed, an **identical spare pump** must be located on an adjacent wall bracket.

Mixer taps are preferred to individual hot and cold taps except in situations where only cold water is provided, in which case a single tap must be used. **Thermostatic mixing valves** (TMV2 or TMV3 as appropriate) must be installed to provide **safe hot water temperatures on all baths and handwash basins** in high-risk environments such as childcare settings, or if an assessment of scalding risk suggests this is necessary.

If TMVs are required, they must be **incorporated within the terminal fitting**. All TMVs must be accessible for routine maintenance and must not be installed in ceiling voids or other difficult-to-access areas. Maintenance access to TMVs must be demonstrated before building handover. **Local isolation valves** must be provided on all faucets; these must be full-bore type with a quarter-turn handle. Where hot water outlets are not provided with TMVs, a sign must be fixed to the backsplash immediately behind the faucet to warn of potentially scalding water.

Electric water heaters must be manufactured by **Heatrae Sadia**, and **showers** by either **Mira or Triton.**

A3.9 Reverse osmosis systems

Where central reverse osmosis (RO) generation systems are installed for departmental equipment, they must be **fed via the laboratory cold water system**. Laboratory RO water services will usually be maintained by departmental personnel, but the design proposals must be discussed with both Estates Services and the department.

The **RO distribution network must be installed in a ring main**, with the circulating loop taken to the valved connection to the outlet. RO installations must use suitably rated solvent-welded plastic pipework with no metal components. Connections to RO outlet taps must also be in plastic with the circulation looped to the tap.

A3.10 Work on hot and cold water systems during a project

During the course of a project, hot and cold water systems must be kept live and a **schedule implemented to run taps and other outlets regularly,** in order to **prevent water from stagnating** in the

system. This is especially important during refurbishment projects during which existing hot or cold water systems are either unused or little-used over an extended period.
For new building projects and new systems, the domestic water systems must be left empty until the last possible moment. Once filled, there must be daily draw-off from the system to avoid the water stagnating.

A3.11 Handover of water systems partway through a contract

If responsibility for a hot or cold water system is transferred to Estates Services during a project, adequate notice must be given of this intention. This will give Estates Services time to arrange for a specialist contractor to access the site and complete a full risk assessment (in the case of a new building) or a risk re-assessment (in the case of a refurbishment). This will also allow for access by the monitoring team to identify assets and complete bar-coding, and to implement a new control regime.

If the building is not due to be fully occupied until a later date, Estates Services will also instigate additional measures such as regularly flushing its water system until the building is brought into full use.

A3.12 Handover of water systems at contract completion

All new and renovated water mains, service pipes and fittings must be **disinfected, flushed and sampled** before returning to service, irrespective of the size of the system.

Water services must be cleaned and disinfected within the seven days prior to handover and a representative number of **potable water samples**, including samples to be tested for pseudomonas, must be taken no less than five days after disinfection. **Water quality must be at an acceptable level according to independent lab testing**, and the installation will not be approved unless all samples are satisfactory.

The **contractor is responsible for daily flushing of all outlets before acceptance**, and this must be appropriately recorded. Estates Services **will not accept handover** of a water system if the flushing record is not provided.

On all new buildings, the **designer must produce a Legionella risk assessment** to demonstrate **how risks have been designed out** and where any **residual risks** are to enable the Estates Services team to compile the in-use Legionella Risk Assessment.

A4 Fuel & laboratory gas services

A4.1 Natural gas services

All installations must comply with current IGEM and other relevant regulations for industrial and commercial establishments (unless agreed otherwise for domestic installations).

Designer and installers must particularly note the **earthing requirements** of gas pipework and proximity to **adjacent electrical services**.

For a gas supply that is normally **metered at 21 mbar**, the **pressure drop** between the primary meter and any booster or the plant manual isolation valve **must not exceed 1 mbar at maximum flow**.

For supplies that are normally **metered at greater than 21 mbar**, the **pressure drop** in the pipework **must not exceed 10% of the design pressure at maximum flow**.

A4.2 Redundant systems

Where buildings or areas are being refurbished, all **redundant gas pipework** (both fuel gas and laboratory gas) must be **removed back to the tee** on the live pipework, and provided with a plugged shut-off valve.

A4.3 Pipework

Pipework must be **mild steel, installed in accordance with *HVCA TR/20***. Pipework **up to and including 50mm** must have **screwed joints**. Pipework **65mm and above** must have **welded joints**. Alternatively, **copper tube** with appropriate **gas-rated mechanical compression fittings** may be used.

Adequate **dismantling points**, using unions or flanges as appropriate, must be provided so that appliances can be disconnected and pipework repaired.

All pipework that carries **fuel gas** must be **clearly identified** as such. This must be done by fully painting with yellow ochre (to *BS 4800 08 C 35*). Tape identification will not be accepted.

Underground pipework must be in **yellow PE with electro-fusion joints**. Detectable underground marker tape must be installed over all buried gas pipework. This must be high-strength plastic tape, incorporating two stainless steel wires as tracers, and must carry a repeated printed warning of black text on a yellow background, reading “CAUTION BURIED GAS MAIN”.

A4.4 Pipework testing

Pipework testing must be in accordance with the latest **IGEM regulations** and a **Gas Safe certificate** must be issued.

The testing process in occupied buildings must be agreed in advance with the Mechanical Services Project Engineer.

A4.5 Shut-off systems

A gas **shut-off valve**, operated by a **heat detector(s) and/or emergency push button**, must be incorporated in the boiler supply pipe. This valve must not be connected to any building fire-detection system other than the one in the boiler room.

Basement and semi-basement boiler rooms must also have a **gas detection system** installed.

A4.6 Metering

All gas meters must be monitored by the PME metering system. Gas metering requirements are set out in Appendix E of this document.

As a minimum, **separate sub-metering must be provided for heating boilers**, **process steam boilers** and **direct gas-fired domestic hot-water heaters**.

The **gas supply to other areas (such as kitchens and laboratories)** must be **metered separately** from the supply to heating boilers, steam and hot water heaters.

A4.7 Gas boosters

Gas boosters must not be used unless there is a specific requirement for one in order to support a specialist process.

A4.8 Laboratory gas services

Laboratory and process gas services, including compressed-air and vacuum will be maintained by departmental personnel, and the design proposals must be discussed with both Estates Services and the department or building user.

As a minimum, **gas systems must be designed and installed in accordance with *HTM 02-01*, Part A** using **medical gas-grade copper tube** with **brazed fittings**. Where required for high-grade specialist processes, stainless steel may be required. The pipework specification must always be agreed in advance.

The designer must liaise with the department to establish the requirement for oxygen depletion alarms. This must be determined based on risk assessment.

A5 Ventilation & air conditioning

A5.1 General design considerations

Designers must consider the holistic design of the building when determining ventilation and cooling strategies. Detail guidance is out in the University's *Sustainability Design Guide (SDG)*. Target values for CO2 levels and fresh air provisions are set out in the SDC.

Generally, **air conditioning systems must be avoided** wherever possible, and must only be used where close control of the environment is **necessary for specific processes**. Designs must incorporate **free cooling**, **natural cooling via exposed thermal mass** and **night-time purge cooling** wherever possible.

Airtight, well insulated, mechanically ventilated spaces with heat recovery (MVHR) are more efficient to run than naturally ventilated ones and is therefore preferred. Air-handling plant must be **full-fresh air without recirculation sections**.

A5.2 Laboratory design considerations

Detailed consideration of laboratory ventilation design is discussed in the *Sustainability Design Guide (SDG)* and designers must incorporate the strategies set-out in the SDC.

Expected cooling loads in laboratories vary considerably. The designer must consult closely with the laboratory users to determine the equipment that will be installed and how much cooling will be needed to offset the heat it produces. **User requests for excessively tight temperature and humidity control** (ie close control) **must be challenged**, as this constrains energy efficiency options.

Similarly, **air change rates must be matched to requirements**, and **unnecessarily high rates** (greater than six air changes per hour) **must be avoided** wherever possible. The system must incorporate the necessary automatic controls (VAV dampers) and air quality monitoring devices (TVOC) to allow the ventilation rate to be reduced during periods of low occupancy, or when air quality levels are within specified limits. Demand-led ventilation in laboratories is the default starting point. Other approaches must be considered only if particular processes/activities (such as CL3 laboratories and cleanrooms) dictate that it is not feasible.

Air change rates must be reduced out of hours. Air loads must be minimised through low air pressure drop design, by selecting high-efficiency fans for all air-handling equipment, and by using variable-speed drives and variable air volume systems.

A5.3 Cooling installations

The designer must always consider how the use of **shared heat (ambient loop) coupled air-source or ground-source heat pumps** with the facility to connect to a wider campus site network can be incorporated into the design.

When existing cooling units are being replaced, or when a department wishes to install cooling for discrete areas within a building, the Mechanical Services Project Engineer must be consulted prior to the design stage. The **air conditioning approval form**, available on the Estates Services website, must be completed before any design takes place.

Separate dedicated cooling systems must be used for **server rooms**, **departmental equipment** and other applications which **require cooling continuously throughout the year**. Designers must look to recover heat from cooling plant that may run through winter months in order to supplement the building's environmental systems.

Redundancy of plant must be agreed on a project-by-project basis with both the Mechanical Services Project Engineer and the relevant departmental representative.

Where practical, **freezers must be located in a dedicated room** so that heat dissipation can be managed more easily. The preference is for forced air or natural free cooling, and for DX systems to be used only as a last resort. The heat dissipated from freezer rooms in the winter must be recovered rather than being discharged to the atmosphere.

Evaporative type cooling towers must not be used under any circumstances. **Uncontrolled open water** and **adiabatic coolers must also not be used**.

A5.4 VRF & DX installations

Where **VRF and split or multi-split refrigerant DX systems** are installed, they must operate under the dictates of the system **manufacturer's proprietary central controller**. This controller must be BACnet or Modbus, linked to the University's BEMS system, and must be **open-protocol and fully viewable with read/write facility for all set-points**.

Where BACnet or Modbus controllers are used, there must always be a hard-wired enable, fault and temperature set-point signal from the Trend BEMS system to the heat-pump.

A5.5 Refrigerant pipework

Pipework must be **refrigerant-quality copper tube with brazed joints**. Long-radius bends must be formed using a pipe bender. Short-radius pre-formed bends and elbows must not be used.

Pipework fittings for branching off to indoor units must be the **manufacturer's specified joints** where these are available. Positioning of these joints must be strictly in accordance with the manufacturer's specification.

All refrigerant pipework must be installed and fixed on a **heavy-duty cable tray** throughout its entire length. No alternative method of fixing is acceptable. Pipework must be separated out and fixed with metal saddle clamps. It must not be bunched or fixed using plastic cable ties or velcro straps.

Control cabling may be run alongside the pipework on the same tray, but must not be tied to the pipework or insulation.

Refrigerant pipework must be **insulated and vapour-sealed along its entire length**. If installed **externally**, it must be **protected from the weather, painted with UV-resistant paint and physically shielded against damage**.

Where refrigerant systems have a charge over 3kg and/or refrigerant with a GWP ≥ 5 **leak prevention to** *BS EN378-1: 2008A2:2012* **must be provided** alongside an appropriate **leak detection system**.

A5.6 Air-handling plant & components

Air-handling unit **fan efficiencies** and **heat-recovery performances** must be carefully selected to align with the project’s energy targets and strategies.

The University’s default expectation is that **all air-handling plant will be located in plant rooms**. The use of weatherproof outdoor air-handling units is not allowed without the agreement of the Mechanical Services Project Engineer. Where this is agreed, external air-handling units must be fully weatherproof to IP65 and an assessment of the reduced design life of the units provided.

Casings must be **double-skinned with sandwiched insulation**. **Internal surfaces must be smooth** and without channels, ridges or protruding spire screws. The internals of air-handling units must not contain any materials or substances that could support the growth of microorganisms.

Fresh air inlets must be positioned so they are **unaffected by vehicle exhausts**, and to be as far away as possible from **fume cupboards**, other **exhaust points** and **heat-rejection equipment such as chillers**. Designers must be able to demonstrate that cross-contamination will not occur.

Where fitted, **frost coils must be of the bare-tube type**. Within the design data for coils, assume heat reclaim for the on-coil temperatures and -10°C winter ambient.

Filters must be easily replaceable and fitted with dirty filter indicators. Bag, HEPA and carbon filters must have a pre-filter. **Energy-efficient filters** must be used in all plant. HEPA & carbon filters must only be used on specialist process systems and not for general ventilation. **Magnehelic pressure gauges** must be installed across all filters and differential pressure switches linked to the BEMS.

All air-handling units must incorporate **heat-recovery devices. Plate heat-exchangers are preferred to thermal wheels in laboratory applications**. Run-around coils must be used where there is a risk of cross-contamination of air-flows (such as when handling laboratory extract).

If humidification is needed, **electric resistive type humidifiers** (Neptronic preferred) must be used, with appropriate RO water treatment. Electrode type electric humidifiers **must not be used**.

Fans must be of the **centrifugal multi-plug type** with **N+1 redundancy** and **remote inverter drives**. Belt-drive fans must not be used.

A5.7 General ductwork systems

All general **ductwork manufacture and installation must be in accordance with *DW/144***.

Kitchen extract must be installed in accordance with *DW/172*.

Flexible ductwork must be limited to a maximum of 200mm, with no bends of offset greater than 15 degrees. Flexible ductwork is not allowed on either commercial or domestic kitchen extract systems.

Access panels must be provided adjacent to all in-line plant and dampers. These must be a minimum of 300x300mm. **Transparent vision panels** must also be fitted adjacent to all motorised dampers fitted in ductwork and air-handling units.

Visual indication of differential pressures (such as magnehelic gauges) must be provided where rooms need to operate at higher or lower pressure than adjacent areas and visual verification of the pressure cascade is required. This is usually limited to CL3 laboratories and cleanrooms, but guidance must always be sought from the building's users and reviewed with the University Safety Office.

A5.8 Fume extraction

Fume cupboard extract systems must be **variable air-volume**, with their operating range matched to the normal operating range of the fume cupboard sash heights.

The maximum diversity of the fume cupboard extract volume must be agreed with the Mechanical Services Project Engineer in conjunction with the departmental users.

Face/bypass fume cupboards are acceptable in some cases, but their use must be agreed with the Mechanical Services Project Engineer.

Each fume cupboard must have a balanced quantity of filtered, heated make-up air introduced into the room, in a manner designed to cause as little disruption as possible to the fume cupboard's air flow pattern. The make-up air systems must recover heat from the fume extract and vary in volume to match the volume of air being extracted.

Fume extract systems must be installed in accordance with *DW/154*.

All **ductwork** must be **chemical-resistant UPVC**, along with all components, including dampers, VAV dampers, measuring stations, access doors etc. No metal components may be located within the air-stream.

Note that fume extract systems are the responsibility of Estates Services, whereas the fume cupboards they serve are the responsibility of the occupying department.

A5.9 Fume extraction fans

Fume extract fans must be **duty/stand-by with inverter-controlled motors**. **Direct drives** must be used; belt-driven motors are only allowed where there is no alternative. Where fans are installed externally, they must be IP65 rated and fully accessible.

A5.10 Fume cupboards

Fume cupboard installations must be in accordance with the current University **Safety Office Policy Statement *S9/01*** and with *BS EN 14175*.

Each fume cupboard (or bank of fume cupboards) must have a **dedicated extract system** which discharges at least **three metres above the highest part of the roof** in accordance with the requirements identified in *BS EN 14175*.

Fume cupboards must be fitted with **Firetrace or a similar suppression system** wherever their use could produce a fire risk within the enclosed cabinet. The fire risk assessment for each fume cupboard will be carried out by the department, based on how it will be used. Provide a fire alarm interface from each fume cupboard fitted with a Firetrace or similar suppression system.

Maintainable components in fume cupboards (such as service isolation valves, electrical distribution boards, VAVs, controls interfaces etc) must be fully accessible through a **lockable and hinged access panel** on the upper part of the cupboard. Having to remove under-bench chemical storage cupboards in order to access maintainable components is not acceptable.

A5.11 Fire & smoke dampers

Fire & smoke dampers must be **installed in accordance with** *DW/145* and in a manner that ensures that regular maintenance can be carried out. Access panels must be installed on both sides of the fire barriers where dampers are installed.

Where the installation and ductwork sizes allow, **fire dampers with external re-settable handles are preferred**. These dampers must still be provided with access panels on both sides.

At the conclusion of the full installation of all services, finished ceilings and fixed furniture installed, the contractor must **demonstrate that each damper installed can be fully accessed and a drop test carried out**. This test is in addition to the statutory drop-tests and must occur no earlier than two weeks before the handover of the project, at a time agreed with the responsible University Mechanical Services Project Engineer. Any damper installation that is deemed inaccessible must be rectified. Provide a photographic evidence record of every fire damper location and include this within the O&Ms.

No fire dampers must be installed in kitchen extract ductwork, fume cupboard extract ductwork or within essential supply/extract ductwork for biological safety cabinets or laboratories. Where this ductwork passes through fire compartments, it must be fully fire clad or (in the case of plastic fume/laboratory extract) provided with a fire crush collar. All solutions must conform to the latest edition of *BS EN 1366*.

A5.12 Ductwork cleaning

Ventilation ducting and external louvre plenums must be provided with an adequate number of suitably sized **access points** to enable the ducting to be thoroughly cleaned.

Ductwork cleanliness must be in accordance with *DW/TM 2*. All systems in laboratories must be re-cleaned thoroughly and swab-tested at handover. For clarity, any ceiling void or plenum that forms part of a ventilation system **must also be included in the cleaning.**

The contractor must provide **verification of the cleanliness of all ductwork systems** at handover and certificates provided.

A6 Above-ground drainage

A6.1 General design considerations

Pipework, fittings and accessories must be designed and installed to ensure that **all appliances drain quickly, quietly and completely at all times without nuisance or risk to health**. Discharge must be conveyed away without cross flow, back-fall, odour, leakage or blockage.

Sanitary discharge stacks and small-diameter sanitary waste and vent pipework and WC floats must be installed in **uPVC with solvent-welded fittings**. Main stacks can additionally be in cast iron or HDPE.

Access caps for cleaning must be fully accessible for rodding, and access through architectural casings must be co-ordinated with pipe accessories.

All drainage stacks must **vent naturally to the atmosphere**. Automatic air admittance valves must be avoided.

The requirement for groundwater sump-pumps must be **designed out** wherever possible.

A6.2 Laboratory drainage

Chemical discharge stacks and small-diameter waste and vent pipework must be installed in **black copolymer polypropylene** (Vulcathene, Geberit or similar) with **electrofusion fittings**.

On new installations, the manufacturer used must be agreed in advance with the Mechanical Services Project Engineer. On refurbishment projects, the manufacturer must be matched to that of equipment already installed in the building. Parts and equipment from different manufacturers must not be mixed in the same system.

A6.3 Redundant systems

Where buildings or areas are being refurbished, all **redundant drainage pipework** must be **removed back to the tee** on the main stacks or ground drains and plugged.

A6.4 Condensate drainage and safety discharges

Low-temperature condensate drainage must be in UPVC with solvent-welded fittings.

Condensate drains from air-handling unit coils and heat-exchangers must discharge to drain via **glass-traps**.

Condensate pipework connected to fan-coil units and in-room MVHR air-handling units **must fall naturally to drain**. Dry traps must be used at the connection to the main stacks. **Condensate lift pumps must be designed out wherever possible.** Where condensate pipework runs in voids used as air plenums, it must be thermally insulated.

Where condensate pipework runs in voids that are used as air plenums, it must be **thermally insulated** to **prevent surface condensation**.

Humidifier discharges, along with safety valve discharges from boilers, chillers, air-source heat-pumps or hot water heaters, must be either **direct** or by way of a **manifold via a short length of metal pipe and tundish**. The tundish must be vertical, incorporate a suitable air gap, and any discharge must be visible. Safety valves must not discharge into PVC drainage stacks. Instead, discharge must either be directly over plant room gullies or routed externally with an appropriate guard. Discharges over gullies must be arranged such that they **do not splash** onto the surrounding floor when running.

A6.5 Sump, storm water and sewage pumps

Sewage pumping stations must have the following minimum features:

- Adequate pit size for operation, maintenance and removal.
- Inverter-driven 3-phase duty/assist pumps.
- Guide rails and auto pedestals, or high-level couplings where appropriate.
- Suitable weight-bearing manhole covers.
- Channel/vortex impeller with additional cutter to prevent ragging for heavy duty applications. (*)
- Macerators must be considered where there are long discharge pipe runs, or an excessive static head. (*)
- Coated ductile iron pipework in the pit.
- Bronze knife valve and self-cleaning full-bore non-return valve for each pump.
- Stainless steel chains and shackles.
- In-line grease trap on the inlet pipework, if serving a commercial kitchen. (*) This must be fitted as close as possible to the kitchen.
- Access points for servicing, including adequate clearance for tripods or lifting beams.
- Twin pump control panel.

- Ultrasonic level control (made by Pulsar, or another equal and approved manufacturer).
- The ability to manually start pumps on a time basis if the start level has not been reached, to avoid stagnant effluent.
- System status readout, to include the level in the pit.
- Automatic duty/standby operation.
- Autorotation of duty pump.
- Run and trip indication of pumps.
- High-level alarm, audible and visual on the panel with volt-free connection.
- An alarm that is linked back to the BEMS.
- The panel must be installed with line of sight of the pumps.

Sump and storm water pumps must have similar features to those listed above, except for the items designated with an asterisk which are not needed in these cases.

Pumping stations must be designed and installed to comply with the current Confined Spaces Regulations and a section on safe systems of work provided in the O&M manuals. Lighting that is suitable for a flammable atmosphere must be provided.

A7 Rainwater harvesting systems

A7.1 Design

All **rainwater harvesting systems must be designed in accordance with** *BS 8515:2009* (or any subsequent revisions) by a suitably qualified and experienced engineer. New buildings often have a planning requirement for **storm water attenuation** (from the Environment Agency). Such an attenuation system must be designed in combination with the rainwater harvesting system.

A7.2 Rainwater collection

Rainwater collection must be from the **normal guttering pipework** of the building. The pipework must be arranged so that rainwater enters the storage tank by **gravity or syphonic action only**. Pumping rainwater to the storage tank is not acceptable.

Supply pipework must be free-draining to avoid stagnation, and arranged to **prevent contamination** entering the system at any point.

Where collection from ground-level or trafficked surfaces is proposed, a **risk assessment** following a recognised procedure (such as *BS 31100*) must be undertaken and presented to Estates Services for approval before being adopted as the accepted solution.

Water run-off from green roofs must be **segregated from rainwater harvesting systems** to avoid contamination and discolouration of water systems.

A7.3 Filtration and treatment

All rainwater harvesting systems must feature **debris filtration** upstream of the storage tank. This must have efficiency of at least 90% and must pass a maximum particle size of 1.25mm.

Rainwater systems must also be provided with suitable system of **biocidal control**, such as UV disinfection as described in the Market Transformation Programme (MTP) publication *Rainwater and Grey Water: A guide for specifiers*.

If water is pumped from the storage tank, a **floating suction filter** (such as the Wisy SAFF, or an equivalent and approved product) must be used in conjunction with a remote pump.

A7.4 Rainwater storage

Any tanks which form part of the rainwater harvesting system must be designed and manufactured for the purpose.

The preferred location of rainwater storage tanks is either in **basement plant rooms** or **below ground outside**. Avoid using external tanks above ground as these provide an opportunity for increases in temperature which can encourage **multiplication of Legionella or algal blooms**. All storage facilities, whether they consist of one tank or several, must be designed to avoid stagnation, contamination and microbial growth.

A7.5 Backup water supply

In all cases, a **mains-fed backup water supply** must be provided to ensure that demand can be met during dry periods. Suitable **air gaps conforming to *BS EN 13076* or *BS EN 13077*** must be used, in order to avoid any possibility of contamination of mains potable water with rainwater, in accordance with the Water Fittings Regulations.

The backup water supply must be arranged and controlled to ensure that **only as much water as is needed for immediate use is supplied**.

Consideration must also be given to the **appropriate use of the rainwater system during dry spells**. Certain uses (such as irrigation) may not be appropriate when the system is being supplied by mains backup rather than rainwater.

A7.6 System arrangement and distribution

The entire system, including collection, storage and distribution systems, must be designed so that there are **no dead legs** and there is an **adequate turnover of water to avoid stagnation**.

All storage tanks must have an **overflow outlet of equal or greater capacity than the inlet** to allow discharge during extreme rainfall. If an anti-surcharge device is fitted, it must **conform to *BS EN 13564***.

Rainwater must be distributed from the storage tank using a **pump located outside the tank and a suction pipe arrangement**, the latter being arranged to minimise the possibility of sucking in air, sediment or debris through use of a floating suction filter. Determine the **flow rate and pressure head of the pump in accordance with *BS EN 12056-4*.** A non-return valve with isolating valve must be incorporated into the suction line to prevent drain down of the water column. Where multiple pumps are used, the system must conform to *BS EN 12056-4* (as amended).

Rainwater pipework must be distinguished from potable water pipework through the **use of different colour pipework, as set out in *WRAS Information & Guidance Note No 9-02-05***. It must not be blue, to avoid any confusion with mains potable water supply pipework.

A7.7 Controls and metering

Controls must be designed to **minimise energy consumption and operational wear**, and to **activate the backup water supply automatically**. They must have suitable connections to allow the system to be connected to a BEMS.

The backup water supply and the pumped outlet from the storage tank must both have **flow meters** so that the system's performance can be monitored. These meters must be capable of being monitored remotely through connection to the PME system.

Consideration must be given to incorporating **status monitoring**, which provides additional information such as how full the tank is, any plant faults, and which supply is being used.

A7.8 Testing

The system must be **flushed and tested** as part of the normal commissioning of the building services systems. **Pipework must be tested in accordance with, and meet the standards of, *BS EN 805***.

Commissioning certification will be provided only after all system components have been tested and shown to comply with all relevant legislation, regulations and standards.

On handover, a **Legionella risk assessment and monitoring programme** for the system must be provided.

A8 Ground & air source heat pumps and LZC technologies

A8.1 Overview concepts

Strategies for the incorporation of renewable energy, and low-carbon heat sources into schemes are discussed in the University's *Sustainability Design Guide (SDG)*.

All heat pumps within the University must be designed, installed, controlled and interfaced with other systems with the primary purpose of **reducing carbon emissions** and **achieving the University's energy targets**. The equipment selections and control strategies for carbon emissions reduction may be different from those for cost savings.

The design must set out clearly in the Stage reports **how much heating and cooling the system is designed to supply** (both in absolute and percentage terms), the likely **availability of the system** (and what happens if this is not achieved), and the **annual average COP** of the system in heating and cooling.

Where bivalent systems are proposed, the **non-heat pump system's operation must not be more than10 percent of the annual heating energy requirement**. The systems must have parallel bivalent rather than alternative bivalent operation. Configure the control system so that the supplementary heat source is not activated to reduce the preheat period when outside temperatures are above the bivalent point.

Ground source systems must be designed so that the **amount of heat extracted from the ground annually is reasonably well balanced with the amount of heat rejected to the ground** as far as is practical. The depth of the loops is limited by the Great Oolite Aquifer, particularly where buildings have deep basements. Designers must take this into account and obtain approval from the environmental agency if they wish to go through the aquifer.

A8.2 Design

Modular heat pumps are preferred over single large heat pumps, and suitable **redundancy** must be installed in consultation with the Mechanical Project Engineer. Simultaneous heat recovery heat-pumps are preferred where there will be waste heat in winter such as in laboratories or any building with process systems. Heat pump locations must be carefully considered to facilitate future maintenance, and a specific strategy must be presented to demonstrate that individual components can be easily removed and replaced through the building.

If the replacement philosophy requires the unit to be craned in and out as a single component, the maintenance strategy must identify suitable crane locations and ensure that these areas are designed to allow for the weight loadings this will produce.

Suitably sized **buffer vessels** must be installed to alleviate short-cycling of the heat pumps. These must be either duty/stand-by or provided with a bypass arrangement, so that the system can still operate in the event of a single vessel failure.

Where **dual heating and cooling heat pumps** are proposed, there must be **full hydraulic separation between the chilled-water and heating distribution systems**. Change-over shut-off valves are not acceptable.

A8.3 Domestic hot water

Where low-temperature heat pumps are used to generate domestic hot water, the system must be designed so that any **central storage vessel can be maintained at 65°C** and a full pasteurisation cycle can be carried out.

A8.4 Controls & metering

Wherever possible, heat pumps must be provided with **Trend outstations**. Where this is demonstrated to be impossible, the heat pumps must **fully interface with the University's Trend system via Modbus or BACnet** with a full read-write availability of the system set-points.

Where BACnet or Modbus controllers are used, there must always be a hard-wired enable, fault and temperature set-point signal from the Trend BEMS system to the heat-pump.

The heating and cooling operation of the system must each be **fully metered** in accordance with Appendix E of this document. As a minimum, **each individual heat pump must have an energy meter** and report the overall energy performance and heat delivered. Where heat pumps are installed in bivalent systems, the BEMS must also report the percentage of total heating/cooling delivered by each system. Meters must have sufficient granularity to measure half-hourly consumption at minimum turndown of the system they are monitoring.

A8.5 Installation

Plant components, access and maintenance strategies and network delivery systems must all be as set out in the relevant sections of this philosophy document.

The designer must **witness the factory testing of the heat pumps under load** at representative source and load side temperatures. The responsible Estates Services Mechanical Engineer must also be given the option to attend this demonstration.

Refrigerant leak-detection systems must be installed on all heat pumps and must send an alarm signal to the BEMS.

A8.6 Commissioning

The heat pump system needs to be witnessed jointly with the BEMS after both systems have been fully commissioned.

A8.7 Operation

At handover, ensure that all the heat pump **meters are reset to zero,** or where this is not possible, record the current values.

The contractor and designer must produce **monthly reports of performance following handover**, which will be reviewed by the Estates Services Building Services and Sustainability teams, and by the Project team, as part of the seasonal commissioning.. Major reviews must also be carried out to assess seasonal performance and used to inform the system's fine turning during the soft landing period. The project manager must coordinate these meetings with participation from designers and the Estates Services Mechanical and Environmental Sustainability teams as part of the seasonal commissioning process.

A8.8 Solar hot water

Domestic hot water generation via solar thermal is not a preferred solution and **will not normally be accepted**. Where this is proposed, a full cost/energy benefit must be provided for consideration, and the final decision will be made by the Mechanical Services Project Engineer and the Environmental Sustainability team.

A8.9 Other LZC technologies

Combined Heat and Power systems (CHP), **wind turbines** and **biomass systems will not normally be accepted** as design solutions.

Appendix B – Electrical Systems

B1 General

As with all building systems, electrical installations must be **readily accessible and straightforward to operate, maintain, extend and replace**. They must also allow for **periodic testing and inspection with minimal disruption to building users**.

Where plant is hidden for aesthetic reasons, 'accessible' means that **hatches, removal panels and other access devices can be removed by a single person without using tools or lifting devices**.

The University's electrical systems and associated equipment are undergoing a **process of rationalisation and standardisation**. It is therefore essential that the principles outlined in this document are strictly followed.

All parts of an electrical installation (load capacity, ie switchgear, cables and containment capacity) must be sized with a **minimum of 25% spare capacity to cater for future growth**.

Although **surface mounting** of electrical services is preferred, it is recognised that prestigious areas within buildings will require a more sympathetic approach. Within such areas, how to **conceal electrical services** must be agreed with the Head of Electrical Engineering Services within Estates Services.

The **selection of equipment**, particularly main switchboards and 11KV apparatus, must also be discussed and agreed with the Head of Electrical Engineering Services at the earliest opportunity. If possible this should be at Stage 2 of capital projects, and must be no later than Stage 3.

The **electrical drawings** referenced in this appendix, and elsewhere in the *Building Services Design Guide* – see Appendix H – are available on the Estates Services website.

All systems must be designed to be **simple, symmetrical and easy to understand**. Drawing no. 400005 illustrates the layout of a typical Estates Services electrical distribution system, complete with labelling requirements.

Systems must be designed, specified and supervised to ensure **full compliance with** ***BS 7671*** as well as other relevant regulations, codes of practice and HSE directives, to ensure the provision of a suitable electrical system to the University's satisfaction.
Circuit protection must be by circuit breakers – fuses must not be used, except in life safety systems or lightning surge protection.

The **neutral conductor must be switched** on the incoming supplies and at strategic points throughout the system to ensure **complete isolation of sections of the system to simplify fault investigations**.

Instrumentation and metering must have sufficient **flexibility to enable load analysis**. See Appendix E – Metering for details.

Laboratories and research rooms must be equipped with their own final circuit distribution boards, which must be complete with recording instrumentation and have facilities for metering if required – see Appendix E – Metering for details. The location of these distribution boards needs careful consideration, and they must be positioned so that they are fully accessible and can be worked on without using a ladder. They must not be positioned above or behind doors or laboratory benches, or in any other position where access may be obstructed by user activities. Only power circuits within the room may be supplied from these distribution boards.

Critical -80° freezers must preferably be grouped together in freezer rooms and fed from a **dedicated distribution board** that is supplied from the building main switchboard.

Fume cupboards must be provided with a **dedicated distribution board** fed from the room distribution board. This board must be tested and verified by the manufacturer after the fume hood is installed and assembled.

All **indoor cables must be Low Smoke Zero Halogen type**, whether armoured or not. All **external cables must be laid directly in the ground, in accordance with part IV of the** ***ESQC 2002*** **regulations**. **Ducts must be avoided** except during road crossings. **Cables must not be located under buildings**. In the event of new buildings being placed across a cable route, the relevant cables must be diverted.

Where the project involves working on or extending existing electrical services, no work may be carried out on the existing systems without the **prior knowledge and approval of the University Head of Electrical Engineering Services**. All work must be carried out in accordance with Estates Services Electrical Safety Rules.

Only electrical contractors who have been **inducted into the Estates Services Electrical Safety Rules** (ie **Blue Book** suppliers) will be allowed to work on the University's fixed electrical systems.

B1.1 External networks

The University owns and operates several external networks in Oxford. These networks are generally of two types:

- **HV Network:** One or more high-voltage substations on a system where all the HV and LV equipment is owned and operated by the University.
- **LV Network:** A network where the LV switchboard which supplies more than one building is directly connected to a local DNO-owned transformer.

The point of supply must be discussed and agreed with the Electrical Engineer at the earliest opportunity.

Any **reinforcement of the University electrical supply network** that is needed because of additional electrical loadings for new or refurbished buildings **must be funded by the individual building project(s)**. The reinforcement must be designed, organised and implemented as part of the project, to comply with the technical details provided by Estates Services.

The design and installation of all new incoming supplies from the University network will be arranged in conjunction with Estates Services based upon the anticipated building electrical loadings provided by the project electrical consultant/contractor. Estates Services will provide values for the HV network fault level and earth fault loop impedance.

B2 HV and LV cable networks

2.1 HV cable networks

For all University networks containing two or more substations, it is expected that the network will be **connected either directly to the local DNO primary substation,** or via a **metered switch located in a local DNO substation**.

All University HV cable networks are designed and installed in the form of an **open ring**. Cables must be routed so that they are not laid together with any other cables that form part of the same network. The **open point on a ring must be determined by the load and building types**, as advised by the Head of Electrical Engineering Services. This is of particular concern for those buildings containing essential supplies where it may be appropriate for the adjacent substation to be on a separate part of the network. This is to enable speedy resumption of supply in the event of an HV cable failure.

The cables must be **PVC insulated, armoured, with copper conductors** complying with *BS 6622*. All the cables in each part of the HV ring network must be a **minimum of 185mm^2**. Transformer cables must be sized by rating and fault level.

Consideration must be given to network design, such as **placing loads over as many circuits as practicable**, **reducing disruption to as few buildings as possible during faults** etc. For guidance, all University high voltage ring circuits must have a **minimum capacity of 8MW**. All systems must be designed for a **50-year life**. All networks must be composed of ring circuits with no spurs or tees, and with joints kept to a minimum.

All cables must be **accurately mapped, including the locations of all joints, onto University standard drawings** maintained by the Estates Space Management team.

2.3 LV cable networks

To enable future maintenance and allow local HV faults to be dealt with, all University networks containing two or more substations must have **each substation connected to at least one other substation via an LV system with a capacity not less than 500kVA**.

Each interconnection must consist of a **minimum of 2* 4c 185mm^2 PVC/SWA/PVC cables run in parallel**. It must also incorporate a **supplementary earth conductor with a minimum size of 185mm^2**.

Each interconnecting cable group must be directly coupled between substations, with no branch/tee joints.

2.4 Building supply cables

For all buildings with a proposed **demand greater than 250 kVA** or house **critical operational services**, **two circuits must be provided from the local University substation**. Each circuit must be connected to a separate transformer, and sized such that it can provide at least 80% of final connected load or 100% connected load if the building has critical operational services.

Design teams must liaise with the Electrical team within Estates Services, and with other stakeholders including building occupants and the Project Board, if applicable, to determine precisely how much spare power capacity is needed.

Building switchboards must ideally be located on the ground floor and positioned so that **supply cables do not pass through significant parts of the building** before reaching them.

2.5 Life safety system cabling

All **cabling associated with life safety systems** must be designed in accordance with *BS 8519*, *BG 70*, *TB 210* , *BS EN 12101-10* and *BS 9999*. This includes requirements for type of cabling, associated containment and location of plant and/or switchboards.

The **project-specific fire engineering report / risk assessment** must be consulted to ensure compliance.

B3 Substations

B3.1 General requirements

All substations that are owned and operated by the University, and located on its land, must comply with the following requirements:

No switch room must have wet services, from drainage to cold water services.

All **substation enclosures** must be constructed in accordance with the *ESQC Regulations 2002*.

All substations must be constructed to **prevent intrusion by rodents or other vermin**.

All substations must also be assessed regarding whether there is a need for **leak detection monitoring**.

All substations must incorporate an **internal HV compound** and an adjacent **fully enclosed LV switch-room**. All access doors must be secured as detailed elsewhere in this document.

All substations must have **1000V rubber matting** to the front and rear of all sections of the LV switchboard. Internal floors must be constructed so as to provide a **non-slip dust-proof surface**.

All **internal LV floor cable trenches must be fully protected by removable marine plywood varnished covers**.

Thermostatically controlled **frost protection electric heating** must be installed in all LV switch rooms. Heating must be fed from the local distribution board. A dedicated **temperature and humidity sensor** must be connected directly into the metering system, to provide environmental information about the switchroom.

Adequate **ventilation** must be provided in all LV switch rooms, to prevent condensation.

Suitable **RCD-protected 13A sockets** must be provided in both LV switch rooms and HV compounds.

Adequate precautions must be taken to **prevent water ingress into the cable trenches from incoming ducts**. A detailed proposal for incoming ducts and how water ingress will be prevented must be discussed with, and agreed by, the Estates Services Electrical Engineer. External groundwork must consist of a **covering of loose pebbles or gravel**, complete with **weed control fabric**.

All substations must include a **sump pump within open trenches**, which must be connected back to the PME system to provide indication of activation and fault conditions.

A **racking trolley** must be provided under the contracted works and left in place at the end of the project within the substation for future operational use.

B3.2 Substation access

Substation door **lock cylinders will be provided by the Estates Services Electrical Engineering team**, and must be installed as part of the contracted works.

LV switch rooms must be suitably sized to provide **at least 1500mm of clear space around front and rear of the switchboard**. This applies to new substations. When dealing with existing substation LV switch rooms, discuss the situation and agree a solution with Estates Services Head of Electrical Engineering.

All equipment, including switchgear, must be placed so as **not to impede emergency evacuation** from the site.

Entrance access doors to switch rooms must be sized to allow for **unimpeded installation and replacement of all components** of switchgear, or the total size of a standalone cubicle/section.

B3.3 Substation wiring

Each switch room must be provided with a suitably sized **3-phase distribution board** in a suitable location on the wall. This must be fed from the centre section of the main switchboard via a suitably sized 4-pole MCCB.

All substation LV switchboards must be provided with a **generator connection point**, as described below. The connection point must be connected to the centre section of the main LV switchboard and sized to match the output of the supply transformer (1No).

The connection point must be fully rated to the generator output and be complete with **power lock connectors** in either a weatherproof remote enclosure in a suitable location external to the LV switch room, or via a standalone cubicle of the LV switchboard (if suitable). If a remote connection unit is used, its location must be agreed with the Estates Services Head of Electrical Engineering.

Functional lighting to a minimum of 500lux at floor level with a **uniformity of 0.4** must be provided in all LV substation switch rooms. All functional luminaires must be complete with **3-hour emergency lighting battery packs**, tested via local key test switches. No standalone emergency lighting will be allowed.

Please refer to Appendix F for details of the **fire alarms** that must be provided within a substation.

B4 High-voltage switchgear and transformers

Each item of HV switchgear must consist of a **630A (21kA rated) Ring Main Unit (RMU) from the Schneider Ringmaster D range**. This can be either close coupled or remote from the transformer, depending on the project's requirements.

The RMU specification must be as follows:

- Schneider Ringmaster RN2d
- Rating - 200A. (at the transformer breaker)
- Non-extensible.
- VIP 400 self-powered protection relay.
- Short time withstand – 21kA.
- All devices to have automation to operate via a T300 device.

RMUs must also feature **motorised devices** on both the **incoming ring switches** and **outgoing circuit breaker**.

Each HV switch must be fitted with a **Schneider T300 remote unit** and **directional C/Ts** fitted to each ring switch, including **Fault Passage Indication**. The T300 controller must not be located in the same space as the transformer, and ideally must be mounted in the LV switch room.

The **transformer** must be protected by a **Schneider VIP400 protection relay**.

Restricted earth fault protection must be provided on all systems where the transformer is not located directly adjacent to LV switch room. The system must be designed to open both HV and corresponding LV switches.

Each transformer circuit breaker must be provided with a **24v DC shunt trip coil**, connected to an **Emergency Power Off switch (EPO)**. Each EPO must operate both the **transformer HV circuit breaker** and the **corresponding LV circuit breaker** on the main LV switchboard.

Each EPO must comprise a **break glass unit** located inside the LV switch room adjacent to the main door and within the HV transformer location. A suitably sized **wall-mounted battery and charger** must be provided to power the system. (Battery charger details can be found in section B4.2 below).

For safety reasons, operators must have **direct unimpeded access from the substation entrance to operating handles**.

At least **1000mm of unimpeded access** must be provided around all the equipment, with a **2000mm operation zone in front of the HV switchgear**.

B4.1 Transformers

Standard substation configuration consists of **two transformers with associated HV switchgear**.

All transformers must be **11000V\415V Tier 2, ground-mounted free-breathing, KNAN Midel 7131 fluid filled**. **Tier 2 cast resin transformers** may be used if suitable for the application (for example where the transformer is located within a building, in order to **reduce fire risk**). The **cooling** method that will be used for cast resin transformers (forced air or natural air) must be discussed with the Head of Electrical Engineering Services at an early stage.

Use of **amorphous core transformers may be considered**; this must be discussed with the Head of Electrical Engineering Services before any detailed design work is done or any transformers procured.

HV tappings must be +-2.5% to +-7.5%. (A 6-position switch must be used).

Transformers must be of the **vector group DYN11**, with an **impedance matching adjacent transformers but nominally <5%**. It must be noted that **transformers may be run in parallel for short periods**.

Each transformer must be **sized to suit the required load**, but must be **not less than 500kVA**. The designer must allow for each transformer to operate at no more than 70% capacity on completion. For transformers greater than 1.5MVA, prior agreement must be sought from the Estates Services Head of Electrical Engineering.

Each transformer must be **directly connected to the LV switchboard using cables or busbar**.

Each transformer must be **mounted on a suitably constructed concrete plinth** with adequate access for cables. Adequate **containment of coolant leakages** must be provided.

Adequate access must be provided to allow **unimpeded transformer replacement**. How this will be done must be detailed in a defined Access and Maintenance Strategy.

The **HV termination box must be of the dry type**, with a **gasket-sealed lid** oriented to accept a local cable connection.

The **LV termination box must also be of the dry type**, with a **gasket-sealed lid** oriented to accept local cable or busbar connection.

All labelling must be as detailed in section B14 of this appendix.

B4.2 Trip batteries

A **24V trip battery** manufactured by **PB Design** (from the **DC tripper** range) must be provided at each substation. It must be a **valve-regulated lead acid battery,** designed for a **10-year life at 20°C**.

The **T300 integral battery system must not be used to trip the LV switch board circuit breakers**. A standalone unit must be designed and installed. However, both systems must be interlinked to operate both the HV and LV circuit breakers.

The system must be fitted with an **audible alarm** with additional **volt-free contacts to enable connection to the PME metering system**.

B5 Earthing

B5.1 Earthing in general

The **earth system** must be **designed and installed in accordance with *BS 7430* and *BS EN 50522***.

An **Earth Rise Potential study (ERP)** must be completed and an earthing design based on its output submitted to the Estates Services Electrical team prior to construction. This must include **details of earth potential rise, Touch and Step voltages**. No HOT sites will be permitted.

Resistivity measurements must be carried out using the **Wenner 4-pin method**.

The earth system must be **TNS**.

A **hard-drawn copper earth**, sized in accordance with a fault-level analysis study, must be provided in the substation. The bar must be **wall mounted on shock-resistant insulators** in a suitable location adjacent to the LV switchboard. The **earth bar must have a minimum of 25% spare ways** on completion.

The external earth electrode system must be connected to the substation earth bar by means of a **removable link** with a suitably labelled green/yellow sheathed copper conductor not less than $70mm^{2.}$

The transformer **neutral/earth link** must be provided in an accessible location within the LV switchboard.

Each transformer and all associated HV switchgear must be **separately connected to the substation earth bar** with a suitably labelled green/yellow sheathed copper conductor.

B5.2 Earthing – special requirements

The clean earthing system must be taken along the same routes as the main distribution. It must **start at the main earthing busbar** and **connect into a multi-outlet busbar at each level**. The interconnections between the busbars must be via **insulated, flexible multi-stranded cable** to minimise impedance to high-frequency leakage currents. The requirements for reference/special earths must be determined with the building user, before being discussed and agreed with the University Electrical Engineer.

B5.3 Generator earthing

An **independent earth electrode** must be installed to meet the requirements of *BS 7430*, to cater for the generator being operated independently to the primary supply. This must be connected back to the MET, within the substation or within the LV switch room.

Refer to section B6 for details of the requirements for neutral to earth contactor arrangement.

B6 Low-voltage switchboards

B6.1 Definitions
For the purposes of this guidance, the following definitions apply:

- **A substation LV switchboard** is supplied directly by one or more HV transformers, and supplies one or more University buildings.
- **A building LV switchboard** is supplied from either the local DNO, or a University substation LV switchboard.
- **A final LV switchboard:** Is any one of the following switchboards that are supplied directly from the building switchboard by cable or busbar riser:
  - Special panel
  - MCCB final distribution panel
  - Any switch board or control panel that contains protective devices

B6.2 Switchboard construction
Unless otherwise specified, the following section applies to all types of switchboard.

All switchboards must conform to *BS EN 61439-2*.

Where top-entry switchboards are installed, they must be mounted on a suitably constructed **plinth with a minimum height of 100mm**. Sufficient space (spatial and gland plate) must be provided to terminate the largest foreseeable size SWA cable (nominally no greater then 300mm^2), taking into consideration the containment routing and bend radii. Additional side-entry glanding boxes are prohibited.

The **switchboard fault rating** must be designed to **withstand the maximum fault current available (including the paralleling of transformers)**. The PSC value must be determined after taking account of all incoming supply characteristics, as well as contributions from connected loads. The fault rating must be determined by calculation and presented to the University Head of Electrical Engineering for approval, prior to the procurement of any switchgear/transformers.

All switchboards must be designed and constructed in **cubicle form** so that they can be extended on either side, and erected by the switchboard manufacturer. Prior to despatch, the switchboard must be **factory tested** in accordance with *BS EN 61439-2*.

All **exposed external metalwork** must be finished with **electrostatically applied epoxy powder primer and paint**.

Ventilation grills on the front of LV switchboards **are not acceptable.**

A **mimic diagram** must be applied to the front of the switchboard. This must accurately indicate the **internal busbar routing** (including height from floor) and **connection to all switches**.

The **switchboard frame must be fully welded**, and manufactured from **Zintec steel at least 2mm thick**. **Panels and doors must** be dished and manufactured from **Zintec steel with a minimum thickness of 1.5mm**.

All **3-phase cable gland plates must be hex-bolted and removable**, with **plates made from Zintec steel at least 3mm thick**. Gland plates for single-core cables must be non-ferrous.

A minimum of **25% spare MCCB ways** are required on all new switchboards. **At least one spare way of each size** must be allowed for (one 250A and one 630A each side of the bus-coupler at minimum), subject to the minimum 25% rule.

Where the number of spare ways proposed dictates that a single spare way would necessitate a further cubicle section, this must be brought to the attention of Estates Services prior to manufacture.

The **minimum frame capacity is 250A TPN**.

The **colour** of the LV switchboard must be **RAL7035.**

B6.2.1 Busbars

All **conductors must be of hard-drawn high-conductivity copper**, **fully rated to the fault rating of the paralleled transformers**.

The **current rating of all neutral bars** must be the **same as the respective phase bars**.

The **earth bar must run the full length of the switchboard** and be positioned to ensure that **connections can be taken easily from it**. Each cubicle section must be positively connected to this bar.

All **spare ways must be equipped with copper work and pluggable base** in the same way as an equipped circuit, to enable future circuits to be added without needing to switch off the incoming supply.

B6.2.2 Switching devices

All **switching devices** must **break all incoming phase conductors simultaneously, including the neutral**.

Switchboard devices up to and including 630A must consist of a suitably sized **plug-in Moulded Case Circuit Breaker (MCCB) from the Schneider NSX range**. The **trip unit** must be from the **MicroLogic 5 range**, and must be fitted with **FDM121 meters**.

The **fault rating** for all switching devices must be assessed via **calculation based on the total fault current of the paralleled transformers**.

Switchboard devices above 630A must comprise a **withdrawable Air Circuit Breaker (ACB) from the Schneider MasterPact MTZ range**, rated to suit the application. All ACBs must have Bluetooth connectivity for opening and closing of the device remote from the switchboard, which must be connected back to the PME metering system for remote monitoring and status of all devices within the LV switchboard. The **trip unit must be a MicroLogic 6P**, sized to suit the application.

All outgoing circuits must be equipped with over-current and short circuit protection from the **Schneider MicroLogic 5/6 A or E ranges** of trip units, complete with **LSI protection and LSIG for generators**.

All **outgoing circuit breakers** must be **able to be plugged into a pre-connected base assembly equipped with a safety trip to prevent plug-in connection to the base unit in the on position**. A pre-connected base (rating to be advised by designer) must be fitted to all spare ways.

All circuit protective devices must be equipped with a **manual "push to trip" mechanism** to test the operation of the device. The **status of the contacts must be clearly visible** when viewed from the front of the switchboard. The "push to trip" actuator must be **adequately shielded** to prevent inadvertent operation.

All switching devices must be capable of being padlocked using a University-approved system which forms an integral part of the switchboard, in both **on** and **off** positions, by means of a Union Cat. No: 3104 padlock.

All **device settings must be determined beforehand and set during commissioning**. All **trip setting details** must be recorded and provided to Estates Services prior to handover.

B6.2.3 Metering and instrumentation

A suitably rated **CT must be fitted to each phase and neutral on all incoming and outgoing circuits**. See Appendix E – Metering for detailed guidance on metering in University buildings.

B6.2.4 Labelling

All switchboards and circuits must be labelled in accordance with Appendix G –Labelling.

B6.3 Substation LV switchboards

This part of the guidance is based on the standard substation arrangement, which comprises two liquid-cooled transformers.

The specific cooling medium to be used must be discussed and agreed with the University Electrical Engineer. A typical general arrangement for a two transformer substation LV switchboard is shown on drawing E400987.1.

B6.3.1 General

All switchboard **incoming and outgoing arrangements must conform to *BS EN 61439* –Parts 1 & 2**.

The construction arrangement must be:

- For **incoming transformer feeder(s) - form 4b type 7**.
- For **outgoing circuits - form 4b type 6**.

The **IP rating must be at least IP31**.

Access to the switch room must be either **direct from outside the building**, or from the adjacent **circulation space**.

The Estates Services Electrical team will provide cylinders for the locks on access doors on request.

The switchboard must be arranged to allow **operation from the front**, with rear access for cabling. Its design must provide for **cables to enter from above or below**, depending on site conditions.

Access to the rear of the panel must be via **padlockable hinged doors**, using 1.25" Pin tumbler padlocks as manufactured by Union Cat 3104. Estates Services will provide type B locks for use in these situations.

LV supplies must be arranged and suitably rated to permit **parallel operation of the transformers**. No interlocking mechanisms must be fitted.

All **switchboards must have a minimum of 1500mm front and rear clearance**.

The panel must be of **fully welded construction**, with no modular or bolted assemblies. It must be complete with **thermal imaging of busbar / cable termination connections**.

The switchboard must be constructed for **arc flash containment to protect the operator**. No vents must be mounted on the front elevation of the switchgear.

B6.3.2 Busbars

All conductors must be of **hard drawn high conductivity copper fully rated**.

B6.3.3 Switching devices

Switchboard devices (including bus sections) above 630A must consist of a **withdrawable ACB from the Schneider MasterPact MTZ range**, rated to suit the application. All ACBs must have Bluetooth connectivity for opening and closing of the device remote from the switchboard. The **trip unit must be a MicroLogic 6P**, sized to suit the application.

For **outgoing circuits up to and including 630A**, a suitably rated **pluggable 4-pole plug-in MCCB from the Schneider NSX range** must be used. The **trip unit must be from the MicroLogic 5 range**, selected to suit the application.

If a **rotary handle** is installed to the MCCB door, the **internal MCCB must feature a lock** so that it can be safely locked off when the door is open.

B6.3.4 Metering and instrumentation

Refer to Appendix E – Metering for detailed guidance on metering in University buildings.

All **metering address modules** must be mounted in an individual compartment.

B6.3.5 Arc flash

The switchboard manufacturer is responsible for completing **arc flash calculations** in order to determine **whether the maximum permissible 40cal/cm^3 is exceeded**. The results of these calculations must be provided to the electrical contractor and to Estates Services. This must in turn inform the **incident level for PPE selection and arc flash containment**, as part of the overall LV switchboard design.

B6.3.6 Neutral/earth requirements

Where generators are to be synchronised to the building, a **neutral to earth contactor** must be installed, to **ensure that the earthing arrangement is completely independent of the primary supply and its associated earthing arrangements**.

B6.4 Building LV switchboards

B6.4.1 General

The **switchboard incoming arrangements** must conform to *BS EN60439-1: 2011* Form 4b type 7. All busbars must conform as a minimum to *BS EN60439-1: 2011* Form 4b type 6.

The building LV switchboard must be designed to accommodate **two LV incoming supplies** with a **single bus-section switch**.

A typical general arrangement for a building LV switchboard, incorporating two incomers, is shown on drawing E400987.2.

A typical general arrangement for a building LV switchboard, incorporating a single incomer, is shown on drawing E400987.3.

The **IP rating must be at least IP31**.

All switchboards must have **at least 1500mm of front clearance**. **Rear-access switchboards** will require **1000mm perimeter clearance**.

No pipework of any kind, or any other **unrelated equipment** (such as emergency lighting inverters), **may be installed within the switch room**.

Access to the switch room must be either **direct from outside the building**, or from the adjacent **circulation space**.

Ventilation grills on the front of LV switchboards **are not acceptable**.

B6.4.2 Busbars

Primary busbars on switchboards must be sized to meet load requirements.

All conductors must be of hard-drawn high-conductivity copper, and must be fully rated.

B6.4.3 Switching devices

For **switchboards up to and including 630A**, the incoming device must be a **fixed unit non-auto 4-pole from the Schneider NSX range**.

Switchboard devices (including bus sections) above 630A must consist of a **withdrawable ACB from the Schneider MasterPact MTZ range**, rated to suit the application. All ACBs must have Bluetooth connectivity for opening and closing of the device remote from the switchboard, which must be connected back to the PME metering system for remote monitoring and status of all devices within the LV switchboard. The **trip unit must be a MicroLogic 6P**, sized to suit the application.

For all **outgoing circuits up to and including 630A**, the device must be a **4-pole plug-in base MCCB**. All spare ways must be fully equipped with base portion.

All **trip units must be from the Schneider MicroLogic 5 range**, sized to suit the application.

If a **rotary handle** is installed to the MCCB door, the **internal MCCB must feature a lock**, so that it can be safely locked off when the door is open.

B6.4.4 Metering and instrumentation

Refer to Appendix E – Metering for detailed guidance on metering in University buildings.

All **metering address modules** must be **mounted in an individual compartment**.

B6.4.4 Arc flash

The switchboard manufacturer is responsible for completing **arc flash calculations** in order to determine **whether the maximum permissible 40cal/cm^3 is exceeded**. The results of these calculations must be provided to the electrical contractor and to Estates Services. This must in turn **inform the incident level for PPE selection and arc flash containment** as part of the overall LV switchboard design.

B6.4.5 Neutral/earth requirements

Where generators are to be synchronised to the building, a **neutral to earth contactor** must be installed, to **ensure that the earthing arrangement is completely independent of the primary supply and associated earthing arrangements**.

B6.5 Final distribution panel boards

This part of the guidance sets out requirements for final, special, and rising main panel boards, generally up to 630A, that are installed in University buildings.

B6.5.1 General

The **switchboard incoming arrangements** must conform to *BS EN60439-1: 2011* Form 4 type 4. All **outgoing arrangements** must conform to *BS EN60439-1: 2011* Form 4 type 3.

The **IP rating must be at least IP31**.

B6.5.2 Busbars

Primary busbars on switchboards must be sized to meet load requirements.

All conductors must be of hard-drawn high-conductivity copper and must be fully rated.

B6.5.3 Switching devices

The **incoming switch device** must be a suitably rated **non-auto 4-pole fixed MCCB from the Schneider NSX range, with MicroLogic 2 protection module**.

All outgoing devices must be a suitably rated **4-pole plug in MCCB from the Schneider NSX range** as above.

B6.5.4 Metering and instrumentation

See appendix E for details of the Metering gateway.

All metering address modules must be mounted in an individual compartment.

B7 Building distribution systems

B7.1 Vertical distribution

Major **LV sub-main distribution systems must be run vertically to serve all floors**. In general this will be in a **central position using busbars**. However, **multiple busbars** may be used on larger buildings.

Risers must have at least 25% spare capacity in terms of **load and physical tap offs**, to allow for future growth of electrical load and to provide space to allocate new electrical distribution boards.

For detailed guidance on metering instrumentation of riser boards, see Appendix E – Metering.

B7.2 Horizontal sub-distribution

All sub-distribution systems must be installed in **accessible circulation spaces** up to the point where cables terminate into final circuit distribution boards, which must be sited either in circulation spaces or in the room(s) the board will serve.

Sub-distribution cables and final circuit wiring on any floor level must be **run between the soffit and floor surfaces of that level**, and must be accessible for inspection over the complete length of run.

Cable containment systems must be **visible and fully accessible throughout their entire length**. Trunking lids must be easily removable and replaceable wherever they are installed.

Containment capacity must be maintained throughout the length of the system; reduced-capacity links between walls and partitions are not acceptable. Dedicated cable trays or baskets must be provided for telecommunication and data cabling – dividers or multi-compartment trunking will not be allowed.
Each room and circulation space is assigned an Estates Services space reference code, and these must be used to label all circuits in accordance with the latest Estates Services standard – see section B14 for detailed guidance on labelling.

B7. 3 Distribution board

Sub-distribution must be **from the riser boards to final circuit boards in laboratory /workshop and circulation spaces**. **Dedicated lighting and power distribution boards are required** - no split load distribution boards will be allowed.

Laboratories and research rooms must be equipped with their own final circuit distribution boards, which must be complete with recording instrumentation and have facilities for metering if required – see Appendix E – Metering for details. The location of these distribution boards needs careful consideration, and they must be positioned so that they are **fully accessible and can be worked on without using a ladder**. They **must not be positioned above doors or laboratory benches**, or in any other position where access may be obstructed by user activities. Only power circuits within the room may be supplied from these distribution boards.

Distribution boards must be positioned so that they are **fully accessible** and can be worked on without the use of a ladder or other aids. They **must never be located in mechanical services plant rooms** unless they serve the equipment in those areas.

Distribution board enclosures must be from the **Schneider Acti 9 range**. The specific configuration must be discussed with the Head of Electrical Engineering Services.

Incoming supply cables to main isolator\switch disconnector must be **fully shrouded**.

All distribution boards must be fitted with a **type 1/2 Surge Protection Device (SPD)** and protected by an adequately selected and sized **circuit protective device**.

B7.4 Final circuit wiring

Where practicable, all **containment must be run on the surface**. Supplies to sockets, data and telephones within a room must be run in **dedicated containment positioned at high level**.

Low-level services for desks must be provided using **two-compartment dado trunking**. **Three-compartment trunking** may also be used, subject to approval from the Estates Services Electrical team. **Conduits may be installed within a wall**; however, suitable access must be available directly above in the ceiling void for future alterations/additions.

Radial circuits, generally 20A, **must be installed at all times to lab and office areas.** The radial circuit must supply the **dedicated 20mA passive RCD**, which will in turn supply sockets in the room.

Sockets in kitchenettes and **general circulation areas** may be installed in a **20A/32A ring main**. **No ring main or radial socket circuit must supply more than one room or laboratory**, although **multiple circuits within a room are acceptable**.

If **-80° freezers** are to be installed, a **dedicated 16A supply for each freezer** must be provided from the local distribution board, terminating into a **single socket outlet labelled "freezer only"**. This circuit **must not be protected by a 30mA passive RCD**.

Flexible conduits must not be used. Where circumstances dictate that no other option is available, it must be **limited to no more than 500mm in length**.

Arc Fault Detection Devices (AFDDs) must be used in accordance with *BS 7671*.

B7.5 RCD protection

Passive RCDs with a sensitivity of 30mA must be provided on all **13A socket outlets**, except those sockets serving **fridges and freezers** which must be protected instead by an appropriately sized **circuit protective device**. RCDs must be sited in the dado trunking in the same room as the socket, so that users can reset them if necessary. If this is impossible, RCD locations must be discussed and agreed with Estates Services.

RCDs must not be located within the distribution board. **Cleaner's socket** outlets must contain an **integral RCD**.

Active RCDs must only be installed in **kitchens or other high-risk areas**. This must be agreed in advance by the relevant Estates Services Electrical Engineer.

Equipment type	Installation method
Air conditioning split DX units	Local isolator
Mechanical control panels	Local isolator
Internal mechanical plant	Local isolator
External mechanical plant	Local isolator
Fan coil units	Fused spur c/w key switch, or lockable isolator
Water heaters	RCD fused spur required
Security equipment (CCTV etc)	Fused spur c/w key switch
Disabled access equipment	Fused spur c/w key switch
Stair lifts	Fused spur c/w key switch
Freezers	Non-RCD-protected plug and socket – documented risk assessment required

Fire alarm panels & equipment	Lockable isolator (such as MK K5880WHI), and fused spur on all other fire alarm equipment
Door holder open devices	Fused spur c/w key switch
Data cabinets/Frodo units	Fused spur c/w key switch
Fume cupboard supplies	Non-RCD-protected plug and socket – documented risk assessment required, or lockable isolator

B7.6 Multi-floor services

This relates to **services which need to be connected at more than one level**, such as **fume cupboards**. A **vertical containment system** must be provided, located next to the main riser, to accommodate all multi-floor electrical supplies.

B7.7 Supplies to lift installations

A suitably sized **cable terminating in the lift motor room with a four-pole, lockable isolator** must be provided to serve the lift installation.

A **distribution board** fitted with suitably rated **Miniature Circuit Breakers (MCBs)** and controlled via a **double-pole lockable isolator** must be installed in the lift motor room, to supply all the electrical services which are normally maintained and tested as part of the University's lift maintenance contract. Each outgoing circuit must have its own **passive 30mA RCD**. The circuits must supply both **normal and emergency lighting in the car, lift shaft lighting, pit lighting** and any **small power requirements** associated with the pit, shaft or car.

Lighting for the lift motor room must be taken from the floor distribution system and not from the lift distribution board. Likewise, **socket outlets in the lift motor room** which are not part of the lift installation must also be **supplied by the floor distribution system**.

The principles above still apply even if a machine room-less type of lift is planned.

B7.8 Electrical supplies to mechanical services equipment

Electrical supplies must be via **dedicated distribution boards**, fed from the building's **main LV switchboard or floor distribution boards**, depending on the requirements around security of supply.

Each **individual item of mechanical services plant** (including pump motors, fume cupboard extract fans, boilers, pressurisation units, water heaters etc) must be **connected to the fixed electrical system via a lockable rotary isolator**, so that it can be safely isolated for mechanical maintenance.

B7.9 External supplies

Where external sockets or isolators are to be used, they must be fully **waterproofed to IP67**. Cables must only enter such sockets and isolators from below.

All external cables must be suitable for exposure to external issues such as UV light and rodents.

Surge protection devices will be required, as defined in *BS 7671 section B*.

B8 Lighting

B8.1 General requirements

Generally internal lighting must consist of **luminaires incorporating DALI control gear**. Lighting circuitry must be controlled and protected from **local lighting boards**, and **not from the room distribution board**. **External lighting does not require DALI configuration**.

A **method of electrically isolating the various lighting fittings and/or circuits**, other than using the MCBs within the lighting distribution boards, must be provided. This is to **enable building users to safely replace luminaires** as necessary.

Where a plug-in connection is not appropriate, the designer must contact the Estates Services Electrical team for guidance. The **method of isolation** adopted must comply with the **'mechanical maintenance requirements'** of *BS 7671* and the **'secure isolation'** requirements of the *Electricity at Work Regulations (1989)*.

Illuminance levels, glare, uniformity and **colour rendering** in all internal areas of the building must be specified in accordance with the *SLL Code for Lighting* and *BS EN 12464*.

All lighting designs must be submitted to the Estates Services Electrical team for approval at the earliest opportunity. No work must take place on site until the scheme has been approved. Lighting calculations to support the design must also be provided where requested.

B8.2 Control system

Centrally administered, fully networked lighting control systems are not acceptable within the University, unless agreed in writing with Estates Services Electrical team.

Lighting controls must be provided to **reduce energy consumption**. General occupied spaces must be provided with **absence detection** (manual on/automatic off). Lights must be switched off when the room has been left **unoccupied for a preset period of 15 minutes** unless otherwise agreed.

Circulation spaces must be provided with fully **automated controls**, with **circulation detectors** set for a **dimming period of 15 minutes** before completely turning off the luminaire when no presence is detected. **Daylight regulation** must be provided in areas where adequate natural light is available.

All lighting control sensors must be of DALI type unless otherwise agreed with the Estates Services Electrical team. All **sensors must be configured using a remote IR device or tablet**. A handheld programmer must be given to the building services manager (if required) after consultation with Estates Services.

The University's **preferred manufacturers for controls** are **Casambi** and **Ex-Or.**

Lighting control systems in **specialised areas** such as seminar rooms, lecture theatres, museums, exhibitions etc must be manufactured by **Casambi**.

Plant rooms, switch rooms and other areas where there are **safety considerations** must either be **traditionally switched** or **manually switched via an absence detector** (set with an eight-hour off delay).

The contractor must allow for **commissioning of the system**. A repeat visit must be made after building handover to check that its operation is correct and properly optimised. Generally this must take place after around three months.

B8.3 Design criteria

Illuminance levels must be as outlined within the *SLL Code for Lighting* and *BS EN 12464*.

The designer must ensure that the **recommended average maintained lighting level** and **uniformity** recommended by the standard are provided by **fixed lighting**. Task lighting such as desk lamps must not be used to meet these requirements unless agreed with the Estates Services Electrical team.

The design must provide a **uniform lighting level** across the space to provide flexibility to change furniture layouts in future, unless specifically agreed with the Estates Services Electrical team.

For laboratories where benching is installed, the **luminaire must be positioned immediately above the lab benching to reduce shadowing** effect on the bench itself. The preference is for a continuous row of **linear luminaires**. **600x600mm modular types must not be used** in this application unless it is unavoidable.

Lighting must provide an **average of at least 420 lux in offices** on the working plane or desk, and at least **750 lux in laboratories**.

When selecting any LED products, the designer must make allowance for the following **maintenance factors**:

- Internal areas (offices, circulation spaces, etc) – 0.9
- Internal plant rooms – 0.8
- External plant rooms – 0.7

The calculation must be undertaken using either **DiaLUX** or **Relux** software.

In all enclosed areas, the maintained illuminances on the major surface must meet the requirements of *LG7*.

B8.4 Luminaire selection

DALI drivers with integral D4i function must be fitted to all internal luminaires, **regardless of whether or not controls are to be applied**. The drivers must be compatible with DALI parts 251, 252 and 253.

Luminaire **colour temperature** must be discussed and agreed with the Estates Services Electrical section during the design phase. Luminaires will generally be **4000K**, but building finishes need to be considered prior to selection. Colour temperature in listed buildings must also be agreed with the Estates Services Conservation & Buildings team.

All LED products must meet the following criteria:

- **5-year warranty** (including driver).
- All LED luminaires must have a **minimum service life of 50,000 hours** at 70% luminous flux at 25°C.
- **Colour temperature must be within a three-step ellipse** on all luminaires (unless otherwise agreed with the Estates Services Electrical team).
- **Minimum Colour Rendering Index (CRI) of 80**, subject to the requirements outlined in *SLL Code for Lighting* and *BS EN 12464*.
- **CRI for the luminaire must not decrease by more than 3 points** for the rated CRI value after 25% of its rated life.
- **Minimum power factor** of **0.95**.
- **Maximum failure percentage of 10%** over the LED's rated life.

External lighting must use LEDs. Luminaires will have their colour temperature selected based on where they are being installed. Any external lighting in the circulation spaces of the ROQ and Science Area must be **2700K with minimum CRI of 80 for the Science Area** and **3000K with minimum CRI of 80 for the ROQ**. Colour temperature for outdoor lighting in other areas (such as

Old Road Campus or Begbroke Science Park) must be agreed with the Estates Services Electrical team.

When **façade lighting** is required, all designs must be submitted for approval to the Estates Services Electrical and Conservation & Buildings teams.

B8.5 Historic buildings

The University understands that **lighting of historic buildings** requires further consideration, and that many of the requirements in this document cannot be achieved without detrimental impact on the building's appearance. The designer and installer must have detailed discussions with the Estates Services Electrical team and the Head of Conservation & Buildings to agree a **system that is as energy-efficient as possible without negatively affecting the building's appearance**.

B9 Generators

B9.1 General requirements

An **integral generator change-over control panel** must be installed within new LV switchboards.

For existing LV switchboards, a separate generator change-over control panel must be installed adjacent to the building main switchboard.

All **cabling to the generator** must be completed in **XLPE/SWA/LSF**, which must terminate into a junction box within (or adjacent to) the generator set. Rubber insulated cabling must be run from the junction box to the generator incomer, to avoid loosening of the cable when glanded.

The system's detailed design must be submitted to the Head of Electrical Engineering Services for approval.

UPS system must not be used to provide standby power for life safety systems.

B9.2 Panel construction

Please see section B6 of this document (on LV switchboards) for details.

B9.3 Switching devices

Please see section B6 of this document (on LV switchboards) for details. All **auxiliary devices** must be **24V DC**.

B9.4 Labelling

Please see section B14 of this document for details.

B9.5 Metering type

Please see Appendix E – Metering for details.

B9.6 Change-over panel

The control panel must have the following instrumentation and control functions:

Instrumentation:

- Mains/generator voltmeter
- Generator running (Red LED)
- Mains healthy (Green LED)
- Generator circuit breaker closed (Red LED)
- Mains circuit breaker closed (Green LED)

Control:

- Simulated loss of supply (key switch)
- Mains restoration (spring return key switch)
- Main incoming circuit breaker(s)
- Generator incoming circuit breaker(s)

The generator changeover panel must be fitted with **a Deep Sea controller automatic transfer switch to control the operation of the circuit breakers** – the specific type to be used must be agreed with the Head of Electrical Engineering Services.

All **incoming supplies must be monitored via phase failure relays**. All three phases must be monitored. The relays must be mounted on the **incoming side** of the changeover panel incomers.

The Deep Sea controller must be programmed with a **time delay to prevent immediate activation of the incoming devices**. The length of delay must be adjustable, from one second to five minutes, with a **default setting of 30 seconds**. All circuit breakers that form part of the control system must be controlled via this controller. **Undervoltage release coils must not be used**.

B9.7 Synchronisation

Generator sets must be designed to synchronise with the mains supply in all instances. The designer must confirm the exact requirements around this with the Head of Electrical Engineering Services during the design phase of the project.

The system must comply with all **requirements as defined in *Engineering Recommendation G99***. It is the designer's responsibility to complete the G99 application on the University's behalf, and to submit it to the DNO with all information needed to obtain permission for synchronisation.

B9.8 Control principles

When **loss of supply** is detected, the **time delay** will be initiated on the Deep Sea controller circuit. If the loss of supply persists by the end of a pre-defined period, the **generator must start**. However, if the mains supply has returned during this time, the system must revert to normal operation.

On reaching the correct speed and voltage, the generator must send a **'ready for load' signal** back to the Deep Sea controller. This must in turn initiate the **opening of the mains incoming circuit breaker(s)** and then **close the generator incoming circuit breaker**. The system is now on generator support.

Restoration of supply must be via a manual return operation via a synchronization inhibit function, enabling **manual changeover back to the primary supply**. Automatic transfer back to mains supply is not permitted unless specifically agreed with the University Electrical Engineer.

On turning the mains restoration key switch, which must be linked to the Deep Sea Controller, a **no break return to mains** must occur. The generator must then run for a three-minute cool down period before returning to standby. The system has now returned to normal operation.

B9.9 Testing facilities

The **'simulation of loss of supply' key switch** must initiate the following sequence of events:

1. **Supply to phase failure relay is failed** (the facility to test each relay will be needed, if applicable).
2. **Generator starts**. On reaching the correct speed and voltage, it **opens the incoming circuit breaker(s)**, and then **closes the generator incoming circuit breaker**.
3. The system is now on generator support.

B9.10 Restoration

Returning the simulation key to its normal position must initiate the following sequence of events:

1. On turning the mains restoration key switch, which must be linked to the Deep Sea controller, a **no-break return to mains must occur**.
2. The generator runs for a **three-minute cool down period** before returning to standby.
3. The system has now returned to normal operating conditions.

B9.11 Drawings

Drawing E001900 details the requirements for **complete generator coverage** for University buildings which have a **dual incoming supply** arrangement. The same principle must be applied for a single incoming supply.

Diagram E001901 details the requirements for University buildings which require **partial generator coverage**.

B9.12 Fuel

B9.12.1 Capacity

All generator systems must feature an **eight-hour day tank**. Generators serving sensitive specialist laboratory facilities that have mandated Home Office approval requirements must also be provided with a **separate bulk fuel tank with capacity for 72 hours** at full system load.

If circumstances dictate a different arrangement, this must be agreed with the University Head of Electrical Engineering Services and the Project Board.

B9.12.2 Fuel level

Any fuel tank associated with the generators must be fitted with **floats to indicate fuel levels** of 0-100%, which must be **connected back to the PME system and BEMS** enabling **remote monitoring of the fuel leve**l. Separate analogue full gauges will be required for day tank and bulk tank, if applicable.

If a separate bulk tank is required, the day tank must transfer fuel from the bulk tank when the fuel level drops to 75% of capacity.

At handover, the system must be **fully fueled (100% of total fuel capacity)**.

Life safety fuel pumps must be connected to the generator supply.

B9.12.3 Bunding

The generator must be provided with adequate **bunding to prevent the loss of fuel**, either during filling or as a result of damage to or a fault in the generator set.

The designer must complete calculations to prove that the bunded arrangement can **hold 110% of the system's total fuel capacity**, including any reductions to account for displacement by solid features such as supports.

B9.13 Generator set

B9.13.1 PRP (Prime Power Rating)

The generator set may be run continuously for an unlimited operating time under varying load factors. An **average load factor of not more than 70% of the Prime Power rating** for both non-fire-fighting and fire-fighting scenarios must be applied. An **overload of 10% is required for 1 hour in 12**.

All generator systems must be compliant with a **minimum rating of G2 rating of *BS ISO 8528***. They must also be **sized in accordance with *BG 70*, *TB 210* and *BS 9999* in terms of frequency and voltage recovery**. **G3 rating** may be required for certain applications in particularly around sensitive facilities where the connected load make severe demands on the stability and level of the frequency, voltage and waveform characteristics of the electrical power supplied by the generator set. **Rectifier and thyristor controlled loads** may need special consideration with respect to their effects on the generator set.

Fuel must comply with *BS 2869*.

The generator must be provided with **engine fault protection** against:

- Low oil pressure
- High water temperature

All fault-level analysis must be completed on the sub-transient state of the generator.

B9.13.2 Alternator

Generator systems must feature **a close coupled, single bearing, PMG excited, self-regulating, brushless 4 pole alternator**. This must generate **3 phase at 50Hz and 400V (ph-ph), with class H insulation, class H and IP21 protection and an anti-condensation heater**. **Radio suppression** must comply with ***EN 61000-6***.

B9.13.3 Alarm and status signals
Volt-free signals for interfacing to the PME metering system for:

- **Generating set start** (VF input)
- Generator **ready for load** (VF output)
- **Low fuel level** (bulk tank) warning
- 0-100% **day tank fuel level indication**
- 25%, 50%,75%,100% **bulk tank fuel level indication**
- Generator **not in auto** (must also be connected to the Estates Services metering system)
- Generator **running** (must also be connected to the Estates Services metering system)
- **Common fault** (must also be connected to the Estates Services metering system)
- **Common alarm** (must also be connected to the Estates Services metering system)
- Fuel transfer **pump failure**
- **Low battery volts** warning

B9.13.4 Alternator circuit breaker
Generator systems must include the following:

A **3-pole circuit breaker**, complete with: **LSIG protection, fixed pattern, lockable complete with auxiliary indications for short circuit, overcurrent and earth fault**.

Fuel transfer pump control section, complete with:

- **Pump duty** selector switch
- **On/Off/Auto** selector switch

The control panel must be equipped with the following controls:

- **Emergency stop button** (twist to reset)
- **Engine heater** (on/off)
- **Alternator heater** (on/off)
- **Battery charger** (on/off/boost)

The control panel must also be equipped with one or more panel **anti-condensation heater**(s). Auxiliaries Distribution System will be required for feeds to:

- Engine heater
- Alternator heater
- Starter battery charger
- Fuel transfer pumps

B9.13.5 Control philosophy

The above control system is designed to work as follows:

The generating set will start upon receipt of a start signal from the Deep Sea controller.

When the generating set has reached its rated speed and voltage, it will give a volt free **"Ready for Load"** signal. **No load must be applied to the set until this signal has been received**.

The **alternator control circuit breaker is normally closed** and is used to protect the generating set.

Upon removal of the start signal, the generating set will continue running for a **user-configurable cool down period (typically 15 minutes**) and then stop.

Any of conditions listed as "**faults**" will cause the generating set to **stop immediately**.

Any of the conditions listed as "**warnings**" will **trigger an alarm (both visual and audible)**, but will not stop the generating set.

Any of the conditions listed as "**electrical trips**" will cause the generating set circuit breaker to open, and the generating set to stop after a cool down period.

The **transfer of fuel from the bulk tank to the day tank must be stopped** if any of the following conditions occur:

- Base tank **high fuel level**
- **Fire detected**
- **Fuel in container bund** warning
- **Fuel in pipework bund** warning

Signage

The generating set must be marked with all appropriate warning signs to relevant European and British standards, including:

- **Voltage** warning signs
- **Noise** warning signs
- **Automatic machinery** warning signs
- **Hot surface** warning signs

Testing

All generators must be fully **works tested**, in accordance with standard diesel engine test procedures. These will include:

- Full **functional test**
- **Load tests**, including:-
    1. 25% load test to stability to the 'G' classification of the set.
    2. 50% load test to stability to the 'G' classification of the set.
    3. 75% load test to stability to the 'G' classification of the set.
    4. 100% load test for 4 hours to the 'G' classification of the set.
    5. 110% load test for 1 hour to the 'G' classification of the set.

B9.13.6 Routine testing

Non-synchronised generators below 350kVA must be programmed to **run off load for five minutes**, once a week.

Synchronised sets of 350kVA and above must **synchronise with the mains** and **run on-load for 30 minutes**, once a week.

Both these routine operations must be scheduled for **9am on Wednesdays** unless otherwise directed.

B9.13.7 Lightning protection

A **risk assessment** in accordance with *BS EN 62305* must be completed on new containerised generator sets, to **establish whether a lightning protection system is required**, taking the surrounding buildings into consideration.

B9.13.8 Earthing

Refer to section B5 for earthing requirements.

B9.13.9 Base frame

The engine and alternator must be mounted on a **heavy-duty fabricated channel steel base frame** with **high-isolation anti-vibration mounts** beneath, designed to give => 96% isolation.

B9.13.10 Control system

The generator control system must include the following features:

Set mounted, automatic-start control **system control cubicle**, comprising:

- **Deep Sea Electronics Controller** (exact type to be confirmed with the Head of Electrical Engineering Services)
- **ATS/auto mains controller**
- Controls for **off/auto/manual** and **Alarm Mute Generator Shutdowns**

Fault (shutdown) protections for:

- Low oil pressure
- High coolant temperature
- Engine over/under speed
- Generator over/under volts
- Generator over/under frequency
- Fire detected
- Emergency stop

Warning alarms for:

- Failure to start
- Low oil pressure
- High coolant temperature
- Generator overcurrent
- Low battery volts
- High battery volts
- Low fuel level (bulk tank)
- Fuel in container bund
- Fuel in fuel tank bund
- Generator not in auto
- Fuel transfer pump 1 and 2 tripped
- Fuel pipe leak
- Low coolant level
- Battery charger tripped

Electrical trips for:

- Alternator circuit breaker tripped
- Automatic voltage regulator monitoring

LED status indication for:

- Remote start
- Generator running
- Fuel pump 1 running
- Fuel pump 2 running
- Generator available

Instrumentation for:

- Generator volts (phase-to-phase and phase-neutral, all phases)
- Generator amps (each phase)
- Generator kVA (each phase and total)
- Generator kW (each phase and total)
- Generator kVAr (each phase and total)
- Generator power factor (each phase and total)
- Generator frequency
- Engine speed
- Engine oil pressure
- Engine coolant temperature
- Engine oil temperature
- Battery volts
- Engine hours run
- Engine starts

Control functions/timers for:

- Multiple attempts to start
- Start delay
- Stop delay
- Cool down
- Warm up
- Fail to stop
- Crank disconnect
- Protection override
- Remaining time until maintenance
- Exerciser function
- 25 event history log

All fault, alarm, instrumentation and history information must be provided via a **two-line graphic LCD display with backlighting**. There must also be **audible indication of alarms and faults**.

B9.14 Maintenance contract

A **maintenance contract must be placed with the generator supplier**. This must provide for **two maintenance visits over a 12-month period**. The contract must be inclusive of all parts and labour.

The contract will commence when the University Electrical Engineer accepts responsibility for the generator system, including all power changeover control systems.

The contract must include provisions for **emergency call-outs**. The Service Level Agreement engineer response time will be determined by the University Electrical Engineer and the Project Sponsor Group; it will be no **longer than 24 hours**.

A copy of the maintenance contract must be submitted to the University Electrical Engineer for approval.

B10 Lightning protection

Systems to protect University property from damage by lightning must be designed, installed, tested and commissioned to form a **fully coordinated lightning protection system** in accordance with *BS EN 62305*, *BS 7430* and *BS 7671 (18th Edition)*. It is recommended that **SPD manufacturer** and **lightning protection specialist must be one and the same** to ensure that an installation certificate is provided without caveats.

Such systems must consist of an **earth termination network**, **down conductors**, **air termination network** and a **Lightning Electromagnetic Pulse Protection System (LEPS)**.

The entire lightning protection system, apart from any natural building elements that are incorporated into it, must be **made by a single manufacturer**. All items must be installed in accordance with the manufacturer's recommendations, including fixing to the fabric of the building.

The **weatherproofing of the building must not be impaired** in any way by fixings or by any part of the lightning protection system, and work on flat roofs must be co-ordinated with the roofing contractor.

Ionisation, lightning attraction or dissipation terminals or other devices which purportedly allow a reduction in the number and/or sizes of air terminations and down conductors **must not be used**, unless specifically agreed with the Estates Services Electrical team. Permission for such measures will only be granted when specific conditions make them necessary.

B10.1 Risk analysis

The contractor must undertake a **risk assessment** of the building and provide a **formal report** as part of the lightning protection system's design. This assessment must either be completed via a **manual calculation** or using **approved calculation software**, such as **Hevacomp** or **Strike Risk**.

The lightning protection system and the transient SPDs must then be designed to meet the requirements of the risk assessment.

B10.2 Earth termination network

The contractor must supply, install, test and commission an **earth termination network**.

The **electrical building earth must be connected to the lightning protection earth**, which is likely to consist of **deep-driven electrodes**.

The design of the earth must take account of any need for **waterproofing**, and ensure that the earth conductors are not isolated.

The contractor must test **soil resistivity** on site using the **4-lead method described in** *BS 7430*, to establish the **depth of the earth electrodes** required.

Estates Services must be given **14 days' notice of the test** and must have the opportunity to witness the results, at the relevant Electrical Engineer's discretion. Once the soil resistivity test has been completed, the contractor must submit its results, together with calibration certificates for the instruments used and the predicted resistance to earth, to Estates Services for comment.

Copper-clad steel rods must have **rolled threads** with the **copper cladding maintained throughout**. **Couplings** must be made of **silicon aluminium bronze** and **be fully threaded** to allow metal-to-metal contact of the rods. Couplings must be counter-bored and long enough to completely cover and protect the threaded portion of the rods, in order to minimise corrosion.

Driving heads for the rods must be high tensile steel, fully threaded to ensure head-to-rod contact.

B10.3 Down conductors

Where possible the **natural conductive components of the building** must be used for the down conductors, including **steel columns**. It is critical that if such natural components are used, they must be **interconnected**, and connected to the earth termination network and air termination network to **ensure electrical continuity** throughout the lightning protection system.

Where possible, **copper tape connections/bonds** must be **concealed within the building fabric**, eg in a screed or similar finish.

Where this is impossible, approval must be obtained from Estates Services for each and every **exposed conductor location**. Where approved, each tape connection must be provided with a **tag** stating "Lightning protection conductor – DO NOT REMOVE OR DISCONNECT".

Coaxial down conductors must not be used.

Contact between dissimilar metals must be avoided, except as permitted in *BS EN 62305-3*, and precautions must be taken to **prevent long-term corrosion**. **Bimetallic connectors** must be installed with **corrosion-inhibiting compounds**, in accordance with the manufacturer's recommendations.

Exothermic welds may be used only with specific approval from Estates Services.

The surfaces of aluminium-to-aluminium joints must be thoroughly cleaned, and a suitable oxide-inhibiting compound applied.

The University of Oxford has many **historic buildings**, and the installation of a lightning protection system risks a major detrimental impact on their appearance. Designers must ensure that the fixing of the air-termination network, down conductors and earth termination system **does not disturb or destroy historic building fabric unless this is absolutely unavoidable**. Interventions must be **kept to a minimum** and must be **reversible wherever possible**.

All fixings must be agreed with the University's Conservation & Buildings team before being installed. Illustrated examples of bad and good practice can be found in English Heritage's *Lightning Protection for Churches – A guide to design and installation, 2000*.

B10.3.1 Earth conductors to columns

Where applicable, each **column or down conductor** must be provided with an **earth point** that is electrically **connected to the dedicated driven earth electrode system via a tape conductor**. Where possible, this must be installed out of view within the fabric of the building.

B10.3.2 Steel columns and supports

Where applicable, all **steel columns and support structures** (eg plant screen support structures) must be **connected to the air termination network**, in accordance with *BS EN 62305*.

B10.3.3 Air termination network

Contractors must select any **metallic roofing materials** used as part of the lightning protection system to ensure they are suitable for use as the air termination network, in accordance with *BS EN 62305*.

The **connection points** must be designed so that they are **not visible**, and details must be submitted to Estates Services for approval. The connection must provide the specialist lightning protection contractor with the ability **to connect the down conductors to the air termination network** using **proprietary clamps** and **25mmx 3mm copper or aluminium lightning protection tape** (with bimetallic joints as required), as appropriate.

Where conductors cross **building expansion joints**, a **flexible link** in the form of a **loop** or a **braided or stranded length of conductor** must be incorporated. The flexible link must be firmly fixed on both sides of the expansion joint.

All mechanical roof plant or plant that **extends out of the protected zone** must be **bonded back to the lightning protection** accordingly. Alternatively, it may be completely **isolated using finials** on either side of the equipment. Which option is used will depend on the specific requirements of the design.

B10.3.4 Lightning electromagnetic pulse protection system

PDs must be provided to **protect the electrical distribution system** and the **equipment it supplies** from the effects of **electrical surges and spikes**, including those caused by **lightning strikes** and **utility network faults**.

Type 1, 2 or 3 SPDs must be provided, in accordance with *BS EN 61643* Part 11, to protect all equipment connected to the electrical distribution systems throughout the building. This must also be done in accordance with *BS 7671*, which details the risk assessment that must be carried out to determine whether protection from overvoltages or surges is required. It states:

> "Protection against transient overvoltages must be provided where the consequence caused by overvoltage effects:
>
> a) Results in serious injury to, or loss of, human life, or
> b) Results in interruption of public services and/or damage to cultural heritage, or
> c) Results in interruption of commercial or industrial activity, or
> d) Affects a large number of collocated individuals."

When using the **Lightning Protection Zone (LPZ) concept**, **Type I SPDs** must be provided at the **origin of the electrical installation or surge**, **Type II at all panel boards/distribution boards**, and **Type III** must be installed **close to sensitive equipment**. Estates Services must authorise all Type III SPD installations.

All SPDs must feature **audible alarms**.

All Type I and Type II SPDs must also feature **volt-free AUX contacts** to enable connection to the University's monitoring system for remote indication of status.

The SPD must be positioned **as close as possible to the point of transfer between zones**.

The list of circuits that must be provided with type I/2 SPDs includes, but is not limited to, the following:

- **LV switchboards**;
- **External lighting** supplies;
- Supplies to **remote buildings**;
- **Plant** supplies;
- **Lift** supplies;
- **PV arrays**;
- All **rooftop circuits** for power, BEMS, data, fire alarm, etc;
- All **power and data/video connections to external cameras and external equipment**; and
- All **laboratory distribution boards**, and other boards serving sensitive equipment.

In accordance with *BS 7671*, **Type II or III SPDs must be installed in sub-distribution boards** or **close to the equipment to be protected**, and must be coordinated.

As a summary:

- **Type I SPD** – Origin of the installation or surge - characterized by a 10/350 µs current wave.
- **Type II SPD** – At sub-panel boards or distribution boards - characterized by an 8/20 µs current wave.
- **Type III SPD** – At plug top level for sensitive equipment - characterized by a combination of voltage waves (1.2/50 µs) and current waves (8/20 µs).

At no point in the installation must the withstand voltage exceed 2.5kV, as per the requirements of BS 7671, unless protection of sensitive equipment (Type III) is required, in which case a value of 1.5kV must be used instead.

The Type I SPD must be selected based on the **protection level of the LPS**, in accordance with *BS EN 62305-2*. Therefore the Impulse Current (Iimp) must be as follows, in accordance with *IED 60364-5-534*:

Protection level (per *BS EN 62305-2)*	External lightning protection system designed to handle direct flash of:	Minimum required Iimp for Type 1 SPD for line-neutral network
I	200kA	25kA/pole
II	150kA	18.75kA/pole
III/IV	100kA	12.5kA/pole

Electromagnetic impulse and **transient overvoltage protection** must be provided throughout the electrical distribution system.

The contractor must engage a specialist **lightning protection and earthing contractor** to undertake the selection of SPDs to be installed within the LV distribution system as described above. This must be the **same company that manufactures the SPDs** to ensure that an **installation certificate** is provided without caveats.

The specialist contractor must liaise with the **switchgear and distribution board manufacturers** to ensure that the devices selected and procured are suitable for the planned installation, and that the manufacturers provide **sufficient space** either within the equipment or within dedicated housings adjacent to it.

All SPDs must be backed up by an appropriate **circuit protective device**, which must be **small enough to protect the SPD, but large enough to carry the related impulse current**. As a rule of thumb (to be checked for each individual project) a 160A MCCB must be used for SPDs to level III/IV and a 250A MCCB for SPDs to level I and II (including III and IV if applicable).

B11 Electromagnetic fields

All systems must comply fully with the latest version of the *Control of Electromagnetic Fields at Work Regulations* and the requirements of *BS 7671.* Details of the precautions that have been taken to achieve compliance must be provided in both the Operation and Maintenance Manual and the Health and Safety file for the project.

Precautions that must be applied for **electromagnetic compatibility and non-ionising radiation sources** include (but are not limited to):

- Specifying **appropriate shielding of cables and electronic components**, to contain electromagnetic fields;
- Appropriate **grouping of all conductors of a circuit within the same ferrous enclosure**, to reduce the propagation of electromagnetic fields;
- Suitable design to minimise **emission of visible light and of ultra-violet and infra-red radiation**. Special precautions must be specified for the controlled use of powerful laser equipment;
- Appropriate designs to **control the use of microwave generating equipment**; and
- Applying **appropriate exposure limits** for radio frequencies between 300 MHz and 3 GHz.

B12 Power quality

B12.1 General
The design of the electrical system must comply with the requirements and parameters of the *ENA Engineering Recommendations G5/5*; *BS EN 50160 Voltage characteristics of electricity supplied by public distribution networks*; *EN 61000,* and *BS 7671*.

Where the power factor of a system will be reduced by inductive loads, **power factor correction** must be incorporated into the design to rectify the power factor. Where the power factor will be reduced due to a distorted current waveform, **harmonic filters** must be incorporated into the design to correct this.

B12.2 Power factor correction
For new installations and refurbishments of buildings or spaces, the designer must **assess the prospective power factor and specify power factor correction** where required, specifically for **heavy duty workshops**. The **minimum resulting power factor** must be at least **0.98**.

Any **power factor correction equipment** provided must be completely **separate from the building's LV switchboard**.

B12.3 Active harmonic filtering
The design of the electrical distribution system incorporating **concentrated non-symmetrical loads** must be implemented in a manner that minimises the effects of:

- **Voltage distortion**, leading to equipment failure and data errors;
- **Excessive neutral currents** overloading conductors;
- High levels of **neutral to earth voltage** causing data errors;
- **Overheated transformers** and **motors**;
- Large **magnetic fields** emanating from transformers;
- Decreased **distribution capacity**;
- **Power factor** penalties;
- **Capacitor failures**; and
- **Failure to trip**, or **premature trip**, of circuit protective devices.

The contractor must allow for the completion of a **harmonic study** in accordance with *G5/5* **eleven months after Practical Completion**, before the end of the defects period. All information must be derived from the embedded metering within the building's main LV switchboard arrangement.

At the point of connection (which will be the building main LV switch board), where the measured THD_V exceeds 3.5% of the nominal operating voltage for 230V systems, or 4% of the nominal operating voltage for 400V systems, **stand-alone active harmonic filtering devices** must be installed under the project main works contract, in order to reduce the harmonic voltage distortion and reduce harmonic currents introduced into the system.

The contractor must also assess the overall **heat gains** that are generated by the harmonic filtering equipment, and assess whether **additional cooling or ventilation** is needed. If so, this must be installed under the project main works contract.

B13 Electric vehicle chargers

B13.1 Installation

Bollards or equivalent protection must be installed to reduce the impact of a **vehicle strike**, complying with the requirements of the local highways authority.

Free-standing charge points must allow **full servicing and replacement without disturbance of the pavement** or other hardstanding surface – no civil work must be needed.

Charger units must be **modular** in design: in the event of equipment failure, the design must allow a module or section to be replaced, rather than a discrete component or the entire unit.

General installation details:

- Ensure all **DNO/Estates Services requirements** have been observed and **capacity management surveys** and all relevant checks/investigations made while conducting site feasibility.
- Fulfil the requirements in the latest edition of the IET's *Code of Practice: Electric Vehicle Charging Equipment Installation*.
- The installation must **comply with *BS 60364*** and any **local and national regulations**.
- The existing electrical load must have been calculated to find the **maximum operating current** for the charging station installation, and the design must be appropriate to the capacity available and integrated into the overall energy system on site.
- An **MCB and RCD must be installed upstream**, with ratings that correspond to the local power supply as well as to the required charging power.
- The correct **specification of power supply cable** must be routed to the installation area, with sufficient cable length to strip and connect the wires.
- The power supply cable must remain within its **bending tolerance** during and after installation.
- All **cables** must match the specifications for the charging station that will be installed.

B13.1.1 Dedicated distribution boards for EVCs

A **dedicated distribution board** must be provided for all EVCs, separate to standard lighting and power. The EVC distribution board must be **supplied directly** from either a **substation LV switchboard** or a **building LV switchboard**. Supplies for EV charging must not be derived from standard lighting and power distribution boards.

The circuit must be protected as follows:

- **Contactors** are required for the EV distribution board so that power can be dropped in the event of **fire activation** via a local EPO. Its position must be discussed with the project team to ensure compliance.

B13.1.2 Earthing

Earthing arrangement must comply with the following:

- *BS 7671 411.4.1*
- MATT:E (PME O-PEN PROTECTION) Protection of electric shock is provided by a device which **disconnects the charging point(s) from the live conductors of the supply and the protective earth within 5 seconds** in the event of a broken neutral

B13.1.3 Fire alarm integration

The EV system must be **interfaced to a local fire alarm system**, which features an interface to operate a **volt-free contactor** on the supply to the distribution board, which will in turn disconnect all EV chargers.

B13.1.4 Insurance requirements

A **fire risk assessment** must be undertaken at earliest stage of design; the results must be discussed and **agreed with the University's Insurance Office** to ensure compliance with their terms and conditions.

No EV installation will be permitted until the confirmation that this has been done is received from the Insurance Office.

B13.2 Metering and communication

All charging sockets must be metered by **MID approved meters**, via a meter integrated into the charge point.

All meters must have **smart functionality** as set out in the **government's July 2019 Electric Vehicle Smart Charging Paper**. Each outlet must provide measurement of energy supplied, to be output to both **display** (where fitted) and to a **remote data acquisition system** compatible with the Estates Services PME metering system.

All charging units must be **compatible with the** ***Open Charge Point Protocol*** **version 1.6 (OCPP 1.6)** or higher.

B13.3 EV charging bay design and cable routes

It is the project team's responsibility to ensure all necessary **planning and building control permissions** are secured from the appropriate authorities, and evidenced. Where the installation is deemed to fall under permitted development, a lawful development certificate must be provided.

For each parking space that requires either an electric vehicle charge point or cable routes for such a charge point to be installed in future, the location of the electric vehicle charge point or future connection must be **suitable for use by all EVs**, regardless of the positioning of the inlet on the vehicle.

Mobility and accessibility considerations must be taken into account for all EV bays when installing chargers. It is particularly important when designing and installing any protection solutions (eg barriers, ramps, tyre stops, lighting) to ensure **sufficient space and light for all users to access the charger** with ease. All installations must comply with the recently introduced *PAS 1899:2022*, which gives detailed specifications on providing accessible charging points.

Where EV bays are provided, a reasonable proportion must also be **line marked as Blue Badge spaces** following the guidance in *Approved Document M Volume 2*.

Enforcement signage and **bay markings**, where provided, must comply with car park and highways regulations.

B14 Labelling

Unless otherwise specified, all labels must use **black characters on a white background**. The font must be sized to fit the label. **Non-adhesive labels** must be **mechanically fixed**, in a secure manner which will nevertheless allow easy replacement. Each label's location will depend on the equipment it is fixed to, but it must be **visible from the front of that equipment** at all times.

B14.1 Substations

B14.1.1 Compounds and buildings

All **entrances to substation compounds and switch rooms** must be identified with a nameplate of at least **160mm*50mm**, in the following form:

PATHOLOGY S/S

Entrances to substation compounds and switch rooms must also display emergency contact information as detailed on the *University Estates Services Electrical Safety Rules – Appendix 4: Model Safety signs*.

IN CASE OF EMERGENCY PLEASE CONTACT
ESTATES SERVICES
THE MALTHOUSE
TIDMARSH LANE, OXFORD
TELEPHONE 01865 278750
EMERGENCY 24H SECURITY SERVICES:
01865 289999

All entrances to substation compounds and switch rooms must also display a **danger label** as detailed in the document referred to above.

B14.1.3 HV switchgear

All **HV switchgear** must be labelled as shown, detailing the **source of the connected cable**:

OBSERVATORY S/S

The label must be sized to match the label fixing plate located on the switchgear.

B14.1.3 Transformers

Each **transformer** must be identified as shown, using a label of minimum size **200mm*50mm**:

TRANSFORMER 1

The label must be securely fixed on the side of the transformer, in a position where it is **visible from the HV switchgear**. **Stencilled identification** is also acceptable.

A label must also be affixed to confirm the **original tap setting**, to enable easy identification in the future.

B14.1.4 Substation LV switchgear

Adjacent to each **incoming and outgoing circuit**, a label must be fitted as shown. The number must be incremental, starting from 1 and preceded by the substation letter (as issued by Estates Services). The minimum size for these number labels is **40mm*20mm**.

B1

The **order of labelling** must be **Transformers – Bus-sections – Final circuits**, as seen from top to bottom, left to right (see drawing E400987).

Additionally, each **outgoing circuit** must be labelled so as to **identify the building supplied**, the **circuit reference** within that building, and the **cable size and type** used. These labels must be at least **100mm*35mm**.

New Building
DB10/001/001.1L123N
2*185mm 4c XLPE/SWA/PVC

B14.2 Buildings

B14.2.1 Building LV switchboards

All building **LV switchboards** must be identified as shown below. The label must be fitted in a prominent position at the front of the switchboard, and must be at least **125mm*30mm**.

20/004/001

The label must be made up of the following parts:

a) **First part (2 digits)**: Level of building, in the form of 00, 10, 20 and so on.
b) **Second part (3 digits):** Space number of location /area.
c) **Third part (3 digits):** Unique number for the switchgear in the form 002, 034, 135 etc. The main department/building switchboard must typically be numbered 001.

The first and second parts of the label will be provided by the Estates Services Space Management team. The third part must be agreed with the University Electrical Engineer before the labels are installed.

A **numbered sequential label**, of at least **45mm*10mm**, must be fitted adjacent to outgoing circuits, as shown. The numbering must run from top to bottom and left to right.

Circuit 1

In addition to this, another label must be fitted adjacent to all incoming circuits, as shown.

SUBSTATION NAME Circuit ref 2*185mm 4c XLPE/SWA/PVC

This label, with minimum dimensions of **100mm*40mm**, must display the **substation name**, the **circuit reference**, and the **size and type of cable** used.

All **outgoing circuits** must be identified as shown, with labels of at least **100mm*40mm**. The distribution board number must be in the form shown above.

Distribution Board Number Circuit ref Cable size and Type

B14.2.2 Distribution boards

All **switchgear and control panels** containing one or more **circuit protective devices** must be **treated as distribution boards** and identified as shown below:

20/004/002

.

Similarly, all **busbar systems** must be **treated as distribution boards** and labelled as such.

In both cases, the label used must measure at least **125mm*30mm** and be fitted in a prominent position on the front panel. It must comprise the following parts:

a) **First part (2 digits)**: Level of building, in the form 00, 10, 20 etc.

b) **Second part (3 digits)**: Space number of area, in the form 023, 031 etc.

c) **Third part (3 digits)**: Unique number for the switchgear, in the form 002, 034, 135 etc.

The first and second part of the number will normally be provided by Estates Services Space Management team. The third part must be agreed with the University Electrical Engineer before the labels are installed.

B14.2.3 Final circuits

All **outgoing ways on all distribution boards** must be identified with:

- a sequential **tag number**; and
- a **circuit reference**.

The **tag number** identifies the actual location of the protective device within the board, with each single module being identified in this way.

The **circuit reference** must be made up of a **way number** and a **phase reference** (L1, L2 or L3). Where an isolator is fitted within the outgoing part of the board, it must be numbered as part of the sequential numbering above.

Both the tag number and circuit reference must **correspond to the distribution board chart**. (See below)

In general, the numbering sequence must be configured to be read **top to bottom, left to right**, starting at the top of the left hand column, and proceeding down to the bottom of the column before moving to the top of the right hand column.

The following examples show various arrangements on different board types. For non-standard boards, contact Estate Services.

Single phase (Horizontal)
Phase reference marked on chart only. Tag and circuit reference must be the same.

1	2	3	4	5	6	7	8

Single phase (Vertical)
Phase reference marked on chart only. Tag and circuit reference must be the same.

1	7
2	8
3	9

4	10
5	11
6	12

Three Phases (Fixed Structure)
Phase reference on both chart and panel. Columns 1 and 4 correspond to tag number.

1	Single-pole device	1L1	7	3L1	Three-pole device
2	Two-pole device	1L2	8	3L2	\
3	/	1L3	9	3L3	\
4	\	2L1	10	4L1	Single-pole device
5	Three-pole device	2L2	11	4L2	Single-pole device
6	/	2L3	12	4L3	Single-pole device

Three Phases (Non-fixed structure), for distribution boards where changeable internal links are used.
Phase reference on chart only. Shown below to indicate examples of non-standard phase arrangements. Columns 3 and 4 correspond to tag number and circuit reference.

Single-pole device	L1	1	7	L1	/
\	L1	2	8	L2	/
Three-pole device	L2	3	9	L3	4-pole device
/	L3	4	10	N	\
\	L2	5	11	L3	Single-pole device
Two-pole device	N	6	12	L1	Single-pole device

Accessories
All final circuit accessories must be labelled using a Dymo machine (black on white) with the circuit reference relating to the protective device.

The circuit identifies the distribution board and circuit It must correspond with the circuit reference column on the distribution board chart:

- For **single-phase circuits (single-pole)**: DB10.5L2
- For **single-phase circuits (two-pole)**: DB2.6L1N
- For **three-phase circuits (three-pole)**: DB22.6L123
- For **three-phase circuits (four-pole)**: DB7.10L123N

B14.2.4 Cable core marking

All **cable cores within the distribution board** must be marked as follows.

Each **phase conductor, including the neutral**, must be identified by its associated **way number and circuit reference**, as shown on the distribution board chart below. The label must be securely fixed in a manner which will allow easy replacement.

The **earth conductors** must be identified with their corresponding number, detailed above.

For single-phase boards the numbering must be as follows:

Example of a single-phase distribution board (new colours)

Position of device (Way on chart)	Circuit device	Phase reference on chart	Core colour	Phase conductor reference	Neutral conductor and Earth conductor reference
1	Spare	1L1			
2	2p Vigi Unit	2L1	Brown	2L1	
3	/	3L1	Blue		2L1
4	Spare	4L1			
5	Spare	5L1			
6	Single-pole device	6L1	Brown	6L1	6L1
7	Spare	7L1			
8	Single-pole device	8L1	Brown	8L1	8L1
9	Single-pole device	9L1	Brown	9L1	9L1

For three phase boards the numbering must be as follows:

Example three-phase distribution board (new colours)

Position of device (Way on chart)	Circuit device	Phase reference on chart	Core Colour	Phase conductor reference	Neutral conductor and Earth conductor reference

1	\	1L1	Brown	1L1	1L1
2	Three-phase device	1L2	Black	1L2	
3	/	1L3	Grey	1L3	
4	Spare	2L1			
5	Spare	2L2			
6	Single-pole device	2L3	Brown	2L3	2L3
7	Spare	3L1			
8	Single-pole device	3L2	Brown	3L2	3L2
9	Spare	3L3			
10	Spare	4L1			
11	Single-pole device	4L2	Brown	4L2	4L2
12	Spare	4L3			

Example three-phase distribution board (old colours)

Position of device (Way on chart)	Circuit device	Phase reference on chart	Core colour	Phase conductor reference	Neutral conductor and Earth conductor reference
1	\	1L1	Red	1L1	
2	Three-phase device	1L2	Yellow	1L2	1L2
3	/	1L3	Blue	1L3	
4	Spare	2L1			
5	Spare	2L2			
6	Single-pole device	2L3	Red	2L3	2L3

7	\	3L1	Red	3L1	
8	Three-pole device	3L2	Yellow	3L2	3L2
9	/	3L3	Blue	3L3	
10	Spare	4L1			
11	Single-pole device	4L2	Red	4L2	4L2
12	Spare	4L3			

For non-standard distribution boards, contact the Electrical team within Estates Services.

B14.2.5 Submain cables

Where **multiple multicore cables are installed**, a label must be fitted to **each end of each cable**. This must detail the location of the remote end of the cable.

The label must be securely fixed and visible from the front of the distribution board.

It must display the **local distribution board reference**, followed by **remote distribution board reference** in the form shown below.

Local end: DB001-DB10

Remote end: DB10-DB001

B14.2.6 Emergency lighting identification

All building **emergency luminaires and accessories** must be identified as shown below. Each label must be fitted in a prominent position, visible without the aid of steps etc.

Emergency Luminaires

(Size must be determined to match the fitting.)

EL00/001

EL Emergency Light

00 Level in building – in this case, ground floor.
001 Unique fitting number (by level)

Key Switch

(Size determined to match switch.)

K00/01

K Key Switch
00 Level in building – in this case, ground floor
01 Unique key switch number (by floor)

Mains fail relay (central battery only)

(Size determined to match that of unit.)

MFR00/01

MFR Main Fail Relay
00 Level in building – in this case, ground floor
01 Unique unit number (by floor)

Records

A **detailed plan** clearly showing the **positions of all the emergency lighting locations**, with their unique identifiers, must be provided for each floor in both electronic (CAD and PDF) and paper forms. The drawing must also show **location of any central battery**, if applicable.

A schedule of all luminaires must also be provided in electronic form, as follows:

Building number	Emergency light number	Emergency light location	Type of fitting	Lamp type	Key number	Key switch location
254	00/001	00.46 main intake	5ft poly carb battery integral	T5 49W *2	00/01	00.46
254	10/010	10.13	Exit sign	T8 8W * 1	10/01	10.32

B14.2.7 Distribution board chart

A **protected paper chart** must be fitted adjacent to each distribution board. It must be visible without needing to open the distribution board door or panel.

The minimum information this chart must include is as shown on the standard University Chart, an example of which follows the brief description of its contents below.

<table>
<tr><td colspan="3">BUILDING NAME
Short description of location of DB</td></tr>
<tr><td>DB Nos
Building Reference 10/13/008</td><td>Designation (eg Clean, Dirty, Plant)</td><td>Manufacturer and Type
MERLIN GERIN 6W TPN</td></tr>
<tr><td>Local Isolator
Type and size of local isolator (or CPD)
Either on the DB or adjacent
Shrouding details</td><td>Submain details
Type and size of cable between remote and local isolator</td><td>Remote Isolator/Location
Type and size of remote isolator/CPD with location and reference number</td></tr>
</table>

Way	Size Amps	Circuit Ref	Circuit Description ZS and PSC readings at distribution board	Cable Size & Type
Physical location of outgoing device (counting top to bottom, left to right)	Protective device size and type	Circuit reference as seen on top line of accessory label	Description of circuit, to include: • Space number (if known) • Local space identity (eg S/O: 10.24 Office 2) (Maximum of 60 characters)	Final circuit cable type and size

Contractors must be aware that the University operates an asset register system which records details of distribution boards and final circuits. This system will automatically generate the standard University Chart. See B15 Asset Information, below.

UED/ DPB	University Estates Directorate Distribution Board Chart	28-Mar-06

THE MALTHOUSE

MILL WORKSHOP

DB Nos	Designation	Manufacturer/Type
174 **00 /025 /18**		**MERLIN GERIN** **12 Way T PN**
Local Isolator	**Submain Details**	**Remote Isolator/Location**
3 Pole 125A ISOLATOR INTEGRAL	**25.0sqmm PVC SINGLES**	**60A TP ISOLATOR** **00/025/029**

ZS 0.22 ohms   PSC 1.34 kA

Way	Size Amps		Circuit Ref	Circuit Description	Cable size	Type
1	20	C	18. 1L1	\ 906	2.5mm	PVC
2	20	C	18. 1L2	TP&N ISOLATOR 00.25 WADKIN SAW	2.5mm	PVC
3	20	C	18. 1L3	/	2.5mm	PVC
4	10	C	18. 2L1	\ 909	4mm	PVC
5	10	C	18. 2L2	15A TP&N ISOLATOR SANDER	4mm	PVC
6	10	C	18. 2L3	/	4mm	PVC
7	16	C	18. 3L1	\ 907	2.5mm	PVC
8	16	C	18. 3L2	20A TP&N ISOLATOR 00.25 WADKIN PLANER	2.5mm	PVC
9	16	C	18. 3L3	/	2.5mm	PVC
10	10	C	18. 4L1	\ 924	2.5mm	PVC
11	10	C	18. 4L2	TP&N ISOLATOR 00.25 MOULDING MACHINE	2.5mm	PVC
12	10	C	18. 4L3	/	2.5mm	PVC
13	6	C	18. 5L1	\ 904	2.5mm	PVC
14	6	C	18. 5L2	20A TP&N ISOLATOR 00.25 GRINDER	2.5mm	PVC
15	6	C	18. 5L3	/	2.5mm	PVC
16	32	C	18. 6L1	\ 905	4mm	PVC
17	32	C	18. 6L2	20A TP&N ISOLATOR 00.25 SANDER	4mm	PVC
18	32	C	18. 6L3	/	4mm	PVC
19	10	C	18. 7L1	\ 908	2.5mm	PVC
20	10	C	18. 7L2	20A TP&N ISOLATOR 00.25 BANDSAW	2.5mm	PVC
21	10	C	18. 7L3	/	2.5mm	PVC
22	16	C	18. 8L1	\ 901	4mm	PVC
23	16	C	18. 8L2	16A TP S/O : CROSS CUT SAW 00.25	4mm	PVC
24	16	C	18. 8L3	/	4mm	PVC
25	20	C	18. 9L1	\ 926	6mm	PVC
26	20	C	18. 9L2	32A TP&N SOCKET OUTLET 00.25 DUST EXTRACT	6mm	PVC
27	20	C	18. 9L3	/	6mm	PVC
28	6	C	18. 10L1	\ 902	2.5mm	PVC
29	6	C	18. 10L2	TP&N ISOLATOR 00.25 MORTICE MACHINE	2.5mm	PVC
30	6	C	18. 10L3	/	2.5mm	PVC
31	16	C	18. 11L1	\	4mm	PVC
32	16	C	18. 11L2	16A TP S/O : WOODLATHE 00.25	4mm	PVC
33	16	C	18. 11L3	/	4mm	PVC
34	10	C	18. 12L1	\ 910	2.5mm	PVC
35	10	C	18. 12L2	TP&N ISOLATOR PILLAR DRILL	2.5mm	PVC
36	10	C	18. 12L3	/	2.5mm	PVC

B15 Asset information

B15.1 Asset register

The University operates an **electronic register for of all distribution boards and final circuits**, based on the above labelling principles. Records are held on a database in Access (part of the Microsoft Office suite).

The contractor must provide a co**mplete list of these assets**, along with all relevant **test record** information, for inclusion in this register. On request the Estates Services Electrical team will provide a template detailing the type and format of the information required.

B15.2 Drawings

On Practical Completion, the contractor must provide the following drawings in CAD DWG format. They must be sent directly to the University Electrical Engineer so that the system can be handed over.

Failure to provide these drawings may delay handover. Copies of these drawings must also be provided with the completion manual, as outlined in Appendix H.

- **Distribution Schematic** showing all cables, switchboards and distribution boards with allocated numbers.
- **Floor layout plans** detailing the location of each distribution board recorded in the register above.

The latest versions of all the electrical drawings are referenced in Appendix H.

B16 Photovoltaic installations

B16.1 System requirements

All photovoltaic (PV) system configurations must be formally submitted to the Estates Services Electrical team for approval.

The designer must provide the University with the following information:

- Year 1 output
- Year 10 output
- Year 20 output
- Annual degradation in efficiency
- Payback calculation, to include output relative to kWp installed and capital cost over a 20-year period
- All data used to form the calculation, which must include shading from building components or adjacent buildings
- Specific details around fixing details, wind load analysis and structural analysis

All this information must be taken di**rectly from the solar PV specialist design model**, and must be provided as a single report.

Two options for photovoltaic systems must be designed for each installation:

1) Provide the **minimum size required to meet any planning / building regulation requirement**, and all further requirements detailed in this document.
2) **Uplift to a larger system** to take maximum advantage of the space available for the array.

The **minimum PV installation size is 4Kw**, unless agreed otherwise with Estates Services.

All PV installations must comply with the following:

- *BS 7671* - Electrical installation regulations.
- *BS EN 62446* - Grid connected photovoltaic systems - minimum requirements for system documentation, commissioning tests and inspection
- *BS EN 50438* - Requirements for the connection of micro-generators in parallel with public low-voltage distribution networks
- Engineering reference G83
- Engineering Reference G99

PV systems must be only installed by a **MCS-accredited contractor**, unless otherwise agreed with Estates Services.

B16.2 PV modules/arrays

PV systems mounted above, or integrated into, a **pitched roof** must use products that have been tested and approved to *MCS 012*. (This involves test procedures used to demonstrate the performance of solar systems under the action of wind loads, fire, rainfall and wind-driven rain).

PV systems using **bespoke building-integrated PV modules** must use products that have been tested and approved to *MCS 017: Product Certification Scheme Requirements: Bespoke Building Integrated Photovoltaic Products*.

All PV modules must comply with the following international standards:

- *IEC 61215* in the case of crystalline types
- *IEC 61646* in the case of thin film types
- *IEC 61730: Photovoltaic (PV) module safety qualification*
- Modules must also carry a CE mark

Sunpower Maxeon PV modules, complete with **40-year warranty**, must be used on new installations unless another type is explicitly authorised.

All PV arrays must be oriented **facing south at tilt angles between 30° and 40° from horizontal** for maximum solar energy exposure, unless site conditions dictate otherwise or Estates Services specifies a different arrangement. Arrays must be **sited to prevent shading from trees, poles or other structures** at any time between 7am and 5pm solar time, at any time of year.

All PV arrays must be **securely installed** to the facility roof or to a ground-mount structure, as dictated by site conditions.

The **mounting kit** used must be have been **tested with the fixing medium** and the **PV panel** used. Rooftop mounted arrays must have **at least 75mm between the top surface of the module and roof surface**, with **no obstructions preventing air flow** between the array and roof surface.

B16.3 Inverters

Solar Edge inverters must be installed, complete with **Modbus connectivity** for connection with the PME metering system and **power optimisation units**.

The location of the inverters must be agreed with the Estates Services Electrical Engineer.

The inverter must be complete with **SafeDC**, with the following functions:

- **SafeDC**, which reduces DC voltage to touch-safe levels during grid failures or inverter shutdown.
- **Module-level monitoring** that sends **automatic alerts** on system issues, preventing potential safety risks and enabling remote troubleshooting.
- **Arc Fault Detection and Prevention** identifies and terminates electric arcs using automatic inverter shutdown for string lengths up to 400m.

B16.4 Remote energy management

The **Modbus connection** in each instance must be **operational and visible on the PME system** at completion.

B16.5 Metering

In addition to the OFGEM-approved meter, a **separate Estates Services meter** must be installed on the **AC side of the inverter**. This must be connected into the Estates Services PME metering system in accordance with the current design guidance. Refer to Appendix E – Metering.

B16.6 Fire protection

The PV system must be configured so that there is a **fireman's switch located adjacent to the building fire alarm panel**. When this switch is operated, the **AC side of the inverter will be disconnected** from the building's electrical system.

The switch must be in the form of a **white break glass unit**, and must be **wired through the fire alarm system**. Only a **manual activation of the break glass** must trip the inverter – it must not be activated through the fire detection system. The break glass must be clearly marked with the following description on a traffolyte label: "FIREMAN'S SWITCH – SOLAR PANELS ISOLATION"

See F2.18 for more information on the firefighter's switch arrangement that must be used for PV installations.

B16.7 Battery storage

If the **output of the system exceeds the operational load of the building in question**, the possibility of incorporating **battery storage** must be discussed and agreed with the Head of Electrical Engineering Services at the outset of the project.

B16.8 G99

It is the responsibility of the project team, and specifically the designer, to **complete a G99 application form and submit it to the DNO**, including all information that is needed for an offer of connection to be agreed.

Appendix C – Lifts

C1 Appointment of lift consultant

For all projects, **specialist lift consultant** must be engaged and incorporate them into the design team to assist with the **vertical transport design**, **procurement** and **installation** phases. This must include the following services, identified within RIBA Stages 1-7:

Stage 1 – Preparation and briefing
Design feasibility studies.

Stage 2 - Concept design

a) **Traffic calculations** to establish the **load, speed and number of lifts** required to serve the building's population.
b) Confirmation of **outline lift equipment requirements**.
c) Initial **performance criteria** required for the lift equipment.

Stage 3 – Technical design

a) Confirmation of outline **lift equipment requirements** and general level of **finishes**.
b) **Final performance criteria** required for the lift equipment.
c) **Draft outline set of specifications** covering all lifts to a level suitable for budget pricing.

Stage 4 – Pre-construction phase

a) Select and agree the most appropriate **contractors** to undertake the proposed works.
b) Develop **final lift technical / performance specification** and **tender documentation** for distribution by the project team.
c) Assess the lift contractor **tender returns**, generate **tender analysis** and make a **formal recommendation**.
d) Attend site to discuss tender analysis and report, and agree if further **contractor interviews** are needed.
e) Attend contractor interviews if necessary following assessment of the tender analysis.
f) Assist as necessary with the successful contractor's **appointment**.

Stage 5 – Construction phase

a) Attend site and carry out a **post contract award meeting** to initiate procurement of the lift. Discuss programme implications and liaise with site representatives.
b) **Assess contractor drawings** and any technical issues during the procurement period.
c) Arrange **pre-start site meeting** to confirm that start arrangements are unchanged and site preparations are in hand.
d) Attend **regular site meetings** and produce recorded **minutes**.
e) **Monitor progress** of works for **stage payments** and **compliance** to programme.
f) Upon completion following the contractor's commissioning of the lift, carry out a **witness test and inspection** of completed works.
g) Generate **snagging items list** and **re-inspect** upon completion.
h) Issue **practical** and **contract completion certificates**.
i) Assess draft **Operation and Maintenance Manuals**.

Stage 6 – Handover

a) Undertake **handover inspection**
b) Assess **completion certificates**
c) Assess final **Operation and Maintenance Manuals**.

Stage 7 – Post-handover

Undertake **end of defects liability inspection** (month 11).

C2 Requirements for lift installations

This section sets out the minimum design requirements that must be used for all lift installation works, whether they are intended for passenger use only or for both goods and passengers, and whether they are in new-build design applications or during part-modernisations or refurbishments of existing lifts in University buildings.

The lift manufacturer / supplier must be approved by the University Mechanical Services Engineer before contracts are agreed and approved.

C2.1 Standards

Each new lift must comply with the current *Lift Directive or Machinery Directive* (product dependant), together with all associated British (BS), European (EN) and International (ISO) Code Standards from a design and installation perspective, together with compliance to *BS 7255 (Safe Working on Lifts)*.

Equipment not manufactured in the UK must be **designed and certified to meet a Code Standard which ensures its compliance with all appropriate British and European Code Standards**, together with International Code Standards as applicable. A **Certificate of Conformity and UKCA markings** must be displayed. Any deviation from these design requirements must be brought immediately to the attention of the University Mechanical Services Engineer.

The installation must be to the highest standard, as expected of a fully experienced trade contractor. All contractors must be **accredited to LEIA** and have appropriate **Quality Assurance accreditation** (*ISO 9001*) together with industry accreditation (*ISO 14001* / *ISO 18001*).

C2.2 Design considerations

Where any new lifts are considered, these must be of the **conventional design (machine room)** if possible, **avoiding any value engineered design package-style lift applications (machine room-less)**. The design must provide the ability to make **future modifications and/or upgrades**, and must not restrict these to the original manufacturer and their closed protocol system, or to in-house design technology.

The lift consultant must complete a comprehensive **survey of traffic flow**, to ensure the lift's capacity, speed etc are specified correctly, and that the design complies with the requirements of *CIBSE Guide D: Transportation systems in buildings*. The survey report must also fully consider the system's **maintenance**

requirements, and how the building would be affected if a lift went out of service, and must include **lift contingency plans**. It must be submitted to the University Mechanical Services Engineer for assessment.

C2.3 Usage type

The quality, design and the manufacture of the lift equipment must be such that it can withstand **heavy usage for a fully occupied building**. While lifts will be used regularly throughout the day by staff and students – not just at peak times – they must also be capable of transporting heavy goods.

Therefore, the lift's key components must be:

- designed for this intended **heavy use**;
- be **readily maintainable by, and available to, all lift service providers** in the UK lift industry; and
- have a **life expectancy of at least 25 years**.

C2.4 Life cycles

A **building life cycle cost assessment (50 years)** must be completed in specific reference to the lifts before any design is implemented. This must include **maintainability**, **statutory examinations**, and **component repairs** due to fair wear and tear. The final report must be issued to the Head of Mechanical Services for assessment.

C2.5 Provision for attending engineers

Each lift installation must also be designed to provide a **safe working environment for attending engineers** and **auxiliary contractors** to work on or around. These design requirements are generic and must be used in conjunction with a full technical performance specification as required for each lift installation, together with the requirements of current industry Code Standards and Directives.

C2.6 Accessibility

Passenger and goods passenger carrying lifts must **meet or exceed all requirements of *Approved Document M Volume 2* and *BS 8300-2:2018*.** Preferred **car dimensions** for all lift scheme designs are tabled within *BS EN 81-70:2021*.

Passenger lifts must have the following minimum dimensions, as defined within Table 3 of BS *EN 81-70:2021*. (Car Type 1 will be permitted only in exceptional circumstances):

- Door entrance: 900mm
- Car width: 1100mm
- Car depth: 1400mm
- Car height: 2200mm.

C2.7 Firefighters & evacuation lifts

Lift operations in the event of a building fire must be designed to meet the **minimum requirements to prevent lift use**. Where the provision of **firefighters lifts** (as defined in *BS EN 81-72:2020*) and/or **evacuation lifts** is required, these must be designed to meet *BS 9999:2017* as a minimum, where applicable. These lifts must be activated by a responsible person and their operation managed. All **communication system** requirements set out in *BS 9999:2017* must be incorporated.

C2.8 Lift installation

The lift contractor must ensure that the lift installation is carried out in accordance with all **manufacturer's recommendations**, and with established **industry methods and best practices**. Lifts must be **engineered to a robust standard**, and all equipment must be **hardwearing** and designed to give **maximum performance and reliability**.

The lift manufacturer or installer must take every practical precaution to ensure **quiet operation** of the new equipment. These precautions must also prevent **vibration** being transmitted to the building structure from the lift machine, counterweight, lift car, controller and all other items of lift equipment. The lift manufacturer or installer must provide details of the **guaranteed noise and vibration levels** which the completed installation will achieve.

C2.9 Call allocation system

The call allocation system must be selected to **maximise lift performance**. Typically it must be of the **full collective microprocessor** type and offer options for secure access and future adaptations by the lift service contractor, without requiring intervention from the lift manufacturer.

C2.10 Goods lifts

Transportation of heavy goods, including **dangerous & hazardous materials**, within any lift must be a **managed process**. The lift's **operation and finishes** must be designed to meet its intended use, particularly where **point loading** is required (using wheeled trollies or pallets), together with the provision of **call & send controls**. An **isolation key switch** must also be provided to prevent lift use, and any secure areas provided with key, access card or keypad **security** either on the landing or within the lift car.

Contingency plans must be produced for goods and passenger lifts, ensuring an element of **redundancy** is incorporated, and that the **building can still function** and accommodate the transportation of goods and people **even if key lifts are out of action**.

C2.11 Car speeds

Passenger lifts must generally be designed for the following speeds and average waiting times. See *CIBSE Guide D section 2.6.12* for general information. The intended traffic flow study will determine the specific requirements, and therefore a full analysis must be provided.

- Up to **1m/s - 8 person** lift, serving up to 4 floors
- Up to **1.6 m/s - 10 person** lift, serving up to 12 floors
- Average waiting time: **30 seconds**

C2.12 Lift finishes

Passenger and goods passenger lift design finishes must meet the building's requirements, and the lift's intended use. Goods passenger lifts must include **pattern stainless steel** (2WL, Canvas, or Linen), **double timber bump rails**, **aluminium chequer plate flooring** and **vandal-resistant light fittings**.

Passenger lift landing entrances must have **extended architraves** (patterned **stainless steel**) to allow for easier access to and egress from the lift. Architraves must be of full depth and include the **building floor numbering** and **University lift identification number**. This must be **engraved on the exit floor landing call button face place**, and **inside the lift car on the car operating panel**.

C2.13 Emergency communication systems

Passenger lift cars' **emergency (trapped passenger) communication system** must be commercially available and manufactured by either **Windcrest**, **Memcom** or **SafeLine**. The voice communication system must be programmed to dial the **University Security Services control room**, which is manned 24 hours a day, on 01865 272944.

Where the trapped passenger system requires an **external telephone line**, a **GSM SIM card system** must be implemented. The system must be designed to accommodate the **best network reception** available, together with a **two-year unrestricted call SIM contract**. The GSM SIM must be designed to operate on all available networks.

C2.14 Floor numbering

In new buildings or new lifts, the provisions of European Code Standard *EN 81-70*, which indicates the **preferred use of -1 0 1 2 3** etc, must be adopted where possible. However, on lift **modernisation and refurbishment projects**, continuing to use the **existing floor markings** must be considered to avoid different identification and possible confusion.

C2.15 Electrical installations

The lift electrical installation must conform to current IET Wiring Regulations (including latest amendments) and be **tested and certified** in accordance with these regulations by a NICEIC-registered electrician.

A **certificate** stating either that **the existing supply has been tested and is adequately rated**, or that a **new supply is required**, must be provided by a NICEIC registered electrician and subsequently approved by the Electrical Blue Book contractor. All works must comply with *BS 7671* and *BS 5266*.

All completed lift installations must comply in all respects with the University's guidance on electrical installations, Appendix B. **Galvanised trunking and tubing** must be used throughout, together with **LED lighting**. All control/gear systems must be designed to meet *BS EN 61439* where applicable.

C2.16 Lift rooms and shafts

Lift rooms and shafts must not contain any other services, and must be equipped with suitable **access ladders**, adequate **smoke ventilation** and the appropriate **LED lighting** and **emergency lighting**.

All rotating parts must be painted yellow and suitably guarded.

Lift motor room doors must be fitted with a locking system made by Yale Security Products Ltd, type GMK suite, ref no YN811(Y), 'L' suite for lift motor rooms. The standard lock must be key-operated externally and thumb turn on the room side, and must come complete with three keys.

C2.17 Fire detectors

The University Fire Officer must be consulted around **fire detection**, **fire compartmentation**, **firefighters** and/or **evacuation lifts** and related issues during the **concept design stage**.

If possible, a **smoke detector** must be installed in the **lift motor room** rather than at the top of the lift shaft, assuming that there will be adequate openings between the lift shaft and the motor room. Where the lift motor room is not directly above the lift shaft, or where the lift is a hydraulic type or there is no lift motor room, then an **aspirated type smoke detector** must be installed at the **top of the lift shaft**, with the part of the detector which requires calibration/maintenance being positioned outside the shaft.

C2.18 Warranty & maintenance service contract

All lift projects must include a **12-month warranty** period and **maintenance service agreement**. This must start at Practical Completion. The condition of the lift installation at this point must be **as new**, including all **lamps and consumables**. Therefore, if any lift is used during a building's construction, all elements that have deteriorated through use must be replaced for new.

The maintenance contract must be comprehensive, including **12 monthly service visits** for **passenger-carrying lifts**, or **six bi-monthly service visits** for **disabled access lifts and goods lifts**.

The contract must also include a **four-hour call out response 365 days, 24/7**. Out-of-service records, service and breakdown reports must be issued to the building manager and Head of Mechanical Services.

If the lift **breaks down more than five times during the 12-month warranty period**, the warranty period must be **extended until reliability has been improved** to the satisfaction of the Head of Mechanical Services.

The 12-month lift maintenance service contract **must be included** in the project. The University will not allow any derogation from this, nor accept any proposal that excludes it. **It is a non-negotiable requirement for all projects.**

C3 Lift handover procedures

C3.1 Testing, witness testing and handover

After installation, the contractor must carry out their own **testing and commissioning** in accordance with the appropriate sections of *BS 8486-3:2017 (New Lifts)* or *5655: Part 10.1.1:1995*, *PAS 32-1:1995 (Modernised / Refurbished lifts)*, plus all subsequent revisions and procedures. After this they must complete any outstanding items.

The contractor **must not offer the installation for witness testing until all works are completed**, including their own testing and application of all finishes.

Witness testing must be included within the lift contractor's scope of works. All **test weights**, **thermometers**, **instruments** and **personnel** must be provided, together with the appropriate **Test and Examination Certificates** duly completed and any other certificates that are required.

Full dynamic tests must form part of the witness test procedures. At minimum these must include:

- **Rated load/rated speed buffer** tests to car and counterweight.
- **Minimum rated load/rated speed or lower** (depending on Code Standard requirements) **car and counterweight safety gear** test.
- **Uncontrolled upward movement** test.
- **Movement away from landing with car door open** test.
- **125% rated load brake** test.
- **Rope brake** test.
- **Traction** test.
- **Door pressure** test.

If these tests cause any consequential damage to the lift car, finishes or equipment, the **contractor must cover the cost of repair**.

A full set of **Test Certificates** and where appropriate **CE marking** and **Declaration of Conformity** must be provided upon completion, including a **grading certificate** for all **stainless steel**, plus certificates for all **electrical services**.

C3.2 Operation and Maintenance Manual

The manual(s) must be in the **eDocs format**, or as dictated by the contract preliminaries.

The Operation and Maintenance Manual(s) must contain, as a minimum, the following information:

- Full **'as built' drawings**
- 'As installed' **wiring diagrams**
- **Test certificates** in accordance with *BS 5655 Part 10.1.1:1995 / PAS 32-1:1999 / BS 8486-3:2017 (New Lifts)*
- **Stainless steel grade specification** certificate
- **Rope test** certificates
- **Component type test** certificates
- **CE Certificate of Conformity** (New Lifts)
- **Electrical installation test** certificates (where applicable)
- **Structural engineer's report** (where applicable)
- **Landing entrance fire test** certificate (where applicable)
- **Maintenance instructions**
- **Lubrication** chart
- **Hand winding** instructions
- **Operating instructions**
- **Component description** and **part number list**
- **Diagnostic check chart**
- Full **description of control system**
- Specialist finish **cleaning schedule**
- **Spares list**

C3.3 Lift acceptance

Lift installations will not be accepted for use by the Mechanical Services Project Engineer until the following items have all been completed:

- **Inspection by the lift consultant**, including dynamic witness testing and operational status.
- Lift **contractor's testing/commissioning**.
- Provision of **declaration certificates**.
- Completion of any **remedial snagging** and **desnag inspections**.
- **Operation and Maintenance Manual** received and **contents approved**; including copies of the test certificates, wiring diagrams, Certificate of Conformity, drawings and spares lists.
- All **communication systems verified** to be fully operational.

Servicing and maintenance of the lift(s) must be included in the project cost for the 12 months following handover. Servicing intervals and maintenance of the lift must be carried out in accordance with the manufacturer's recommendations.

C3.4 12-month defects liability and maintenance period

From the date of completion of the final lift and/or of each lift on the project the contractor must commence the fully comprehensive **maintenance and defects liability period**, which must continue for 12 months or as otherwise agreed.

Regular **maintenance must be carried out monthly**. This must include **cleaning**, **oiling**, **greasing**, **adjusting** and **replacing or repairing** all parts of the installation and accessories as necessary to ensure its operation is satisfactory. It also includes **checking of levelling** and making any necessary adjustments.

Maintenance visits must be carried out strictly on a **one-visit-per-lift-per-month** basis, and the routine maintenance visit must not in any circumstances be combined with visits made due to breakdowns or other specific requests.

Any **components which become necessary but are not covered by the defects liability** must be provided at no extra cost.

Servicing of the lift during the initial twelve months defects liability & maintenance period must include **full cleaning** of the lift machine room/space, lift pit and lift shaft, as well as cleaning and dusting of all voids, ledges, and internal building fabric in addition to the installed lift equipment.

The contractor **must not store cleaning material, grease or oil** in the lift shaft or machine room/space.

The contractor must **renew all lamp**s which may be found at the time of any inspection to be defective. This includes shaft lighting, machine and car lighting.

A report must be made available, upon request, providing details of the following:

- The **service visits performed**, and their **dates**.
- Whether the installation is in a **satisfactory and serviceable condition**.
- A detailed list of all breakdowns and other attendances at site, together with the remedial action taken on each occasion.

The contractor must attend to **breakdowns and emergency visits** on a **24/7** basis at no extra cost.

The contractor must also provide **full instructions on running, operation and hand winding** the installation to the employer's appointed staff or their client's appointed employees.

Before the end of the defects liability and free maintenance period, the lift contractor must permit **free access to the lift consultant** for **verification of the lift's maintainability and operational status**. If any **latent defects** are identified at this point, the end of the defects liability and free maintenance period will not be approved until they are fully addressed.

Appendix D – Building Energy Management Systems

D1 General requirements

All Building Energy Management System (BEMS)-controlled systems must be engineered to a standard that is both high and consistent across the University's estate, to provide **optimal energy usage** and **control of building services**.

The University's BEMS Engineer must be consulted on progress of the BEMS design at key stages. As a minimum, these must include:

- At the project appointment, to agree the **BEMS and metering strategy**
- Stage 3 & 4 delivery **gateway reviews**
- Stage 5 **review of BEMS proposed architecture** for comment, prior to procurement of BEMS equipment
- Review of **Motor Control Panel (MCP) drawings** for comment prior to construction
- Review of **SET drawings** prior to commissioning

BEMS equipment (including, but not limited to, all outstations and loose controls) must be **manufactured by Trend Controls**. **BEMS contractors** must be **Trend Approved Partners**.

All on-site **wiring installations** must be in accordance with the University Electrical Philosophy and appendices. All BEMS contractors working on University sites must be **Blue Book approved**.

The control system must be designed to suit the requirements of the particular building services that are (or will be) in place, and must always incorporate sufficient features to operate the plant safely with the minimum of energy use.

All **plant control must be via conventional hard-wired BEMS inputs and outputs**.

Main items of plant such as **chillers**, **heat pumps** and **central VRF** must be networked back to the BEMS via **Modbus** or **BACnet**, to provide full **graphical interface** and **read/write facility** for main control set-points, as agreed with the BEMS Engineer.

Where BACnet or Modbus controllers are used, there must always be a hard-wired enable, fault and temperature set-point signal from the Trend BEMS system to the equipment.

All other equipment – including (but not limited to) **air-handling units (AHUs)**, **fan-coil units (FCUs)** and **variable-air valves (VAVs)** – must be fitted with **Trend outstations** networked back to the main BEMS. Manufacturers' **closed-protocol proprietary control systems will not be accepted**.

Terminal unit controllers are not to be fixed programme / application type and must be **freely programmable**.

D2 BEMS control panels

D2.1 Control panel forms

General **control panels must be form 2 type 2**, with **separate control and power sections** unless otherwise agreed in writing by the University BEMS Engineer. Power supplies for **mechanical plant** must be via **plant room-mounted distribution boards** and **not the BEMS control panel**.

D2.2 Form 2 type 2 panels

D2.2.1 Power sections

The power section must house the following:

- An **electrical distribution board**, complete with its own **integral main isolator**. This board must not be used to supply power to mechanical plant items. It must be fitted with **MCBs for the final sub circuit protection**. Both the isolator and the individual MCBs must be lockable in the OFF position.
- 240V/24V transformer - power for field devices, ie valves and damper actuators
- 240V/24V transformer - power for Trend outstations & modules (UPS backed up.
- 240V/24V transformer - control circuit
- UPS
- Phase failure relay
- Any relays with 230V connections
- 230V 13A socket, RCD protected
- Mains healthy indicator, fascia-mounted

There must be **no exposed single-insulated cables** with a **voltage potential of 50V or higher**. Door interlock isolators are not required.

D2.2.2 Control sections

The control section must house the following:

- Trend outstations and I/O modules – outstation must be 24V AC powered
- 24V AC/24V DC PSUs
- Relays (24V or less)
- IT hub with spare port for laptop

- Field wiring terminal rail
- Fascia mounted LED Indicators, H/O/A switches, IQ View Display Panel, Reset buttons etc.

Digital input multiplexers must not be used.

Power to mechanical plant must be fed from a separate distribution board located adjacent to the main BEMS panel. This board must be in accordance with the University Electrical Philosophy and associated appendices.

D2.3 Form 4 type 6 panels

Form 4 type 6 panels must be used where it is necessary to maintain **continuous operation of plant** that serves:

- Laboratories that have mandated Home Office approval requirements
- Laboratories containing specialist scientific equipment
- Computer suites

If in doubt, seek confirmation of the panel that must be used from the University BEMS Engineer.

D2.4 Control panels – general

Control panels must not be located in outdoor locations. If control panels do need to be installed outside, then protected outdoor rated control panels with appropriate sun/rain hood or shield and conditioning if required. Panels may only be located externally with the approval of the University's BEMS Engineer.

Control panels must be provided with at least **25% spare capacity**. 'Spare capacity' refers to both **physical space** and to **hardware to support the spare I/O channels**. All **spare I/O** must **be wired within the MCP** up to the field terminal rail.

All live **conductive parts ≥ 50V** within the panel must be **shrouded**. Panels must be designed and installed so that a maintenance engineer does not need to go inside the control panel to make any adjustments.

All relays that form part of an interlock circuit (hardwired or software), such as fire alarm, pressurisation unit fault, frost thermostats, damper end switches etc, and all those that connect to outstation inputs, must have **gold-plated contacts**. All MCPs controlling mechanical plant that serves **laboratories, data** suites, research establishments etc, must have a UPS fitted within the MCP to back up the Trend outstations and associated I/O modules.

All control wiring must be adequately identified and protected. It must be installed to the latest industry standards and comply with all requirements of the University Electrical Philosophy and associated appendices.

Control panel wiring must be configured so that all types of plant failure are indicated by appropriate warning lamps on the panel fascia. In addition a fascia common BEMS fault indicator lamp must also be fitted. This must connect to a controller output, and send an alarm signal when any software alarm is current.

A fascia-mounted fault reset button must also be provided to reset all latched alarms, both hard wired and software.

All safety interlocks must be hard- and soft-wired.

The control system must be designed so that all plant restarts automatically following a power supply interruption. The BEMS must be included within the 'black building test' following discussion with the project team.

The MCPs must be designed so that in the event of an outstation failure, the plant will still be able to run in Hand using the MCP H/O/A switches. Plant with modulating outputs may need to have 0-10 V adjustable signal units fitted within the MCP to achieve this.

The Hand position of all H/O/A switches must be monitored to provide an alarm on the BEMS if any switch is put in the Hand position.

Control panels must be fitted with LED lamps and lamp test push-button.

Control panels must be complete with fascia-mounted display panels, to enable local monitoring and operation of the plant. These must be installed at eye level and have the appropriate passwords and pin numbers active, as agreed with Estates Services.

On sites with only one MCP, an IQView4 must be used. On sites with multiple MCPs, the main plant MCP must be an IQView8b, while the others must be IQView4.

D3 BEMS networking and system engineering

D3.1 Networking – general

All buildings / BEMS outstations must be networked and connected back to a **BEMS supervisor**. If the supervisor is remote (ie off-site) the BEMS network will need to connect to the building's Frodo Local Area Network.

Where IP addressable outstations are used, an **ethernet switch** must be provided within the control panel. This switch must have a **spare port** for use by the BEMS service engineer. A **patch cable** will need to be installed from this switch to connect to an external data point socket.

If there is more than one network cable connecting to an MCP, a **separate network panel** must be provided. This will house the IT switch and will be powered from an **alternative power source**.

Where additions or alterations are planned to an existing BEMS, the University BEMS Engineer must be consulted before any works begin on site.

D3.2 Sensors

The mechanical services designer is responsible for **specifying the type and number of BEMS sensors / devices** necessary to achieve the **desired level of control**.

Specific University requirements:

- At least one **outside air temperature sensor** per system. This must be sited on a north-facing wall.
- **Flow & return temp sensors** on:
  - Each boiler (or heat pump)
  - LTHW boiler (or heat pump) primary circuits
  - LTHW secondary circuits (CT & VT)
  - Each Chiller (or heat pump)
  - CHW chiller (or heat pump) primary circuits
  - CHW secondary circuits (CT & VT)
  - Domestic hot-water secondary circuits
  - Immersion sensors on each cold-water tank section
  - Immersion sensors on any domestic hot-water buffer or storage vessels

- LTHW & CHW air-handling unit coil flow/return connections. For AHUs with 3-port control valves, the sensor needs to be located before the control valve bypass connection.
- DP transducers (AI) across all AHU filters.

D4 BEMS head-end supervisory systems

Head-end site supervisory PC systems must be avoided. These systems will not be supported by the University Controls team. In these cases, a multi-**user web server version** will be provided. Elsewhere, building users will use a **web client** to access a **remote BEMS supervisor**. The University BEMS Engineer must be consulted during each project's early design stage to determine and agree the head-end strategy.

The controls BEMS contractor must make provision for adding the **graphics and user pages** associated with the new control system, along with **additional licencing points required by the project**, onto the **Trend supervisor**(s). The location of the Trend supervisor must be agreed with the BEMS Engineer.

The **format** of the graphics and user pages must be the same as those already on the system, and must be submitted to the BEMS team for comment and approval.

The appointed BEMS contractor must engage with the University's BEMS Engineer and review the University's **existing head-ends** to establish the exact format of the graphics required.

A **relevant extract** from the description of operation must be included on each graphic page within an info box and a **jump button** engineered for it.

All points on a schematics page must be **checked and verified** as part of the **commissioning** process.
In addition to the schematics, the BEMS contractor must include setting up users, diaries, alarms and scheduled events.

Passwords and **PIN numbers** for any new addition to the Trend BEMS network must be discussed and agreed with the University BEMS Engineer.

D5 BEMS engineering

D5.1 General

When engineering the system, all efforts must be made to **keep communications traffic to a minimum**. In general, all common items of plant must be controlled from a **single outstation** and not from two smaller ones.

If a **control sensor** is in a **remote location**, it must be **hard-wired back to the outstation** which has the controlled device connected to it. In such instances it is **not acceptable to use IC Comms**.

To allow user operation, data plots must be engineered for the following points:

- All real inputs (analogue and digital)
- All real outputs (analogue and digital)
- IC Comms. (data points entering the controller)
- IC Comms. (data points leaving the controller)
- Calculated set points
- Demand bits
- Hours run sensors

D5.2 BEMS alarm strategies (energy)

These must be configured to **alert the BEMS operator when plant is operating outside normal control**. They must include:

- Heating systems operating above set point by 'x' DegC after a time delay of 'y' minutes
- Cooling systems operating below set point by 'x' DegC after a time delay of 'y' minutes
- Plant running when the building is unoccupied

D5.3 BEMS alarms - general

Alarms must be **configured/enabled** but with the **alarm transmission disabled**. A list of the alarms must then be issued to Estates Services, who will decide on the alarm classification.

Building critical alarms (including **anything life safety related**) **must not be solely on the BMS**. Building Critical alarms must be transmitted to a monitored space – either the building's reception or Security Services and the SmartWatch system.

Alarm groups must be set up for **critical** and **non-critical alarms**. Alarms that are not to be sent will be assigned to alarm Group 0.

Alarm routes and destinations must be configured with **each route having a software switch [W999]** to disable the alarm transmission. Once the project is fully complete, the controls installer will verify that alarms are being received as expected at the remote supervisor.

D5.4 BEMS testing and commissioning

Off-site software testing

All control software must be **fully tested and documented off site**, using SET and simulation mode, and full records of the testing must be provided.

On-site pre-commissioning

This covers point-to-point checking of all points, power & control. Records of this process must be included in the Operation and Maintenance Manual.

On-site commissioning

This covers setting up the control devices, including **checking functionality**, **sensor calibration** checks and **verification of control**. All scenarios must be checked, including (but not limited to) **out of occupation** and **restarting following a power failure**.

D5.5 BEMS documentation

The control system – including hardware, software and panels – must be **fully documented**. At handover, the documentation must include the following, as a minimum:

- LAN map
- Network schematic line diagrams
- Panel wiring diagrams
- SET files hard copy
- SET file electronic copy, in both SET and PDF formats. The PDF must be produced when the project is deemed to be complete.

- Backup of supervisor files
- Testing and commissioning records
- Schedule of equipment, including models & serial numbers
- Equipment data sheets

Appendix E – Metering

E1 Introduction

The University has a large energy distribution system, encompassing electricity (both high- and low-voltage), natural gas, gasoil, water and heat energy. Managing these energy flows effectively relies on high-quality data supplied from numerous sources.

The University's approach to metering, as outlined here, is intended to ensure that as it continues to expand, a **minimum standard of energy metering** is adopted. This standard is based on **existing installed equipment** and known **future legislative requirements**.

If at any stage a designer or installer **believes they may not achieve the standards set out below**, they must contact the Building Services team in Estates Services for further guidance.

In all cases, the Technical Support Engineer (Metering) and the Environmental Sustainability team must be **notified of any new meters**, or of any **changes to existing metering arrangements**

All meters need to be **readable from the floor without the use of mirrors or access equipment**. If this is impossible, a **permanent access platform** must be installed.

All meters must be capable of resolving half-hourly consumption of the system they are monitoring at minimum turn down.

The electrical drawings referenced in this section are available on the Estates Services website.

E2 Electricity meters and instrumentation systems

E2.1 General requirements

The **SSE local grid distribution system** supplies the University with electricity. This either **feeds directly** into University buildings or **supplies the University's own high-voltage (HV) and low-voltage (LV) distribution systems**.

All buildings that are fed from the SSE local grid or the Oxford University HV network are **metered at point of supply**. There is also a comprehensive **sub-metering network** in many buildings. This sub-metering network, **Schneider EcoStruxure Power Monitoring Expert (PME)**, supplies and processes **half-hourly data on electricity consumption** to the University's energy-management system, **SystemLink**.

Revenue half-hourly (HH) supply meters that are not on Oxford University's HV and LV distribution network also produce half-hourly data for billing purposes. This **data is supplied by SSE and transferred to SystemLink**. University **sub-metering** is also in place on **LV distribution boards** across the estate. The half-hourly data from these is also available to PME and SystemLink.

As well as normal electricity supplies, the University also has a small number of **standby generators** and **Combined Heat and Power (CHP) plants** that have the ability to both **synchronise and feed the LV grid system**. These systems have **special metering requirements**, which are set out in section E3.

The following sections outline the requirements for energy metering and monitoring of the University's electrical systems. They detail the metering and instrument requirements from the substation through to final sub-distribution within a building. The general principles are shown in the Standard University Metering and Instrumentation diagram E400978 Sheet 1.

These metering requirements must be read in conjunction with *CIBSE Guide TM39 Building Energy Metering* as required by Part L2 of the Building Regulations.

Schematics showing how the meters interrelate must be provided.

E2.2 Current transformer general arrangements

Installations of **instrument transformers (C/Ts)** must comply with *BS EN 61869-2:2012*.

C/Ts must be installed on outgoing circuits such that they can be **replaced without disrupting other circuits**.

All C/Ts must be **Class 1**, with a **minimum capacity of 2.5VA**.

The **C/T ratio** must be dependent on site. **C/T secondary** must be **5A**.

C/Ts must be fitted on **all phases** including the neutral.

All C/T secondary wiring must be wired to **separate terminal blocks** (Klippon or equivalent) with shorting links such that connections and alterations can be carried out while the switchboard is in use. See drawing E400978, sheet 2.

A **label detailing the C/T type, size and ratio** must be fitted adjacent to this terminal block. This must be fully accessible without the need to isolate the switchboard.

C/T configuration for metering must take place from the terminal block.

E2.3 Voltmeter monitoring – general arrangements

A **fuse-protected three phase and neutral reference voltage** must be provided for each section of the switchboard.

Fuses required for **instrumentation and metering** must **be not less than 10A rated** and must be sited so that they can be removed safely without the need to isolate any part of the switchboard. All fuses must be **labelled with size and circuit details**.

All **voltage potential cables** must be **6mm LSF double insulated**.

The voltage measuring arrangement along with instrument or meter requirements must be as outlined elsewhere in this document.

E2.4 Meter and sub-meter types

It must be noted that the University currently operates an existing **remote monitoring system** using **Schneider EcoStruxure Power Monitoring Expert (PME)** and that all electronic meters and instruments must be **compatible with this system**.

Table 1, below, details the various meter types that must be used in different situations:

Metering	Location	Meter type	Comments
1.1 Substation transformers	Substation LV panel	Schneider PowerLogic PM8000	Each transformer must be metered. Each meter must be mounted in a separate enclosure adjacent to the substation LV panel. Meters must be connected to the Frodo network individually.
1.2 Substation LV switchboard sub-metering	Substation LV panel	Schneider PowerLogic NSX MicroLogic 5/6 Type E system using FDM121 meters	Each device must be equipped with communication function via an IFM interface module. Up to 15 meters can be connected to an EcoStruxure Panel Server 24v Gateway, which must be networked to the Frodo system.
1.3 Building main	Building main switchboard	Schneider PowerLogic PM9000 or PM 8000 if an administration or office building	The incoming supply to the building must be metered. Where the supply comprises two incomers, both supplies must be summated onto single meter. The meter must be connected to the Frodo network.
1.4 Building main switchboard sub-metering	Building main switchboard	Schneider PowerLogic NSX MicroLogic 5/6 Type E system, using FDM121 meters	Each device must be equipped with communication function via an IFM interface module. Up to 15 meters can be connected to an EcoStruxure Panel Server 24v Gateway, which must be connected to the Frodo network.
1.5 Building distribution sub-metering	Sub MCCB distribution boards/panel boards	Schneider PowerLogic NSX MicroLogic 5/6 Type E system using FDM121 meters For existing buildings, sub-meter type will depend on the system already present in the building. Please check with the Estates Services Electrical team.	A network point connected to the Frodo system must be installed adjacent to the distribution board, unless specifically agreed otherwise with the Electrical team. Each device must be equipped with communication function via an IFM interface module. Up to 15 meters can be connected to an EcoStruxure Panel Server 24v Gateway, which must be connected to the Frodo network.
1.6 Building distribution sub-metering	Distribution boards	Schneider PM5300 if standalone distribution board or Schneider PM5100 if combined distribution boards or final circuit metering is required. For existing buildings, sub-meter type will depend on	A network point connected to the Frodo system must be installed adjacent to the distribution board, unless specifically agreed otherwise with the Electrical team. If PM5100 is required, an EcoStruxure panel server 24v gateway must also be

		the system already present in the building. Please check with the Estates Services Electrical team.	installed and connected to the Frodo network.
1.6 Building final circuit metering	Final circuits in distribution boards	Schneider PowerTag	An EcoStruxure panel server 24v gateway must also be installed and connected to the Frodo network.

E2.5 Meter networks

All **meters must be connected to the ETSTN Frodo network** using a **CAT 6** data cable.

Where sub-metering is to be installed, **up to 15 submeters** can be installed to each Schneider EcoStruxure Panel Server. Any links from meters must be in **Belden 9841** type cable (RS486). Metering networks must be spilt by floor where possible.

E2.6 Substations – HV metering

No metering or instrumentation is required.

E2.7 Substations – LV metering

For the purposes of this guide, a **substation LV switchboard** is defined as a switchboard which is **supplied directly by one or more HV transformers**, and **feeds one or more University buildings**.

An **analogue voltmeter** and **selector switch** must be mounted adjacent to all the **incoming LV isolating devices**, reading **ph-ph and ph-n volts**. A **separate switch must select incoming volts or busbar volts**. **Potential fuses** must be placed so that connections can be made without needing to isolate any part of the switchboard.

A **C/T must be fitted on each incoming phase and neutral connection** and **wired to a terminal block**, as shown on drawing E400978, sheet 2. The terminal block must be located so as to permit access without needing to isolate any part of the switchboard.

A **main meter** must be installed on **each transformer circuit**.

The meters must be configured to **read all phases and neutral current**.

The meters must be correctly **calibrated**, with **all previous energy readings and maximum demand readings reset to zero**. **Thermal demand** must be set at **30 minutes**.

E2.8 Substation LV switchboard – outgoing circuits

For all **outgoing circuits** that are to supply **variable loads greater than 63A (50kW)**, a **Schneider FDM121 meter** with associated **NSX Micrologic 5/6 A or E trip units** must be used.

All meters must be networked together and connected to a Schneider EcoStruxure Panel Server.

The network cable must be terminated at a location that:

- Is accessible without the need to switch off the power
- Allows an external cable connection

E2.9 Building metering – incoming circuits

For the purposes of this guide, the **LV building switchboard** is defined as a switchboard which is **supplied from either the local DNO** or from a **University substation LV switchboard**.

An **analogue voltmeter and selector switch** must be mounted adjacent to each of the **incoming LV isolating devices**, reading **ph-ph and ph-n volts**. A **separate switch** must select **incoming volts or busbar volts**. **Potential fuses** must be placed so that connections can be made without the need to isolate any part of the switchboard.

The C/Ts must be wired as shown on drawing E400978 sheet 2. The terminal block must be located so as to permit access without disruption to normal switchboard operation.

E2.10 Building metering – outgoing circuits

For all **outgoing circuits** that are to supply **variable loads equal to or greater than 63A (50kW)**, a meter as outlined in Table 1 in section E2.4 must be installed.

E2.11 Building metering – riser/tap offs

The **riser** is defined as the **vertical/horizontal distribution system, cable or busbar**, supplied from the **building LV switchboard** and/or **other riser**.

For all **tap off circuits** that are expected to supply **variable loads greater than 63A (50KW)**, the meter detailed in Table 1 in section E2.4 must be used.

The **C/Ts** must be wired as shown on drawing E400978 sheet 3, including **earth leakage**. The terminal block must be sited so as to permit access without disruption to supplies.

E2.12 Building metering – sub-distribution boards

For the purpose of this guide, the **departmental sub-distribution board** is defined as a distribution board that **supplies one or more distribution boards** with a **combined variable load in excess of 63A**. It may be supplied from either the **building LV switchboard** or the **riser**.

For all **sub-distribution board circuits** that are expected to supply a **variable load greater than 63A (50KW)**, the meter detailed in Table 1 above must be used.

A **C/T** must be **wired on each phase and neutral**, as shown on drawing E400978, sheet 3.

The terminal block must be sited to allow access without disruption to normal switchboard operation.

E2.13 Building main metering

Each building switchboard must have a **single main meter** (see Table 1 in this document) fitted in a **separate enclosure** adjacent to the switchboard.

Where switchboards comprise **two incoming circuits**, **C/Ts** must be **summated onto single meter**.

The **C/T wiring** must be configured to **read all phases, neutral and earth leakage current**.

The meter must be **calibrated with all previous energy readings and maximum demands reset**. **Thermal demand** must be set at **30 minutes**.

E3 Energy generation systems

E3.1 Standby generators

The University has numerous **standby generators** installed at key locations to ensure a reliable electricity supply even if the HV distribution system fails. All standby generator installations must have the following metering installed:

- A suitable **electrical meter** (type to be confirmed by the Estates Services Electrical team) to dynamically measure and record the **energy KWh output** from the unit. This meter must be connected to the Frodo network and linked to the PME automated metering system via Modbus – EcoStruxure Panel Server.
- A **flow-metering device** that complies with *BS 2869:2010* must be fitted to the gasoil supply to record the **gasoil usage** of the unit. This device must record dynamic flow and total consumption in litres, reporting to the PME automated metering system over the Frodo network.

E3.2 Photovoltaic panel systems

The Feed-in-Tariff requires an OFGEM-approved **generation meter**. In addition to this meter, a **separate Estates Services** meter must be installed on the **AC side of the inverter** and connected back to Estates Services as described in section E2.1.

E3.3 Combined Heat & Power (CHP) plants

The University has numerous **CHP plants** installed across the estate to improve the energy efficiency of individual buildings. All CHP installations must have the following metering installed:

- A suitable meter from Table 1 must be used to dynamically record the unit's **energy KWh output**. This meter must be connected to the Frodo network and linked to the PME automated metering system. Refer to Appendix B – Electrical Services Installations for guidance on selection.
- A suitable revenue **standard gas meter** (see section E4.1 below on natural gas meters) must be installed on the **gas supply** to the unit. This is in addition to any existing gas meter for the building or other installed plant. This meter must be connected to the Frodo network and linked to the PME automated metering system.

- A **heat energy flow meter** (see section E5 on heat energy meters) must be fitted to the **flow and return pipework** from the CHP to the final heat load. If the CHP is fitted with a separate **heat energy 'dump' device**, this must be **separately metered** on both the flow and return. All heat energy meters must comply with *The Renewable Heat Incentive Guidance*, Volume 1, Chapter 7.

E4 Gas and water meters

E4.1 Natural gas service

Generally, in line with the University's carbon reduction strategy no new gas systems must installed.

The University has numerous historic **gas meters** installed**, both revenue and sub-metering**. Some of these meters are connected to an individual BEMS.

This arrangement is **not consistent with a total energy metering strategy**, and gives **limited scope for effective data management**. To bring consistency to the methodology of gas meter data collection, the following standards must be followed:

- All gas meters installed on the University estate must comply with *the Gas (Meters) Regulations 1983*, *SI 684* and the *Measuring Instruments (Gas Meters) Regulations (SI 2006/2647)*.
- All gas meters installed must be stamped in accordance with the Gas Act 1986.
- If the meter in question is a revenue meter owned by meter asset manager (MAM) or others, an **automated method** must be installed to ensure that **half-hourly data** is supplied to the University's Environmental Sustainability team via PME. All gas sub-meters must be connected to the Universities automated metering system PME over the Frodo network.
- The gas supply to areas such as **kitchens and laboratories** must be **metered separately** from the supply to **heating boilers** and **hot water heaters**.
- All meters must be **capable of resolving half-hourly consumption** of the system they are monitoring at minimum turn down.

E4.2 Water

The buildings on the University functional and collegiate estates are supplied either directly from a **Thames Water pipe feed**, or from a **University water network** that has itself been fed from a Thames Water pipe feed. Some buildings have data collection systems linked to the BEMS. All water meter installations must comply with the *Water Supply (Water Quality) Regulations 2000*, and *The Measuring Instruments (Cold Water Meters) Regulations 2006 (S.I 2006 No.1268)*.

Controls must be designed to **minimise energy consumption** and **operational wear**, to **activate the back-up water supply automatically**, and to provide suitable **connections** to allow the system to be **connected to the BEMS**. Consideration must be given to incorporating **status monitoring** which provides additional information on subjects such as how full the tank is, any malfunctions, which supply is being used and so on.

Flow meters must be provided to the **back-up water supply** and the **pumped outlet from the storage tank** to enable the performance of the system to be monitored.

The meters must be **monitored remotely** through connection to PME via a pulse acquisition module and a Schneider EcoStruxure panel server, enabling the dynamic collection of consumption data. All water meters installed on the University estate must comply with *BS EN 14154-3:2005+A1:2011* and *OIML R49* as well as with the Water Regulations.

If the main water meter is a Utilities meter, a sub-meter must be installed and connected to the PME over the Frodo network.

The **water supply to separate systems must be sub-metered** – these systems include but are not limited to, **potable hot and cold water**, **laboratory hot and cold water**, and **kitchens**.

All meters must be capable of resolving half-hourly consumption of the system they are monitoring at minimum turn down.

E5 Heat energy metering

E5.1 General

All heat meters must have the following characteristics and be capable of meeting the following performance standards.

Heat meters must meet the **Class 2 requirements** in Annex MI-004 of the *EU Measuring Instruments Directive (MID) 2004* and comply with *The Renewable Heat Incentive Guidance*, Volume 1, Chapter 7.

The guidance note specifies that all heat meters used for RHI purposes must consist of:

- a **flow sensor** (or **meter**)
- a **matched pair of temperature sensors** (such as two thermocouples) – the two temperature sensors must have been calibrated together as a pair to make sure the temperature difference between the input and output of the system is measured to the stated accuracy level; and
- a **calculator/digital integrator** – the integrator must be provided with both Modbus and pulse output.

All heat meter installations must conform to **EU MID Class 2 standard**. The **Kamstrup Multical 603 meter with Modbus card** must be used unless Estates Services explicitly approves an alternative. All heat metering must be **independent** and **must not be linked with electrical metering**. A **Schneider EcoStruxure 24v Gateway** must be used, connected to the Frodo network.

Digital integrators must have an **integral display** which allows recorded parameters to be viewed locally. They must also be provided with Modbus output for connection to the PME system over the Frodo network.

Displays must be at a suitable height where they can be viewed without any specific access equipment.

All meters must be capable of resolving half-hourly consumption of the system they are monitoring at minimum turn down.

E5.2 Data transmission

Heat meters must be capable of recording and transmitting the following data at a **minimum frequency of every 30 minutes**:

- Heat (energy) consumed (kWh)
- Flow temperature
- Return temperature
- Flow rate (m^3/hr)

Extreme care must be taken when installing and commissioning heat meters. These must be **calibrated in situ** after installation. They must be **checked before practical completion**, and then **checked again within a month** after this date to ensure they are providing accurate data. **Good-quality heat meter data must be in place before seasonal commissioning** can take place.

Appendix F – Fire Safety

F1 Sprinkler & fire-suppression systems

F1.1 Design and installation

All **sprinkler and fire-suppression system design and installation** must be approved by the University's **insurance provider**, **Fire Officer** and **Safety Office**, and must comply fully with their requirements.

For server rooms, inert gas systems are preferred to wet systems.

F1.2 Access for maintenance and plant room design

Sprinkler plant room access must comply fully with the guidance on mechanical plant rooms set out in Appendix G of this document, and with the requirements of the University's insurance provider.

In addition to the requirements of the University's insurance provider, the following must also be provided in all sprinkler plant rooms:

- **Plant room schematic** & **valve chart**
- **Building block plan**, with coverage zones identified
- **Storage tank data plate**
- **Leak detection** alarmed to a zone on the main fire alarm panel
- **Floor gully**, where the sprinkler plant room is at ground floor level or above.
- **Sump pit** and **duty/stand-by lift pumps**, where the sprinkler plant room is belowground.

F1.3 Server room fire-suppression systems

Additionally to the above and the insurance provider's requirements, the following must also be provided to server rooms with inert gas suppression systems:

- **Open protocol alarm panel** linked to main fire-alarm panel, with **hold-off for room evacuation**.
- **Room discharge pressure relief duct**, routed via an external louvre.
- **Key-activated purge extract fan**, discharging via an external louvre.

The **pressure relief duct** must be **separate from the purge extract fan ductwork**.

F1.4 Fume cupboard fire-suppression systems

Fume cupboards **must be fitted with Firetrace or similar suppression systems wherever their use could produce a fire risk**, either within the enclosed cabinet or within the associated ductwork.

Installations must comply with the current University Safety Office *Policy Statement S7/01* on fume cupboards.

Upon the discharge of the fire trace system, the fire alarm interface link to the fume cupboard must activate the main building fire alarm. Any fault output (eg low-pressure gas alarm) from the fire trace system must alert a fault, but not set off any fire alarm.

F1.5 Dry risers

Where dry risers are required as part of a building's fire strategy, their design and installation must be dictated by the University's insurance provider and by the Fire Officer within the University Safety Office, complying fully with their requirements.

F1.6 Fire hose reels

Where legacy **hose reel systems** are installed in existing buildings, the **Fire Officer** must be consulted to determine if they must be **removed**. Where the Fire Officer directs that a legacy hose reel systems must be removed, the redundant water dead legs must be **removed back to the live pipework**. The redundant tee connection on the live pipework must be removed and replaced with a through joint.

Any **historic dead legs** or **redundant hose water systems** encountered within the demised space of a project must also be **removed.**

F1.7 Smoke dampers and smoke extract systems

Duct-mounted smoke dampers must be wired back to a **central smoke damper control panel**. This panel must be **open protocol** and interfaced with the main fire alarm panel.

The smoke damper control panel must **indicate the open/closed status and any fault status** of each individual smoke damper.

The operational philosophy of mechanical smoke extract systems and automatic roof smoke vents must be **discussed and agreed with the University's Fire Officer**.

F.2 Fire alarm systems

F2.1 Fire alarm design, specification and installation criteria

Designs for all fire alarm and detection systems in University buildings must be submitted to the **University Fire Officer within the Safety Office**, and to the **University Fire Engineer within Estates Services**, for approval at the design stage of the project.

F2.2 Meeting relevant standards

Fire alarm systems must be designed, installed, tested and commissioned to all requirements detailed in the latest edition of *BS 5839 -1* and *BS 7671*. Any departure from the requirements of these standards must be authorised in writing by the Fire Officer or Fire Engineer. This philosophy document is not intended to supersede or redefine the BS requirements. It details University-specific requirements that must be complied with alongside those of *BS 5839*.

F2.3 Organisation accreditations

The **fire alarm must be designed, installed and commissioned by a *LPS 1014-* or BAFE-accredited company**. If the initial designer is not *LPS 1014-* or BAFE-accredited, they must specify that the appointed *LPS 1014-* or BAFE-accredited specialist will adopt design responsibility.

The designer must also specify that on completion and certification of the design, install and commissioning/handover modules, an *LPS1014* or BAFE certification of compliance will be issued.

F2.4 System categories (*BS 5839*)

Fire alarm systems must be designed as follows:

- **Buildings with sleeping risk** (L1 as defined in *BS 5839-1*): In addition to the fire alarm provision identified above, all sensors in sleeping accommodation buildings must be multi-sensors and include visual loop-powered beacons.
- **Buildings with no sleeping risk** (L2 as defined in *BS 5839-1*): This category gives the coverage necessary to enable all occupants, other than possibly those in the room of origin, to escape safely. L2 specifies that fire detection must be provided for all escape routes, rooms exiting onto escape routes and specified areas of increased fire hazard/risk.

The University defines these areas of increased fire risk as:

- Laser laboratories
- Laboratories using highly flammable gases or naked flames
- Highly flammable store rooms
- Rooms containing radiation hazards
- Rooms containing photocopiers
- Workshops with cutting, grinding or hot works
- Kitchens
- Plant and boiler rooms
- Lift motor rooms
- Server rooms
- Any other room containing high levels of flammable material storage or potential ignition sources. (These are defined as ignition sources that are not controlled by regulations with prescribed testing and maintenance regimes, such as fixed wiring.)

F2.5 Mandatory system specification

All systems must be:

- **Analogue addressable**
- **Open protocol**. Use of proprietary closed protocols will never be accepted.

The panel must include:

- A **latching security key switch**
- Sufficient **emergency refuge buttons and LEDs**

System specifications:

Component	Manufacturer	Model	Notes
Fire panel	Advanced	MxPro 5	Must have a BEMS card fitted so Smartwatch can be integrated.
Wireless fire panel	Advanced	MxPro 5	Must have a BEMS card fitted so Smartwatch can be integrated.

Linear heat cable	Cables Britain	Listec	Must be monitored for fire and fault, including power supply.
Air sampling	Xtralis	VESDA	Must be monitored for fire and fault, including power supply.
Air sampling	Hochiki	FIRElink	Must be monitored for fire and fault, including power supply.
Automatic detection and alarm devices	Hochiki	ESP Protocol	Must be monitored for fire and fault, including power supply.
Wireless automatic detection and alarm devices	EMS	FireCell	Must be monitored for fire and fault, including power supply.
Beam detectors	Xtralis	OCID	Must be monitored for fire and fault, including power supply.
Beam detectors	Hochiki	Fire Beam Xtra	Must be monitored for fire and fault, including power supply.
Deaf pager	Scope	PageTek Pro2	Must trigger with any activation of the building fire alarm.

F2.6 Wireless systems including door holders

Wireless systems must not be proposed for a project unless there is a particular justification for their use. Any wireless installation must be authorised in writing by the Fire Officer and Fire Engineer.

Where the designer has approval to specify a wireless system, a detailed **radio survey** must be carried out, recorded and made available at handover.

Wireless or audibly activated door hold-open devices must not be specified unless the Fire Officer and Fire Engineer have approved their use.

F2.7 Fire panel link to Oxford University Security Services

The fire alarm system must be **connected to the University Security Services control room, relaying fire alarm and fire alarm fault signals for 24/7 monitoring**.

This must be done via a **Smartwatch unit** which is connected to the local Frodo network via a Cat6 cable. For more details about this, consult the Security Services *Crime Prevention Design Guide.*

All systems must incorporate a **'Security Alert' facility**, with a dedicated switch labelled 'Security Alert'.

This switch will **activate all sounders on an intermittent basis**, and will also activate a **separate output to the Security Services control room through the Smartwatch**. The switch must not activate the fire alarm output.

F2.8 Cabling

The specified cabling of the fire alarm system must meet the **enhanced requirements of** ***BS 5839***, providing improved resistance to fire and heat.

Fire alarm cables must also be suitably segregated from other services, and supported to avoid premature collapse, as specified in *BS 5839* and *BS 7671*.

F2.9 Existing systems

Careful consideration must be given to whether a project requires **additions to an existing fire alarm**. Think about areas including the following:

- Is the panel in **good working order** and not at the end of its life? Is it technically capable of the required additions?
- Is there **sufficient capacity on the loop** for the number of additional devices needed?
- Have the **loop and battery calculations** been done to take into account the proposed additions?
- Is the **existing fire alarm cabling** suitably fixed and contained, per *BS 5839*?

The University Fire Engineer must be contacted after the initial survey has been carried out to assess the condition of the existing system using the criteria identified above.

F2.10 Certification & documentation

Documentation and certification must be submitted to the University Fire Officer and Fire Engineer at the stages defined below. All documentation must also be uploaded to Edocuments.

Project stage	Documentation to be submitted	Document format
RIBA Stage 4	Fire alarm and detection system design proposal	PDF or DWG
	Cause and effect matrix document	PDF
Practical Completion	*LPS 1014* or BAFE Design Certification	PDF
	LPS 1014 or BAFE Installation Certification	PDF
	LPS 1014 or BAFE Commissioning / Handover certificate detailing variations	PDF
	LPS 1014 or BAFE Certification of Compliance	PDF
	'As fitted' drawings of the fire alarm loops and network cables, including any joints	PDF or DWG
	Sound pressure (dBA) levels taken from all areas marked on a drawing	PDF or DWG
	Full asset list of fire alarm installation	PDF
	Fire alarm device location plans showing zoning and location of all devices, including loop and address number	PDF or DWG

F2.11 Zone drawings

The zone drawings must include **fire alarm device location plans**, **showing zoning and location** of all devices, including **loop and address number**.

A copy of the zone drawings must also be handed over as part of practical completion so that University records can be updated.

The following information must be displayed adjacent to the fire alarm control panel:

- Location of **incoming power supply isolation switch**
- **Shutdown valves** for incoming **gas mains** & **water supply**
- **Shutdown** for any **flammable laboratory gases**
- **Foam inlets**
- **Dry riser**
- **Emergency refuge** area
- Any **inert gas discharge system**

F2.12 Labelling

Every fire detection and alarm device must be **labelled with its full address**, including panel, loop and address number.

Interfaces must also be clearly labelled by function, eg BEMS shutdown, doors etc.

Every firefighter's switch must be labelled to clearly indicate its precise function, including a plan, section or diagram if this is considered necessary to avoid confusion.

F2.13 Listed building and heritage considerations

Where the fire alarm system design is for a listed building, the designer and project manager must liaise with the **Conservation and Buildings team** within Estates Services, and with the **University Safety Office**, to discuss and agree **planning permission** for the proposed system.

Any deviation from *BS 5839* must be recorded, along with any communications around or justifications for that deviation.

F2.14 Voids and risers identification

Fire alarm detection devices located in areas not readily visible, such as in vertical service risers or above suspended ceilings, must be provided with a **means of identifying their precise location**.

This locator identification must be a **label, disc or remote indicator**, and must show the device address.

F2.15 Lift shafts

Point detection must not be used in lift shafts. **Linear heat cable** must be used as a first option. **Air sampling** must also be considered as an option to cover the lift shaft.

If linear heat cable or air sampling are used, an **accessible test point** must be provided. Test points must never be located in the lift shaft.

F2.16 Emergency refuge and accessible toilets

Disabled refuge alarms must be designed in conjunction with the University Conservation and Buildings team's *Accessibility Design Philosophy Document*

The **emergency refuge alarm panel** must be located next to the building's main fire alarm panel.

Where emergency refuges are required, the system must be **open protocol and comply with** *BS 3839-9*.

The emergency refuge location must be indicated on the control panel, and the relevant emergency refuge must be **marked on the zone drawing**.

Fire detection in any accessible toilet area must include **both visual and audible alarms**. Fully enclosed cubicles must be individually provided with visual devices.

F2.17 Deaf pager system

The deaf pager system requirements must be agreed with the University Conservation and Buildings team's Accessibility team.

If required, fire alarm systems must be fitted with **a radio paging system with monitoring facilities**, complying with *EN 300 220 (Radio)* and *EN 301489 (EMC)*.

Two alpha-numeric vibrating pager units and chargers must be supplied for each system.

F2.18 Fire alarm cause and effect

The designer must specify that the appointed fire alarm specialist will issue a detailed **cause and effect document** to the University Safety Office Fire Officer and University Fire Engineer at RIBA Stage 4.

The cause and effect document must be passed to the fire alarm specialist so it can be implemented and witnessed at handover.

The table below lists **minimum expectations for alarm cause and effect**.

Careful consideration must also be given to other disciplines affected by a fire alarm's operation – for example:

- Door access release
- AOV and window vents
- Dampers
- BEMS

Discipline	Cause	Effect
Fire alarm visual and sounder devices	Activation of any detection device in the building	All sounder and visual devices in the building operate.
Gas Supply	Activation of detection devices in the room where the gas supply enters the building or where gas-burning plant is located.	Gas supply shutdown
Solar PV (i)	Activation of the white call point located next to the fire alarm panel	Solar PV panel shutdown
EV chargers (ii)	Activation of detection in the same zone as the EV charger	EV charger panel shutdown
Door holders	Activation of any detection device in the building	All door holders in the building operate and close.
Lift grounding all	Activation of any detection device except devices on ground floor	Lift will ground to exit floor and doors open. This can be overridden by key switch if lift is an evacuation lift.
Lift grounding ground floor	Activation of detection devices on ground floor	Lift will ground and doors open to dedicated safe area. This can be overridden by key switch if lift is an evacuation lift.
Air handling for fume cupboards, biological labs or other damaging or dangerous areas (iii)	Activation of any detection device in the building	These **must never shut down** under any detection activation.

Fume cupboard suppression system (iv)	Activation of the fume cupboard suppression system via fire alarm input module	All sounder and visual devices in the building operate.
Sprinkler, water mist or gas suppression systems (v)	Building sprinkler, water mist or gas suppression system activation	All sounder and visual devices in the building operate
Internal escape route and final exit electronic locks (vi)	Activation of any detection device in the building	All internal escape route and final exit doors operate to facilitate safe escape.

Notes to the cause and effect table:

(i) Firefighter's switch for photovoltaic systems (PV)
The PV system must be configured with a fireman's switch located adjacent to the building fire alarm panel. On operation of the switch, the AC side of the inverter will be automatically isolated from the building electrical system.

The switch must be in the form of a white break glass unit, mounted next to the main fire alarm panel and wired through the fire alarm system.

Only a manual activation of the break glass must trip the inverter, which must not happen as a result of any aspect of the fire detection system's operation.

The break glass must be clearly marked with PV Isolation on a traffolyte label.

(ii) EV chargers
When the fire alarm that is in the same zone as the EV charger is activated, this must cut the power to the charger, which will then need to be manually reset.

More details about EV chargers can be found in section B13.

(iii) Fume cupboard fire dampers
Fire dampers must not be installed in the extract ductwork of fume cupboards or biological cabinet extract ductwork.

(iv) Fume cupboard gaseous suppression system
Fume cupboards must be fitted with **Firetrace or similar suppression systems**, wherever fume cupboard use could produce a fire risk within the enclosed cabinet or within the associated ductwork.

The suppression system must be linked to the building fire alarm system via an interface.

(v) Sprinklers, water mist and gas suppression systems
Planned gas flooding/oxygen depletion fire suppression systems, together with suppression systems for kitchen ranges and hobs must be approved by the Fire Officer and Fire Engineer. These must be linked to the fire system via an input unit.

Consideration must also be given to how these systems will be monitored for faults if there is not a head end located.

(vi) Internal and final exit electronic locks
Magnetic plate locks are the preferred locking device. All internal escape route and exit doors must unlock when the fire alarm activates (fail safe unlocked). Final exit doors must fail safe locked and be released by way of the normal push button, unless fitted with intruder detection and push bar or pad mechanisms.

Final exit emergency escape doors cannot be manually locked without having an appropriate form of release from the inside.

Plate locks must always be provided with a push switch to release them, together with a green break glass unit, which will completely isolate the the lock in the event of a push switch failure. Electronic keep locks are not acceptable unless a lever handle or knob (to mechanically de-latch the door) is fitted on the escape side of the door.

More information on this can be found in the University's Security Services *Crime Prevention Design Guide*.

F2.19 Firefighter's switch
A **firefighter's switch must be provided in an agreed safe location to permit essential air handling shutdown** at the discretion of building users or the Fire Service. This switch must be independent from the fire alarm system.

A secure **switch to restore extraction only, regardless of fire alarm condition**, must be provided. This must be adjacent to the main fire alarm control panel and will be used for post-fire smoke purging at the Fire Service's discretion.

All **switches must be labelled** to detail their function.

Atriums or void spaces that are provided with openable vents to control building temperature **must also be provided with a fireman's switch** to enable vents to be opened or closed on the instructions of the Fire Service.

F3 Emergency lighting

F3.1 General

The emergency lighting design must be submitted to the University Fire Officer for approval.

The system must be **designed, installed, tested and commissioned to all requirements as detailed in** ***BS 5266*****,** ***BS 7671*****,** ***BS 8519*****,** ***BG 70*** **and** ***Approved Building Regulations***, specifically Part B. As a **minimum** it will require **0.5 lux for open areas**, and **1 lux for defined escape routes, high-risk areas** and **focus points**.

All emergency luminaires must be **LED type and have standby load of no more than 1.5W, connected load of no more than 5W**.

F3.2 System design

Luminaires must be carefully selected for the environment into which they are being installed – for example, they must have a **suitable IP or ATEX rating** if being installed in plant rooms, kitchens, hazardous areas etc. They must conform to **all current EN regulations** and incorporate appropriate **CE marking**.

The University's preference is for **new emergency lighting systems to use Bluetooth for wireless communication** in most cases. Central battery systems may be used in areas with restrictions on access, such as in atriums and lecture theatres.

The design of new emergency lighting systems must incorporate **self-testing ability**, including the facility to set the **automatic testing times** for the system. The designer must liaise with the building user to discuss and establish the appropriate time, taking into consideration operational requirements within the building such as experiments/research, teaching, or animal holding facilities. The self-test system must incorporate **remote monitoring** which connects through the data network and provides a visualisation at the building reception desk or facility office (to be agreed with the occupying department).

Emergency lighting must be provided **internally on all escape routes leading to final exit points** from the building. It must be provided **externally along routes from these final exit points to the muster point**.

Areas that must be provided with emergency lighting include, but are not limited to, the following:

- Plant rooms
- Rooms/areas over $60m^2$
- Escape routes

- Lifts
- Disabled WCs
- Reception areas
- First aid/treatment rooms
- Refuge spaces
- Stairs, and any change in floor level
- External stairs that are designated as a means of escape
- Rooms over 8m^2 without daylight
- Rooms where specific high-risk tasks are carried out
- Outside final exits, leading to fire muster points
- Points of emphasis throughout the building, such as electrical panels, firefighting equipment, first aid points, manual call points, fire alarm control/indication equipment, where safety signage is located, push bars/pads or security devices at exit doors

Consideration of **high-risk areas and focus points** must be integral to the emergency lighting design. These include, but are not limited to, the following:

- Mechanical and electrical plant rooms
- Kitchens, excluding kitchenettes
- First aid rooms
- Treatment rooms
- Refuge areas
- Fire alarm control and indicating equipment
- Reception areas
- Escape door panic bars
- Access control break glasses
- Fire extinguishers
- First aid equipment

In new buildings or when rewiring existing ones, **BS type pictogram symbols, in accordance with *ISO 7010*** must be used throughout the installation for **emergency way-finding signage**. There must be no mixture of signage within an individual building. If this occurs, discuss the issue with the Estates Services Electrical Engineering team to agree a solution.

The emergency lighting system must be designed with **stand-alone, self-contained, individual LED luminaires**. **Batteries must be NiMh**, and must be **replaceable without the use of a special tool**.

Integral/combined type general/emergency luminaires must not be specified unless their use is approved by the Estates Services Engineer.

At the concept design stage, the designer must assess the proposed refurbishment or new build's individual needs for emergency lighting provision. **Self-contained 3-hour standalone, self-test LED emergency lighting** must be specified, unless there are specific needs that cannot be provided by such a system. These exceptional cases include (but are not limited to):

- Where emergency light fittings must be sited in locations that require mobile elevating work platform (MEWP) **access equipment** for access and maintenance, or that impose other restrictions on access.
- For **high hazard areas that require 10% or 100% of general lighting lux levels**, where these outputs cannot be achieved through standalone, self-contained fittings.
- Within **listed buildings where planning permission is a constraint**. The design of systems within conservation areas/buildings must be through liaison with Estates Services Conservation & Buildings team and the Electrical Engineer.

Where projects present special requirements as indicated above, central battery systems may be considered with the agreement of the Estates Services Electrical Engineer.

Mixing of emergency lighting systems must be avoided as far as possible. For example, if a building has a central battery system with slave luminaires, this system must be adapted and extended as necessary, rather than adding a self-contained solution for the extension/refurbished area. Where the existing system is not appropriate for additions and/or alterations due to its age or capacity, a solution must be agreed with the Estates Services Electrical Engineer.

Where the Estates Services Electrical Engineer has agreed the use of a central battery system, the designer must specify a **230V maintained and non–maintained output central battery cubicle** capable of providing for the **connected load of the entire building** (plus an allowance of **25% for future growth**) for **at least three hours**.

The central battery system must use **sealed lead acid low-maintenance cells with a 10-year life**. Facilities must be provided for mains monitoring of designated lighting circuits at each sub main distribution board position, to switch on the emergency lighting circuits where the general lighting circuit has lost output.

The **supply to the central battery system** must be from the building's **main LV Panel**. The system and all its subcomponents must be located in its own **two-hour fire compartment**, separate from all other electrical distribution equipment.

The central battery system must incorporate the functionality of operating under a fire alarm activation. This will be facilitated by connection of an addressable relay (fire alarm interface) to the fire alarm system, which will **switch on the emergency lighting system if the fire alarm activates**.

As with Bluetooth-enabled systems, the central battery system must also have a **self-test facility with remote monitoring**. This must connect through the data network and provide a visualisation at the building reception desk or facility office – the location must be agreed with the occupying department.

Labelling requirements for emergency lighting are detailed in Appendix F – Labelling. The selected system design must be agreed in writing with the Project Manager, Estates Services Electrical Engineer, Safety Office and the building manager or other responsible person within the occupying department.

Appendix G – Maintenance Access & Plant Rooms

G1 General access for maintenance

G1.1 Access & maintenance strategy

The systems must be **designed and installed to provide suitable access for maintenance, repair and replacement of consumable parts**.

The designer must produce an **Access & Maintenance Strategy**, engaging with the Estates Services M&E Project Engineers to agree plant room designs and access routes.

This document must include **access routes** from the plant locations to external drop-off points, **sizes and weights of replacement components** and an **equipment movement plan**, and **plans for plant replacement and maintenance/replacement of key components**.

The designer must ensure that the agreed Access & Maintenance Strategy is carried forward to the contract and developed by the installation contractor.

Where service lifts are part of the plant replacement strategy, they **must be designed as 'goods lifts'** in accordance with Appendix C, and must be capable of fitting and carrying the **largest and heaviest piece of regularly maintained** equipment in the plant room.

G1.2 Equipment in ceiling and roof spaces

Wherever possible, the designer must **avoid positioning equipment, such as fan coil units, which require regular servicing and maintenance, in ceiling voids and roof spaces**. Where this is entirely unavoidable, a **safe, easy means of access** must be provided. This could involve full-sized hinged panels, boarded-out walkways in roof spaces and deep ceiling voids, etc.

Fan-coil units or any other maintainable components installed in deep ceiling voids must be **directly above the ceiling finish** and must be **accessible from below the finished ceiling level**.

Equipment which needs to be serviced or regularly accessed **must not be located above laboratory benches, computer equipment or fixed room furniture** etc. Every effort must be made to locate such equipment away from occupied areas.

Where equipment is installed before internal walls are completed, ensure that these walls will not impair its serviceability once they are built.

Where ceiling schemes incorporate plasterboard margins, **no maintainable equipment may be installed above this margin**.

G1.3 Confined spaces

Do not install maintainable components in areas that could become confined spaces.

G1.4 Riser cupboards

Risers must be **accessible from corridor or circulation areas** and must not be located in areas with restricted access, such as laboratories or private offices. Mechanical and electrical risers must be separate from each other.

Riser cupboards must provide for a **minimum clear working area of 750mm x 750mm** for each item of equipment that requires access for operation and maintenance. All riser cupboards must have **solid floors**, a **level threshold** and **doors secured with the University's suited Yale cylinder type 88 night latch barrel locks.**

Where branch valves are located in a mechanical riser, or in the ceiling next to it, a **valve chart** must be fixed in the riser with numbers corresponding to tags on the valves, identifying the sub-systems or areas of the building served.

Electrical riser must be **located in circulation areas** and connected to **'riser' distribution boards** located on each floor adjacent to the risers.

The **layout of the equipment in all riser cupboards is the responsibility of the designer** and must not be left to the installation contractor to coordinate on site. The designer must produce detailed drawings which show the precise layout of all equipment within the riser cupboard, including the position of all busbar joints and tap-off units, valve locations and maintenance access arrangements.

G1.5 Hazardous areas

All plant and equipment serving hazardous and restricted access areas (such as limited-access research/process rooms, containment rooms, CL2 & CL3 laboratories etc) must be designed and installed so that they can be **fully maintained and isolated from outside the hazardous or restricted area**.

All isolation branch valves and ductwork flow controllers must be accessible from adjacent corridors.

G1.6 Roof access

Where equipment that will need to be maintained and eventually removed is sited on a building's roof, it is particularly important that all parts of the roof are safely accessible.

Ladders are not acceptable as a means of gaining access to any rooftop area with maintainable equipment. Access must be by a **staircase with a clear width of at least 800mm**.

A **level non-slip pathway** must be provided, wide enough to afford removal and replacement of equipment as dictated in the Access & Maintenance Strategy. **Lighting and emergency lighting** must be provided along the full length of all such access pathways.

Edge protection or parapets must also be provided for all access routes and areas of the roof where plant is located. Mansafe latchways and fall arrest systems are not permitted as a means of providing safe access for maintenance.

Where pipework, ductwork or electrical trays run across designated walkways, **proprietary purpose-built step-overs** must be provided.

G2 Plant room design

G2.1 Plant room locations

Main plant rooms must be at **ground level** if possible and must be separate from any utilities intake room.

If a ground floor location is not possible, a **lower ground floor or basement** location may be considered. In this case, access must be via double doors from an adequately sited well, with ramped access if possible.

Substation layout design must be approved by the Estates Services Head of Electrical Engineering Services.

G2.2 Access to plant rooms

All plant rooms must have safe, easy, secure access. Where there are floor-level changes at plant-room entrances, ramps must be provided.

All plant rooms must be of adequate size and height, as defined in the Access and Maintenance Strategy. Entering them must be as easy and safe as entering any other room in the building.

Ladders are not acceptable as a means of gaining access to any plant room or rooftop plant area. Access to roof plant areas must be by a **staircase with a clear width of at least 800mm**.

Where **mezzanine floors** are installed in plant rooms, they must be fully accessible both above and below, and must not create confined spaces or restrict access.

G2.3 Plant room doors & access control

Doors must double and at least **wide enough to allow removal of the largest replaceable components**, as defined in the Access & Maintenance Strategy.

Doors leading into Estates Services mechanical plant rooms and roof plant areas must be fitted with the Estates Services **SALTO access system** and programmed to be restricted **to Estates maintenance staff only**.

Doors leading into Estates Services electrical switch-rooms and sub-stations must be fitted with the **University's suited Yale cylinder type 88 night latch barrel locks.**

Doors leading into Estates Services lift motor rooms must be fitted with the **University's suited Yale cylinder type 88 night latch barrel locks.**

G2.4 Plant room maintenance access

Adequate space must be provided around all plant for safe maintenance, inspection and replacement. Along access routes, there must be at least **2000mm of headroom** under plant, pipes, conduit, trays, ducting etc.

Access space around plant must be at least **900mm**, or more if recommended by the equipment manufacturer.

All plant must be installed so that **vibration and noise** are not transmitted to occupied areas.

Appropriately positioned **lifting beams** must be provided to enable large items of plant such as pump motors to be safely replaced.

Any plant located on a roof must be provided with adequate lighting and a non-slip walkway with guard rails to permit safe access.

Tripping hazards must be avoided – particularly low-level pipework discharging over floor drains located on access routes.

The **layout of the equipment in all plantrooms is the responsibility of the designer** and must not be left to the installation contractor to coordinate on site. The designer must produce detailed plans and elevations which show the precise layout of all equipment within the plant room, fully co-ordinated with all maintenance and access arrangements.

Access to departmental plant areas and server rooms must not be via an Estates Services controlled plant room. **Plant rooms containing departmental equipment must be separate from Estates controlled plant rooms.**

G2.5 Bunding, flood & floor protection

All plant rooms that are located above occupied areas that contain 'wet' services must be fully **tanked and bunded**, with sufficient **drainage points**, to prevent the possibility of water damage to the areas below.

Floors must be laid to fall towards drains. All penetrations through the tanked floor must have a minimum of 100mm upstands all around the openings.

The contractor must **flood-test** all bunded plant rooms before handover, to prove that the floors fall to drain without puddling.

Where there is significant risk of damage from leakage – for example in plant rooms above laboratories – a **leak-detection system** must be installed and wired back to a locally monitored area. This must not be connected to the BEMS and is not a substitute for bunding the plant room. To reduce the risk of false alarms, leak detection cables must be run on wire baskets that are very slightly raised above the floor. Alternatively 'prong type' detectors may be used if appropriate.

All **discharges to plant room drains**, such as those from condense or blowdown, must be adequately designed and installed to prevent water leaking onto the plant room floor. If there is a need to bund a drain to cope with the flow, then a separate drain must be provided.

All main plant must be raised above the plant room floor on a **concrete plinth**.

G2.6 Services

All plant rooms must have adequate **ventilation**, floor **drainage**, good uniform **lighting**, **emergency lighting**, an adequate number of **power sockets**, a **WiFi access point**, a **fire alarm** sounder and appropriate **fire detection**, and some form of **frost-protection heating**.

G2.7 Plant room information & labelling

All plant, equipment and controllers must be **clearly labelled** to identify their function and which area of the building they serve.

Labels must be made of white traffolyte with black lettering, securely fixed to each item of equipment.

Mechanical plant room must be provided with a **valve chart and associated schematic drawing**. Each valve in the room (including control valves, strainers, regulating valves and safety valves) must have a number tag corresponding to the schematic and information chart.

The schematic and valve chart must be fully laminated and fixed to the plant room wall with plugs and screws. The valve chart must identify each valve's size, location and system, circuit and area of the building served as appropriate.

A separate legend must identify the **emergency isolation points** for main services or areas of the building.

Appendix H – Guidance Notes

The following documents provide additional information and general guidance on how contractors and designers can comply with this *Design Guide*, examples of 'what good looks like' and some of the University's wider policies.

H1 University Philosophy Documents & Design Guides

The University provides a suite of design guides and philosophy documents covering a wide range of subjects. They can be downloaded from https://estates.admin.ox.ac.uk/contractor.

H2 Electrical Services documents

The University provides a suite of guidance notes and standard drawings to inform contractors and designers on how to comply with this *Building Services Design Guide* and the University Safe Systems of Work, with additional information to assist with handover. These documents are available on request from the Estates Services Electrical Team. They include:

- OUES BS E GN001 Uninterruptable Power supplies / Central Battery system (UPSCB)
- OUES BS E GN002 Visual Electrical inspection of Mechanical plant
- OUES BS E GN003 Electrical Works in Trunking Systems
- OUES BS E GN004 In Service inspection and testing of electrical equipment
- OUES BS E GN005 Electrical Work in cableways
- OUES BS E GN006 Lighting wiring colours
- OUES BS E GN007 Preferred Installation Methods
- OUES BS E GN008 - 18th Edition
- OUES BS E GN009 Blue Book Operation of Protective Devices
- OUES BS E GN010 Non mains voltage wiring
- OUES BS E GN010 Approved Supplier list for non mains voltage cabling
- On site Guide to Installing Fire Stopping
- 40510L - Lift Electrical Installations - General Arrangement Block Electrical Schematic Diagram
- 400005 - Typical Distribution Network to Illustrate Standard Numbering and Labelling System
- E400978 - General Arrangement of Metering/Instrumentation in University Buildings (sheet 1 of 3)
- E400978 - CT General Arrangements (sheet 2 of 3)
- E400978 - CT General Arrangements with Meter/Instrumentation (sheet 3 of 3)
- E400979.1 - Electrical Systems Labelling Principles

- E400987.2 - Typical Building LV Switchboard (2 Incomers)
- E400987.3 - Typical Building LV Switchboard (Single Incomer)
- Electrical Services handover check sheet

H3 Mechanical Services documents

The University provides some advice on its policies for Legionella prevention, and additional information to assist with handover:

- Estates Services *Legionella Design Guide*
- Mechanical Services Asset Register capture spreadsheet.
- Mechanical Services handover check sheet

H4 Accessibility documents

The University's Accessibility Policy sets out its general requirements around access to buildings and providing an inclusive environment for staff, students and visitors. It is available at https://edu.admin.ox.ac.uk/equality-policy.

Detailed guidance can be found in the Accessibility Design Philosophy Document, available at https://estates.admin.ox.ac.uk/contractor.

H5 Environmental Sustainability documents

The University also produces a Sustainability Design Guide, which sets the mandatory sustainability standards with which new buildings and renovation projects must comply – an essential prerequisite for achieving the University's challenging targets of net zero carbon emissions and a net positive impact on biodiversity by 2035. The Sustainability Design Guide is available at https://sustainability.admin.ox.ac.uk/sustainable-buildings.

H6 Data cabling documents

The University's requirements around telecommunications cabling infrastructure are set out in the IT Cabling Standards Philosophy Documents, which are available on the Estates Services website at https://estates.admin.ox.ac.uk/contractor. If more detailed guidance on the subject is needed, contact IT Services – see https://www.it.ox.ac.uk/contact-us.

Appendix I – Checklist for Designers

All designers of building systems must fill in the relevant sections of the following table, noting any **failures to comply** with the instructions in the corresponding section of this document, clearly describing the **nature of the non-compliance**, and stating **why this is necessary** in the circumstances. The completed checklist must be returned to the Project Manager.

At each project Gateway Review and each Stage Review, the designers must re-submit the checklist and obtain approval from the Building Services team within Estates Services. The team will assess all areas of non-compliance and determine whether they are acceptable or whether remedial action must be taken. This check-list must be included in the M&E section of each Stage report.

Where designers are working on a capital project, non-compliances must also be replicated on the standard Concerto 'Derogations List' form.

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
Appendix A – Mechanical Systems			
A1 Piped services			
A1.1 Horizontal distribution			
A1.2 Vertical distribution			
A1.3 Pipework supports			
A1.4 Isolation valves			
A1.5 Thermal insulation			
A1.6 Flexible connections, expansion bellows and inertia bases			
A1.7 Protection from frost and freezing			
A2 Low-pressure hot water, steam, condenser water and chilled water systems			
A2.1 Heating systems			
A2.2 Chilled water systems			
A2.3 Pipework			
A2.4 Redundant systems			

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
A2.5 Pipework testing			
A2.6 Radiators & heat emitters			
A2.7 Fan-coil units			
A2.8 Heating & cooling coils			
A2.9 Plate heat-exchangers			
A2.10 Steam systems			
A2.11 Circulation pumps			
A2.12 Pressurisation units			
A2.13 Boiler installations			
A2.14 Water treatment			
A3 Potable & non-potable water systems			
A3.1 General			
A3.2 Water system types			
A3.3 Pipework installations			
A3.4 Redundant systems			
A3.5 Water metering			
A3.6 Water storage tanks			
A3.7 Cold water booster pumps			
A3.8 Hot water systems			
A3.9 Reverse osmosis systems			
A3.10 Work on hot and cold water systems during a project			
A2.11 Handover of water systems partway through a contract			
A3.12 Handover of water systems at contract completion			
A4 Fuel & laboratory gas services			
A4.1 Natural gas services			

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
A4.2 Redundant systems			
A4.3 Pipework			
A4.4 Pipework testing			
A4.5 Shut-off systems			
A4.6 Metering			
A4.7 Gas boosters			
A4.8 Laboratory gas services			
A5 Ventilation & air conditioning			
A5.1 General design considerations			
A5.2 Laboratory design considerations			
A5.3 Cooling installations			
A5.4 VRF & DX installations			
A5.5 Refrigerant pipework			
A5.6 Air-handling plant & components			
A5.7 General ductwork systems			
A5.8 Fume extraction			
A5.9 Fume extraction fans			
A5.10 Fume cupboards			
A5.11 Fire & smoke dampers			
A5.12 Ductwork cleaning			
A6 Above-ground drainage			
A6.1 General design considerations			
A6.2 Laboratory drainage			
A6.3 Redundant systems			
A6.4 Condensate drainage and safety discharges			
A6.5 Sump, storm water and sewage pumps			

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
A7 Rainwater harvesting systems			
A7.1 Design			
A7.2 Rainwater collection			
A7.3 Filtration and treatment			
A7.4 Rainwater storage			
A7.5 Backup water supply			
A7.6 System arrangement and distribution			
A7.7 Controls and metering			
A7.8 Testing			
A7.9 Access for maintenance			
A9 Ground & air source heat pumps and LZC technologies			
A8.1 Overview concepts			
A8.2 Design			
A8.3 Domestic hot water			
A8.4 Controls & metering			
A8.5 Installation			
A8.6 Commissioning			
A8.7 Operation			
A8.8 Solar Hot Water			
A8.9 Other LZC technologies			
Appendix B – Electrical Systems			
B1 General			
B1.1 External networks			
B2 HV and LV cable networks			
2.1 HV cable networks			
2.3 LV cable networks			
2.4 Building supply cables			
2.5 Life safety system cabling			
B3 Substations			
B4 High-voltage switchgear and transformers			
B4.1 Transformers			

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
B4.2 Trip batteries			
B5 Earthing			
B5.1 Earthing in general			
B5.2 Earthing – special requirements			
B5.3 Generator earthing			
B6 Low-voltage switchboards			
B6.1 Definitions			
B6.2 Switchboard construction			
B6.2.1 Busbars			
B6.2.2 Switching devices			
B6.2.3 Metering and instrumentation			
B6.2.4 Labelling			
B6.3 Substation LV switchboards			
B6.3.1 General			
B6.3.2 Busbars			
B6.3.3 Switching devices			
B6.3.4 Metering and instrumentation			
B6.3.5 Arc flash			
B6.3.6 Neutral/earth requirements			
B6.4 Building LV switchboards			
B6.4.1 General			
B6.4.2 Busbars			
B6.4.3 Switching devices			
B6.4.4 Metering and instrumentation			
B6.4.4 Arc flash			

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
B6.4.5 Neutral/earth requirements			
B6.5 Final distribution panel boards			
B6.5.2 Busbars			
B6.5.3 Switching devices			
B6.5.4 Metering and instrumentation			
B7 Building distribution systems			
B7.1 Vertical distribution			
B7.2 Horizontal sub-distribution			
B7. 3 Distribution board			
B7.4 Final circuit wiring`			
B7.5 RCD protection			
B7.6 Multi-floor services			
B7.7 Supplies to lift installations			
B7.8 Electrical supplies to mechanical services equipment			
B.7.9 External supplies			
B8 Lighting			
B8.1 General requirements			
B8.2 Control system			
B8.3 Design criteria			
B8.4 Luminaire selection			
B8.5 Historic buildings			
B9 Generators			
B9.1 General requirements			
B9.2 Panel construction			
B9.3 Switching devices			
B9.4 Labelling			

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
B9.5 Metering type			
B9.6 Change-over panel			
B9.7 Synchronisation			
B9.8 Control principles			
B9.9 Testing facilities			
B9.10 Restoration			
B9.11 Drawings			
B9.12 Fuel			
B9.12.1 Capacity			
B9.12.2 Fuel level			
B9.12.3 Bunding			
B9.13 Generator set			
B9.13.1 PRP (Prime Power Rating)			
B9.13.2 Alternator			
B9.13.3 Alarm and status signals			
B9.13.4 Alternator circuit breaker			
B9.13.5 Control philosophy			
B9.13.6 Routine testing			
B9.13.7 Lightning protection			
B9.13.8 Earthing			
B9.13.9 Base frame			
B9.14 Maintenance contract			
B10 Lightning Protection			
B10.1 Risk analysis			
B10.2 Earth termination network			
B10.3 Down conductors			
B10.3.1 Earth conductors to columns			

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
B10.3.2 Steel columns and supports			
B10.3.3 Air termination network			
B10.3.4 Lightning electromagnetic pulse protection system			
B11 Electromagnetic fields			
B12 Power quality			
B12.1 General			
B12.2 Power factor correction			
B12.3 Active harmonic filtering			
B13 Electric vehicle chargers			
B13.1 Installation			
B13.1.1 Dedicated distribution boards for EVCs			
B13.1.2 Earthing			
B13.1.3 Fire alarm integration			
B13.1.4 Insurance requirements			
B13.2 Metering and communication			
B13.3 EV Charging bay design and cable routes			
B14 Labelling			
B14.1 Substations			
B14.1.1 Compounds and buildings			
B14.1.3 HV switchgear			
B14.1.3 Transformers			
B14.1.4 Substation LV switchgear			

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
B14.2 Buildings			
B14.2.1 Building LV switchboards			
B14.2.2 Distribution boards			
B14.2.3 Final circuits			
B14.2.4 Cable core marking			
B14.2.5 Submain cables			
B14.2.6 Emergency lighting identification			
B14.2.7 Distribution board chart			
B15 Asset information			
B15.1 Asset register			
B15.2 Drawings			
B16 Photovoltaic installations			
B16.1 System requirements			
B16.2 PV modules/arrays			
B16.3 Inverters			
B16.4 Remote energy management			
B16.5 Metering			
B16.6 Fire protection			
B16.7 Battery storage			
B16.8 G99			
Appendix C – Lifts			
C1 Appointment of lift consultant			
C2 Requirements for lift installations			
C2.1 Standards			
C2.2 Design considerations			
C2.3 Usage type			
C2.4 Life cycles			

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
C2.5 Provision for attending engineers			
C2.6 Accessibility			
C2.7 Firefighting & evacuation lifts			
C2.8 Lift installation			
C2.9 Call allocation system			
C2.10 Goods lifts			
C2.11 Car speeds			
C2.12 Lift finishes			
C2.13 Emergency communication systems			
C2.14 Floor numbering			
C2.15 Electrical installations			
C2.16 Lift rooms and shafts			
C2.17 Fire detectors			
C2.18 Warranty & maintenance service contract			
C3 Lift handover procedures			
C3.1 Testing, witness testing and handover			
C3.2 Operating and Maintenance Manual			
C3.3 Lift acceptance			
C3.4 12-month defects liability and maintenance period			
Appendix D – Building Energy Management Systems			
D1 General requirements			
D2 BEMS control panels			
D2.1 Control panel forms			
D2.2 Form 2 type 2 panels			
D2.2.1 Power sections			

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
D2.2.2 Control sections			
D2.3 Form 4 type 6 panels			
D2.4 Control panels – general			
D3 BEMS networking and system engineering			
D3.1 Networking – general			
D3.2 Sensors			
D4 BEMS head-end supervisory systems			
D5 BEMS engineering			
D5.1 General			
D5.2 BEMS alarm strategies (energy)			
D5.3 BEMS alarms - general			
D5.4 BEMS testing and commissioning			
D5.5 BEMS documentation			
Appendix E – Metering			
E1 Introduction			
E2 Electricity meters and instrumentation systems			
E2.1 General requirements			
E2.2 Current transformer general arrangements			
E2.3 Voltmeter monitoring – general arrangements			
E2.4 Meter and sub-meter types			
E2.5 Meter networks			
E2.6 Substations – HV metering			
E2.7 Substations – LV metering			

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
E2.8 Substation LV switchboard – outgoing circuits			
E2.9 Building metering – incoming circuits			
E2.10 Building metering – outgoing circuits			
E2.11 Building metering – riser/tap offs			
E2.12 Building metering – sub-distribution boards			
E2.13 Building main metering			
E3 Energy generation systems			
E3.1 Standby generators			
E3.2 Photovoltaic panel systems			
E3.3 Combined Heat & Power (CHP) plants			
E4 Gas and water meters			
E4.1 Natural gas service			
E4.2 Water			
E5 Heat energy metering			
E5.1 General			
E5.2 Data transmission			
Appendix F – Fire Safety			
F1 Sprinkler & fire-suppression systems			
F1.1 Design and installation			
F1.2 Access for maintenance and plant room design			
F1.3 Server room fire-suppression systems			
F1.4 Fume cupboard fire-suppression systems			

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
F1.5 Dry risers			
F1.6 Fire hose reels			
F1.7 Smoke dampers and smoke extract systems			
F.2 Fire alarm systems			
F2.1 Fire alarm design, specification and installation criteria			
F2.2 Meeting relevant standards			
F2.3 Organisation accreditations			
F2.4 System categories (*BS 5839*)			
F2.5 Mandatory system specification			
F2.6 Wireless systems including door holders			
F2.7 Fire panel link to Oxford University Security Services			
F2.8 Cabling			
F2.9 Existing systems			
F2.10 Certification & documentation			
F2.11 Zone drawings			
F2.12 Labelling			
F2.13 Listed building and heritage considerations			
F2.14 Voids and risers identification			
F2.15 Lift shafts			
F2.16 Emergency refuge and accessible toilets			

Section	Fully compliant? (Y/N)	Specific details of non-compliance (if applicable), with clear explanation of why compliance is not possible	Non-compliance approved by Estates Services? (Y/N)
F2.17 Deaf pager system			
F2.18 Fire alarm cause and effect			
F2.19 Firefighter's switch			
F3 Emergency lighting			
F3.1 General			
F3.2 System design			
Appendix G – Access for Maintenance			
G1 General access for maintenance			
G1.1 Access & maintenance strategy			
G1.2 Equipment in ceiling and roof spaces			
G1.3 Confined spaces			
G1.4 Riser cupboards			
G1.5 Hazardous areas			
G1.6 Roof access			
G2 Plant Room design			
G2.1 Plant room locations			
G2.2 Access to plant rooms			
G2.3 Plant room doors and access control			
G2.4 Plant room maintenance access			
G2.5 Bunding, flood & floor protection			
G2.6 Services			
G2.7 Plant room information & labelling			

`

ESTATES SERVICES

T: 01865 278750
E: estatesbuilding.services@admin.ox.ac.uk
https://estates.admin.ox.ac.uk

UNIVERSITY OF OXFORD