ESTATES SERVICES

MECHANICAL AND ELECTRICAL DESIGN PHILOSOPHY 9

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INTRODUCTION

The purpose of this document is to provide general guidance to Consulting Engineers and Contractors on the design requirements of electrical and mechanical installations within buildings which will be operated and maintained by Estates Services. At its highest level this document is intended to set out requirements that minimise the total life cost of building services i.e. the total life cost of purchase, operation, maintenance and replacement costs.

The principles referred to in this document have been influenced by maintenance, operational and environmental sustainability requirements, and also by the need to standardise the mechanical and electrical services throughout the University's 650,000 m^2 of building stock.

To accommodate the ever increasing demand for continuity of services it is essential that systems are designed so that they can be repaired, maintained, inspected and extended with minimal disruption to the building user.

New systems should be as simple as possible and there **must be adequate, safe and easy access provided to all parts of the installations.**

Designers should note that all routine maintenance work is only carried out during normal working hours. Systems should be designed such that they can be maintained by a single person if possible. Designers must be aware of who is responsible for the various services so that separate plant rooms can be provided where necessary for Estates Services and departmental plant.

It is essential that the proposed building services for all projects are discussed with the University Head of Building Services as soon as possible after the appointment of the Building Services Consultant or Contractor to ensure that there are no misunderstandings over the contents of this document or the reasons for a particular requirement. All work within listed and historic buildings requires careful consideration and all proposals **must** be agreed with the Head of Building and Conservation before any work is carried out.

Where the project involves working on or extending existing building services, no work may be carried out on the existing systems without the prior knowledge and approval of the University Head of Building Services. This is particularly important in the case of existing electrical systems where all work must be carried out in accordance with Estates Services Code of Practice 'Electrical Safety on Low Voltage Systems'. Please note that only the University Electrical Engineers can authorise work to be carried out on the University's existing fixed electrical installations.

The Estates Services Direct Labour Organisation (DLO) Manager must also be consulted before any work is carried out on any mechanical services installations within existing buildings. They will assist in the location of isolation valves, provide advice on the draining down/refilling of wet systems, etc. The DLO is responsible for the operation of the majority of the University's mechanical services and it is essential that they are told of any impending work on

installations under their control. No contractor is allowed to isolate existing mechanical services without consultation with the DLO. Contractors must obtain a 'transfer of control' permit from the DLO before commencing work on any system.

Only contractors who are on the Estates Services Approved Contractor's List will be allowed to carry out work on the University's existing mechanical, electrical and controls installations unless otherwise approved by the Head of Building Services

A site visit can be arranged if required to inspect a typical existing installation in order to see at first hand the principles outlined in this document.

The University Head of Building Services must be consulted before any changes are made to an agreed building services design because of a need to reduce project costs. Value engineering should be carried out as part of the project design process and not after tenders have been received.

The designer should always select and specify the most energy efficient plant and equipment wherever possible. Any alternative equipment manufacturer proposed by the contractor may only be used if it is equally as energy efficient as the originally specified item and is also approved by the Head of Building Services.

To assist Estate Services in assessing whether or not the Project mechanical and electrical design complies with this Philosophy Document, the check list on pages 4 to 8 must be completed by the Designer and given to Estates Services Project Manager before the design can be signed off at stage D. An explanation must be provided for all items where non-compliance is indicated and agreed by the Head of Building Services.

REASONS FOR REVISION

Sections generally revised with minor comments

Design Philosophy checklist updated and completion at stage D added.

Introduction

Reference to transfer of control document added.

Section 1.2 updated regarding maintenance reviews.

Section 1.4 updated regarding metering and BMS logging and includes guidance on seasonal commissioning.

Section 1.5 clarified

Section 2.0. 'Accessible' clarified

Section 2.1 Plant room bunding and leak detection amended
Section 2.5 Trench heating prohibited

Section 2.9 night time purge requirement added. Air conditioning form cross referenced.

Section 2.11 Electrical requirements added. Approved lift contractor to be used.

Section 2.12 BMS section deleted

Section 2.14 Fused spur requirement for trace heating.

Section 2.27 Ground source Energy Systems section added (previously issued as an appendix to M&E 8).

Section 3 updated:
Section 3.11.8 maximum size of plug and socket arrangement reduced.
Section 3.12 Section updated, with inclusion of external lighting.
Section 3.13 Fire Alarm Section added.
Section 3.14 Update to emergency lighting requirements.
Section 3.16.7 Change in control philosophy for generator systems.
Section 3.21 metering deleted and information added to section 6 and updated.
Section 3.26 Photo voltaic section added.

Section 4 On-line Building Information (Operation and Maintenance manual) updated with Edocuments information and moved to a separate document.

Section 5 BMS section added (was a subsection of Mechanical).

Section 6 Metering Strategy added.

The following checklist must be completed and agreed at stage D of the design.

Design Philosophy Checklist

Project:

Consultant:

Signature: **Dated:**

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Appendix C: CAD Layer Details	Now Section 8	

SECTION 1 – STANDARDS AND RESPONSIBILITIES

1.0 Standards

All plant, equipment and systems shall be designed and installed in accordance with the appropriate British Standard or European equivalent, Codes of Practice, relevant Statutory Instruments and Regulations, Building Regulations, University Environmental Sustainability Policy, Estates Services Policy & Procedures document 'The Control of Legionella Bacteria in Water Systems' the Sustainability Building Philosophy and the University Safety Office Policy statements.

The University of Oxford Standing Orders or 'Estates Regulations' (current edition), University Environmental Sustainability Policy, Estates Services Policy & Procedures document 'The Control of Legionella Bacteria in Water Systems' and the University Safety Office Policy Statements are available either on the website or for inspection at Estates Services.

1.1 Responsibility

The following table which is taken from the Estates Regulations (current edition) indicates the division of responsibilities for the operation and maintenance of the listed services. The list is not exhaustive and is intended as a guide only. Designers should check with Estates Services Project Manager or Head of Building Services if in doubt.

Responsibility for Mechanical and Electrical Services	
Estates Services	**Department**
Heating installations	Medical gases
Domestic hot and cold water systems	Demineralised water systems
Natural gas	Water treatment plant serving only departmental equipment
Air conditioning	Process water cooling systems
Ventilation	Warm and cold rooms
Lift installations	Compressed air systems
Steam plant and associated pipework distribution	Steam plant and associated pipework distribution serving **only** department equipment
Fume cupboard extract systems	Fume cupboards
Lightning Protection Installations	Autoclaves, sterilizers and cage washers
Electrical sub-stations and switch rooms	Safety cabinets and associated extract systems
Fixed electrical distribution system including light fittings and associated lighting controls.	Electrical equipment (including UPS) connected to socket outlets and isolators of the fixed electrical installation.
Building management systems	Emergency lighting (guided by the Safety Office responsibility)
External lighting	Fire detection systems (Safety Office responsibility)

Standby generators required by legislation, CHP and ground source heat pumps Sprinklers and misting systems maintenance	Sprinklers and misting systems (weekly testing) Standby generators for departmental requirements only.

Estates Services equipment should be located in dedicated and separate mechanical and electrical plant rooms under the control of Estates Services, with Departmental equipment being located in separate plant rooms which are under the control of the Department. If shared plantrooms are unavoidable then the project manager must consult with both the department and Estates Services jointly.

1.2 Maintenance Philosophy

It is a requirement that all systems should be designed such that they can be repaired, maintained, inspected, extended and removed with the minimum of disruption to the building user. The Consulting Engineer or Contractor must submit a detailed maintenance philosophy to Estates Services, as early as possible in the design of the project, and in all cases before the completion stage E, to demonstrate that the above objectives are being met.

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

The philosophy should detail for example:

(i) The effects on the building user of planned maintenance on the various plant items;
(ii) The effect of periodic test and inspection programmes of the electrical installation;
(iii) The provision of any standby plant;
(iv) The provision of any alternative sources of electrical supply to maintain essential services, etc.
(v) End of life removal

In the event of a cost minimising exercise (value engineering) it is important to ensure that the client representative and PSG are made fully aware of the effects of any changes which will increase disruption or add cost to their activities.

1.3 Deviations from the Philosophy Guidelines

The Consulting Engineer shall provide a written report to the Head of Building Services highlighting where the principles of the Design Philosophy cannot be complied with, together with a justification for the alternative solution proposed. The form on pages 4 to 8 needs to be completed.

1.4 12 Months Defects Period (Soft Landings and Seasonal Commissioning)

The project costs shall include for the mechanical services commissioning contractor (and/or the BMS controls contractor) to visit the new or refurbished building during the 12 months defects period on a quarterly basis in order to carry out adjustments/fine tuning of the mechanical services installations throughout the building. A quarterly review (seasonal commissioning) meeting shall be held with the client representative building manager or other nominated representative, Estates Services mechanical services engineer and the commissioning engineer. Minutes of the meeting shall be recorded.

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

Seasonal commissioning as a minimum should include:

- Confirmation that all meters are reading correctly;
- Comparison of meter data with predicted performance;
- Review of all BMS graphics to confirm that they are reading correctly;
- Review the BMS graphics to confirm they are a reasonable representation of the system schematics;
- Review of set points and dead bands;
- Review of real occupancy hours and level (with the building FM manager)
- Discussion of perceived performance / comfort levels;
- Review sensor and driver plots and compare with actual occupancy;
- Detailed performance review of LZC plant including representatives from the equipment suppliers;
- Detail performance review of weather compensation;
- Detailed performance review night set back;
- Detail performance review of night purging;
- Detailed performance review of heat reclaim devices;
- Review of rain water collection devices.

1.5 12 Months Servicing and Maintenance Agreement

For complex package plant e.g. CHP, GSES, generators, lifts etc. a fully detailed maintenance proposal with a full breakdown of costs shall be provided to Estates Services. **It is essential that the maintenance quotation is obtained prior to ordering the plant**. The maintenance proposal shall cover only those mechanical services which are the responsibility of Estates Services (see clause 1.1) and shall detail all of the plant, equipment and installations to be maintained and shall provide a schedule of work to be carried out. The proposal shall be fully comprehensive and include for all necessary consumables such as filters, drive belts, etc. a 365 day, 24 hour emergency call out cover with a maximum of a four hour response time to deal with breakdowns for five year contracts. The total life cost should be considered **before** purchasing complex plant.

The maintenance quotation should not be binding on the University. An order may be placed by Estates Services Building Services Section directly with the contractor for the maintenance contract after handover.

1.6 Control of Access to Plant Areas

In order for Estates Services to control access to the areas it is responsible for, all lift motor rooms, mechanical services plant rooms, electrical substations, switch rooms and riser cupboards shall have Estates Services suited locks fitted. Lock details shall be as follows: the main suite is electrical, 'P' suite is for mechanical plant and 'L' suite is for lift motor rooms. There is a grand master key which will unlock all three suites and sub-master keys for each individual suite. Door locks shall be as supplied by Yale Security Products Limited, type GMK suite, ref YN8114(Y). The standard locks shall be key operation externally with thumb turn on room side for emergency exit purposes and each lock shall be supplied with three keys.

The use of SALTO Door Access Systems for Plant Rooms is subject to approval by Head of Building Services.

Access into all underground heating ducts is controlled by Estates Services and entry into the ducts can only be allowed after a risk assessment has been carried out, a method statement approved and a permit to work in Estates Services. Underground ducts are treated as confined spaces.

1.7 Utility Supplies

Estates Services Energy Manager is responsible for organising the gas, water and electricity supply contracts for all of the University's functional estate. All new utility supplies or alterations to existing utility supplies **must** be arranged through Estates Services Energy Manager.

1.8 Use of Dynamic Simulation Models for Part L CO2 Calculations

Designers working on all new buildings and extensions to the current Part L Building Regulations must use a dynamic simulation package (approved by the Department for Communities and Local Government [DCLG]) rather than the Simplified Building Energy Model (SBEM) for calculating CO2 emissions. Estates Services reserve the right to allow the use of SBEM for simple buildings and extensions. The Designer must send a copy of the BRUKL (Building Regulations United Kingdom Part L) Output Document 1 Compliance with ADL2 (Approved Document Part L-Conservation of Fuel and Power – Part 2 – New Buildings other than Dwellings) to Estates Services Energy Manager for comment prior to Part L submission. A table of the input variables must also be provided which includes occupancy hours, plant running hours, occupancy density, small power load density (W/m^2), internal design temperature and air change rates.

A copy of the 'Asset Rating' BRUKL Output Document 1 Compliance with ADL2 using actual construction data must be handed to Estates Services Energy Manager before final handover of the building.

The National Calculation Method (NCM) allows calculation by accredited software, dynamic simulation models or SBEM. See www.ncm.bre.co.uk for the latest updates.

1.9 Redundant Installations

It is the policy of Estates Services that where buildings or parts of buildings are being refurbished all redundant equipment, cables, pipework etc shall be removed. It is particularly important that no 'dead legs' are left in the hot and cold water or natural gas services. All redundant pipework must be removed back to the tee position on the remaining live pipework and capped off.

1.10 Draining of Hot and Cold Water Systems with Standing Water During the Project

If during the course of a project, especially refurbishment projects where existing Hot Water or Cold Water systems are not used or underused, wherever possible the system should be drained to manage the Legionella risk.

If there is a need to retain water supplies, for instance to maintain services to toilets or hand-wash facilities or where Asbestos removal requires a water supply then there must be an adequate Risk Assessment and measures should be taken such as regular flushing of the system and as soon as possible the systems drained thereafter.

1.11 Handover of Water Systems

If during the course of a project the responsibility for Hot or Cold Water systems is handed to Estates Services then adequate notice should be given of this intention in order for Estates Services to allow their appointed specialist contractor to have access to complete a full risk assessment in the case of a new building or a re-risk assessment in the case of a refurbishment, to allow for access for the monitoring team to identify assets and complete bar-coding and implement a new control regime. If the building is not due to be fully occupied then Estates Services would instigate additional measures such as flushing until the building is brought into full use.

1.12 Effect of Additional Installations on Existing Services

Consideration should be given during any new project or refurbishment to the surrounding area/s that may be affected by the works. This includes the cleaning of surrounding buildings externally and internally e.g. ductwork and filters that may need more attention due to the works. Also any internal spaces that may need any services modified and/or any effects to the environmental conditions of any spaces that could be compromised because of the works need to be included within the project or refurbishment.

SECTION 2 – MECHANICAL SERVICES INSTALLATIONS

2.0 General

It is an absolute requirement that all systems are designed to be easily and safely accessible and are straightforward to operate, maintain and replace. 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).

All work within listed and 'historic' buildings requires careful consideration and all proposals **must** be agreed with the Head of Building and Conservation during the design process and before any work is carried out. Building and Conservation should also be consulted on works on buildings that are not Listed but are historically significant.

2.1 Plant Rooms including Boiler Rooms

2.1.1 General

All plant rooms must have safe, easy, secure access and, in the case of basement and ground floor rooms, the access must be direct from the outside of the building in which the plant rooms are located. All plant rooms must be of adequate size and height. Access to all plant rooms must be as safe and easy as entering any other room within the building.

The use of vertical ladders will not be accepted as a means of gaining access to any plant room or roof top plant area.

All plant rooms shall have adequate ventilation, floor drainage, good uniform lighting, emergency lighting, a telephone, a data point, rcd protected 13 amp socket(s), a fire alarm sounder and appropriate fire detection. Telephone and data points are in addition to those dedicated for equipment monitoring.

All plant rooms which are located above occupied areas and contain 'wet' services shall be fully tanked and bunded with sufficient drainage points so as to prevent the possibility of water damage to the areas below. Floors should be laid to fall towards drains. All penetrations through the tanked floor shall have a minimum of 100mm upstands all around the openings.

Where there is significant risk of damage from leakage e.g. Plant Room above laboratories, a leak detection system must be installed and wired back to a locally monitored area. It must **not** be connected to the BMS and is not a substitute for bunding the Plant Room. To reduce the risk of false alarms, leak detection cables should be run in appropriate locations on wire baskets such that they a very slightly raised above the floor. Alternative 'prong type' detectors may be used if appropriate.

All discharges to plant room drains e.g. from condense, blowdown shall 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.

Doors into Estates Services plant rooms **must** be fitted with Estates Services suited locks and adequate access **must** be provided for future plant replacement.

Door Locks shall be as supplied by Yale Security Products Limited, type GMK suite, ref no. YN8114(Y), 'P' suite for mechanical plant rooms. The standard lock shall be key operation externally, with thumb turn on room side for emergency exit purposes and each lock shall be supplied with three keys.

Adequate space shall be provided around all plant for safe maintenance, inspection and replacement. Headroom under plant, pipes, ducting, etc., along access routes shall not be less than 2000mm with access space around plant being not less than 900mm or more if recommended by the equipment manufacturer.

All plant shall be installed so as to prevent vibration and noise transmission to occupied areas. Appropriately positioned lifting beams shall be provided to enable the safe replacement of large items of plant such as pump motors.

Any plant located on a roof shall 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 in access routes.

Access to departmental plant areas, server rooms and electrical switch rooms must not be via an Estates Services controlled mechanical services plant room.

Open flue gas and oil fired heating and hot water heaters must always be located in a separate plant room from supply and extract ventilation plant.

2.1.2 Roof Plant Rooms

Access must be by a staircase having a clear width of at least 800mm. Floors shall be tanked and bunded to prevent water damage to floors below and there must be an adequate number of drainage points provided.

2.1.3 Low Level Plant Rooms

Main plant and boiler rooms should be at ground level and **must** be separate from any electrical intake room. If a ground floor location is not possible then consideration may be given to a lower ground floor or basement location, in which case access must be via double doors from an adequately sited well, with ramped access if possible.

2.1.4 Equipment Located in Ceiling and Roof Spaces

The designer shall avoid wherever possible positioning equipment such as fan coil units which require regular servicing and maintenance in ceiling voids and roof spaces. However, where this is absolutely unavoidable, then a safe, easy means of access shall be provided, e.g. full sized hinged panels, boarded out walkways in roof spaces and deep ceiling voids, etc. Any equipment which needs to be serviced must not be located above laboratory benches, computer equipment, fixed room furniture, etc., and every effort shall be made to locate equipment away from occupied areas.

2.2 Hazardous Areas

All plant and equipment serving hazardous and restricted access areas such as animal rooms, containment rooms, etc., shall be designed and installed such that they can be totally maintained from outside of the actual area. The requirements of the University Safety Office briefing document for category 2 and 3 containment areas must be followed. Visual indication (i.e. magnehelic gauges) of differential pressures shall be provided where rooms are required to operate at a greater or lesser pressure than adjacent areas.

2.3 Distribution of Piped Services

2.3.1 Horizontal Distribution

Main horizontal distribution pipework shall be at high level in corridors, in a single depth and preferably not hidden above ceiling tiles. If ceiling tiles are unavoidable then they must be easily removable and replaceable.

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

2.3.2 Vertical Distribution

Main vertical distribution pipework shall rise in a wide shallow duct containing a single depth of pipes with access from full height doors at each floor level. Such vertical ducts shall be complete with solid floors at each level, open mesh type flooring is not acceptable.

2.4 Low Pressure Hot Water Heating Systems

All wet heating systems shall be designed as low pressure hot water systems. Medium and high pressure systems are not acceptable.

Radiators should be used in preference to fan coil units and to natural convectors wherever possible. All mild steel pipework shall be heavyweight mild steel to BS1387 up to 150mm and to BS3600 for larger sizes. Thin walled stainless steel pipework may be used as an alternative if using crimped fittings. Trench heating must not be used.

Pipework up to and including 50mm shall have screwed joints and pipework 65mm and above welded joints. Adequate dismantling points using unions or flanges as appropriate shall be provided to enable appliances to be disconnected and pipework to be repaired.

2.5 Laboratory and Domestic Hot and Cold Water Systems

2.5.1 General

All water systems must be designed to comply with L8: Legionnaires' disease. The control of legionella bacteria in water systems. Approved Code of Practice and HSG274: Legionnaires' disease - Technical Guidance issued by the Health & Safety

Commission and the requirements of the current Estates Services Policy & Procedures document 'The Control of Legionella Bacteria in Water Systems'.

Galvanised mild steel pipework, fittings and calorifiers shall not be installed; only copper, stainless steel or appropriate plastic materials may be used. Flexible connections to terminal fittings are not permitted (as these are a potential site for bacteria growth) final connections must be copper or stainless steel. The only exception will be mixer taps which have integral flexible connection but these should be avoided if possible. Location isolation valves (ballofix type) are to be provided to all water systems

In order to standardise across the University Estate only Yorkshire Fittings Limited Xpress jointing system is approved as an alternative to traditional methods of jointing of copper pipework.

Where buildings or areas are being refurbished all redundant pipework shall be removed back to the tee on the live pipework and the tee removed and a through joint used wherever practicable.

All drinking water outlets must be supplied directly from the mains supply pipe.

Any work on water services must be given prior approval by the Head of Building Services and/or the Mechanical Engineer with adequate information provided on application. A transfer of control must be issued by the DLO.

Suitable pre-treatment water softening plant should be considered particularly for hot water systems.

Spray and aerated taps shall not be used.

2.5.2 Hot Water Systems

Plate heat exchangers or direct gas fired hot water heaters should be used in preference to storage calorifiers.

Hot water with central storage and associated pipework distribution systems shall only be used if it is impractical to use point of use electric hot water heaters. Trace heated hot water flow pipework shall not be used in place of a pumped hot water return.

Mixer taps are preferred to individual hot and cold taps. Thermostatic mixing valves (i.e. TMV2 or TMV3 as appropriate) shall be installed on all baths and wash hand basins in high risk environments such as child care following an assessment of the scalding risk to provide safe hot water temperatures. If TMVs are required they should be incorporated within the terminal fitting and all TMVs must be accessible for routine maintenance and must not be installed in ceiling voids or other difficult to access areas. Local isolation valves (ballofix) must be provided for testing for both hot and cold water feeds.

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

2.5.3 Cold Water Systems

Two cold water storage tanks shall be provided to enable supplies to be maintained whilst one tank is taken out of service for inspection/cleaning. If a dual tank is specified it must be designed so that it can operate for long periods with only one tank in use. The tank should be capable of being cleaned from outside. If this is not possible then suitable provision should be made for confined space entry.

A water meter shall be fitted in the mains cold water supply pipework to all cold water storage tanks and these meters together with the water storage temperature of each tank shall be monitored by the Building Management System. Refer to Section 6 Metering.

The main meter on the incoming cold water supply to the building and any other sub-meters shall be monitored by the ION metering system. (See reference section 4.6 in Project Managers Guidance of Sustainable Building Philosophy document).

2.5.4 Handover of Water Systems

All new and renovated water mains, service pipes and fittings must be disinfected, flushed and sampled before returning to service irrespective of pipe diameter.

Water services must be cleaned and disinfected within 7 days of handover and a representative number of potable water samples, including pseudomonas, must be taken no less than 5 days after disinfection. The water services must be of acceptable water quality and will not be accepted unless all water samples are satisfactory. The contractor will be responsible for flushing of all outlets before acceptance and this should be appropriately recorded.

A Legionella Risk Assessment must be issued before any water system is accepted.

2.6 Natural Gas Service

A gas shut off valve, operated by a heat detector(s) and/or emergency push button shall be incorporated in the boiler supply pipe. This valve must not be connected to any building fire detection system other than that located within the boiler room. Gas pipework shall be heavyweight mild steel to BS 1387(EN 10255).

Basement and semi-basement boiler rooms shall have a gas detection system installed.

The gas supply to other areas such as kitchens and laboratories shall be separately metered from the heating boilers and hot water heaters.

All gas meters must be monitored by the ION metering system. See Section 6.

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

For a gas supply that normally is metered at greater than 21 mbar, the pressure drop in the pipework, at maximum flow, shall not exceed 10% of the design pressure.

Gas boosters should be avoided if at all possible.

All installations must comply with current IGEM and other relevant regulations for industrial and commercial establishments (unless agreed otherwise for genuine domestic installations). Designer and installers should particularly note the earthing requirements of gas pipework.

2.7 Steam Systems

Steam shall not be used as a primary or secondary form of heating or for humidification. It is the policy that where steam is necessary, it should be generated adjacent to the point of use. Steam plant which serves only departmental equipment, e.g. cage washers, autoclaves, etc., will be maintained by department personnel and the design proposals should be discussed with both Estates Services and the building user.

2.8 Isolation Valves

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

All items of plant shall be fitted with isolation valves. Commissioning valves and other throttling valves must not be used for isolation there must be dedicated isolation valve.

2.9 Air Conditioning and Ventilation

The use of air conditioning systems shall be avoided wherever possible except where close control of the environment is necessary. Natural ventilation should always be used in preference to mechanical ventilation. Designs should incorporate free cooling and/or night time purge cooling wherever possible. Not only are these requirements of the Carbon Management Strategy, they also reduces the total life cost of the building.

When existing A/C units are being replaced or a department wishes to install cooling to discrete areas within a building, the Mechanical section 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.

All air handling plant shall be located within plant rooms and the use of weatherproof outdoor air handling units should be avoided.

Evaporative type cooling towers must not be used under any circumstances. Evaporative cooling systems e.g. adiabatic should be avoided to reduce maintenance costs and water hygiene risks.

Ventilation ducting shall be provided with an adequate number of suitably sized access points to enable the ducting to be thoroughly cleaned. Adequately sized access panels shall be provided adjacent to all in-line plant and dampers. See-through vision panels shall be provided adjacent to all motorised dampers fitted in ductwork and air handling units.

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

Filters shall be of the easily replaceable type and shall be fitted with dirty filter indicators. Bag, HEPA and carbon filters shall have a pre-filter. Energy efficient filters should be used in all plant.

Fresh air inlets shall be positioned so as to be 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.

Electric resistive type or gas steam humidifiers (Neptronic preferred), with appropriate RO water treatment, shall be used for providing humidification. Electrode type electric humidifiers must not be used.

Separate dedicated cooling systems should be used for server rooms, departmental equipment and the like which require cooling continuously throughout the year.

Gauges shall be installed across all filters. Magnehelic gauges are preferred.

2.10 Fume Cupboards

Fume cupboard installations shall be in accordance with the current University Safety Office Policy Statement University policy S7/01 on fume cupboards.

Wherever practical each fume cupboard (or bank of fume cupboards) shall have a dedicated extract system which discharges at least three metres above the highest part of the roof. Extract fans must be easily accessible.

Each fume cupboard shall have a balanced quantity of filtered, heated make-up air introduced into the room in a manner designed to cause the minimum possible disruption to the fume cupboard air flow pattern.

All fume cupboards and associated extract fans shall be numbered in accordance with Estates Services current requirements.

2.11 Lift Installations

The lift manufacturer/supplier must be approved by the Head of Building Services or Mechanical Services Engineer before contracts are placed.

Lift installations shall comply with BS(EN) 81 and all disabled persons legislation. Car top controls, a pit stop switch and adequate shaft lighting shall also be provided. Please consult with the Mechanical section regarding proposed tenderer. An engraved plate with Estates Services unique lift reference number shall be fixed within the lift car. Lift numbers will be provided by Estates Services Mechanical Services Engineer.

Where necessary, the facility to send unaccompanied loads such as gas cylinders to their destination floor shall be incorporated in the lift control system.

A 'Windcrest' voice communication system and emergency lighting shall be incorporated into the lift car. The voice communication system shall be programmed

to dial up the University Security Services control room which is manned 24 hours a day on 01865 272944.

The lift shaft shall not contain any other services within it, and shall have a pit access ladder and adequate smoke ventilation at the top of the shaft.

Lift motor rooms shall have good uniform lighting, including emergency lighting and emergency stop switches fitted in appropriate positions.

Lift motor rooms shall be adequately heated/cooled and ventilated to suit the type of lift equipment.

All moving parts in the lift motor room must be painted yellow and suitably guarded.

There must always be an upward flow of air in lift shafts.

See clause 3.11.7 in the electrical service section for details of how the wiring serving lift installations shall be configured. All electrical installation within the shaft and the lift itself shall comply with Section 3 of this document.

Lift motor room doors **must** be fitted with Yale Security Products Limited, type GMK suite, ref no YN811(Y), 'L' suite for lift motor rooms. The standard lock shall be key operation externally and thumb turn on the room side complete with three keys.

Lift installations **will not be accepted for use** by Estates Services until:

- they have been inspected and passed by the University's lift insurance company;
- the O&M manual has been received and approved;
- the test certificates have been approved;
- wiring diagrams have been supplied;
- communication system is in place and fully tested.

Servicing and maintenance of the lift(s) shall be included in the project cost for the 12 months following handover. Servicing intervals and maintenance of the lift shall be carried out in accordance with the manufacturer's recommendations.

A smoke detector should preferably be located 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 the lift is an hydraulic type or there is no lift motor room, then an aspirated type of smoke detector should be installed at the top of the lift shaft, with that part of the detector which requires calibration/maintenance being positioned outside of the actual lift shaft.

2.12 BMS Section Relocated

This section is intentionally blank – see section 4.0 for BMS.

2.13 Asbestos

The use of asbestos in any form is forbidden. Existing buildings and services installations may contain asbestos contaminated materials and this possibility must be brought to the attention of any potential contractor. Estates Services maintain a register of where asbestos has been found and made safe in existing University buildings and there is also an Asbestos Register available based on a 'visual only' survey of the University's buildings. All sightings of suspected asbestos material must be reported to the University Safety Office so that the relevant action can be taken in accordance with the current Asbestos Policy Statement.

2.14 Thermal Insulation

Mechanical services pipework and ductwork shall be insulated as necessary to conserve energy or prevent condensation and freezing.

Fibre glass insulation must not be used in any form. Surface finish to the insulation shall be appropriate for the location but in plant rooms 'Isogenopak' sheeting shall be used in preference to aluminium cladding for pipework, and Ventureclad or similar should be used for ductwork.

Valves and flanges, plate heat exchanger, pump bodies etc. shall be insulated with purpose made high quality easily removable muff covers, **aluminium valve boxes are not acceptable.**

The insulation to pipework either in the open air or in external service ducts shall be rigid sectional insulation backed with an approved waterproof finish to form an unbroken surface along the entire length.

Trace heating is to be avoided. Where unavoidable the system needs to be properly insulated and accessible for routine testing. A list of each separate system must be included with the Operation and Maintenance manuals. Tracing heating should be installed on a fused spur **not** a plug and socket.

2.15 Stand-by Plant

A risk assessment shall be carried out to decide whether or not to provide stand-by plant where there is a need to maintain constant environmental conditions at all times. The risk assessment shall consider the vulnerability of the plant in question, the effect of down time for maintenance, the importance of the service being provided and the consequences of failure of the plant to the users.

Where automatic changeover of plant is provided, a suitable alarm shall be provided to alert the appropriate staff that plant has failed and needs attention.

Generally all ventilation plant shall have run and standby motors and heating, chilled water and hot and cold water systems shall have run and standby pumps. Twin headed pumps are acceptable in most situations so long as supplied with a blanking flange.

2.16 Energy Efficiency

This section should be read in conjunction with the Sustainable Buildings Philosophy Document (section 3.2 and following in the Project Managers' Handbook) which applies to all building projects.

Plant, equipment and systems must be specified at the time of tender and the most energy efficient plant and equipment available must be selected for use. It is not acceptable for the selection to be made by the installation contractor. Any alternative equipment manufacturer proposed by the contractor may only be used if it is equally as energy efficient as the specified item and is also approved by the Head of Building Services.

All systems shall be designed to be as energy efficient as possible. Time and temperature controlled zones shall be as small as practicable, with each room being independently temperature controlled.

Appropriate heat recovery measures shall be incorporated wherever practical and cost effective.

Free cooling shall be incorporated into air conditioning systems wherever possible.

Radiators shall always be used in preference to fan convectors and shall be fitted with thermostatic radiator valves. **Only Herz valves must be fitted**.

Natural ventilation systems shall be used in preference to air conditioning systems wherever possible.

All electric motors shall be of the high efficiency type (4 pole on three phase motors).

All air handling units should be fitted with high efficiency aerofoil bladed fans wherever possible.

Ductwork shall be fitted with appropriate turning vanes to DW144.

2.17 Frost Protection and Freezing

Appropriate frost protection and prevention of freezing must be provided to all plant, equipment and systems to all current guidelines and regulations. All critical systems or exceptions must be discussed and agreed with the Head of Building Services.

2.18 Sustainable Laboratory Design

Laboratories consume large quantities of energy and water; typically 40-50% of a laboratory's annual electrical consumption is consumed by the ventilation system. The Sustainable Building Philosophy Document should be followed for any new laboratory developments.

There are five key principles which should be considered when designing sustainable laboratories:

- Match air change rates to requirements. Avoid high (>6) air change rates wherever possible. Consider reducing air change rates out of hours.
- The request for over 'tight' temperature and humidity control should be challenged as this constrains energy efficiency options.
- Minimise loads by low air pressure drop design, selecting high-efficiency fans for all air handling equipment, use of variable speed drives and the specification of lower face velocity fume cupboards wherever possible.
- Match variable loads and supply through a variable air volume system.
- 'Right size' equipment so that supply capacity matches loads.

2.19 Water Treatment

Appropriate water treatment **must** be provided for all steam plant, laboratory and domestic hot water services, heating installations, chilled water installations, heat recovery systems, humidifiers, low and zero carbon technologies (e.g. solar, GSHP).

2.20 Identification and Labelling

All plant and equipment must be clearly labelled to identify their function and the area of the building that they serve.

All control equipment must be clearly labelled to indicate their function.

Labels shall be white traffolyte with black lettering, securely fixed to each item of equipment.

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

2.21 Flexible Connections and Inertia Bases

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

2.22 Cold Water Booster Pumps

Cold water booster sets should have the following minimum features:

- Duty/assist pumps
- Inverter control on each pump
- Plastic, Stainless steel or copper manifolds for potable water applications
- Control panel with system monitoring
- Auto rotation of pumps
- Monitoring by the Building Management System

2.23 Sump, Storm Water and Sewage Pumps

Sewage pumping stations shall have the following minimum features:

- Adequate pit size for operation and maintenance and removal
- 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 should be considered where there are long discharge pipe runs or an excessive static head (*)
- Coated ductile iron pipework in the pit
- Bronze gate valve and self-cleaning non-return valve for each pump
- Stainless steel chains and shackles
- In-line grease trap on the inlet pipework if serving a commercial kitchen (*) Fitted as close as possible to kitchen
- Access points for servicing including adequate clearance for tripods or lifting beams
- Twin pump control panel
- Ultrasonic level control
- Facility 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
- Auto rotation of duty pump
- Run and trip indication of pumps
- High level alarm, audible and visual on the panel with volt free connection
- Alarm linked back to the building management system
- Panel should be installed with line of sight of the pumps

Sump and storm water pumps shall have similar features as the above but not the items indicated above by an asterisk.

Pumping stations must be designed and installed to comply with the current Confined Spaces Regulations and a Safe Systems of Work provided within the O&M manuals. Lighting, suitable for a flammable atmosphere, should be provided.

2.24 Biomass, Solar Hot Water, Combined Heat and Power

Remote monitoring of plant by external contractor. Connections and access should be approved by Estates Services and available three weeks prior to PC. Some system may require a dedicate phone line in copper rather than VOIP.

The metering for renewable energy generation systems must comply with the relevant regulations in order to be approved for any government repayment scheme. See Section 6 Metering.

2.25 Boiler Installations

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 e.g. by the provision of tundishes within plant rooms. Externally run condensate lines must insulated.

2.26 Rainwater Harvesting Systems

All rainwater harvesting systems as a whole shall be designed in accordance with BS 8515:2009 (or any subsequent revisions) by a suitable qualified and experienced engineer. New buildings often have a planning requirement for stormwater attenuation (from the Environment Agency). The design of an attenuation system should be combined with the rainwater harvesting system design.

2.26.1 Rainwater Collection

Rainwater collection shall be from the normal guttering pipework of the building. The pipework shall be arranged such that rainwater enters the storage tank only by gravity or symphonic action. Pumping of rainwater supply to the storage tank is not acceptable.

Supply pipework shall 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 BS31100) 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.

2.26.2 Filtration and Treatment

All rainwater harvesting systems will be provided with debris filtration upstream of the storage tank which shall have a minimum efficiency of 90% and that will pass a maximum particle size of <1.25mm.

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

Where water is pumped from the storage tank, a floating suction filter (such as the Wisy SAFF or equal and approved) shall be used in conjunction with a remote pump.

2.26.3 Rainwater Storage

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

The preferred location of rainwater storage tanks shall be either in basement plantrooms or externally below ground. The use of external tanks above ground shall be avoided to reduce the opportunity for increases in temperature which may

encourage multiplication of Legionella or algal blooms. All storage facilities whether consisting of one or more tanks, shall be designed to avoid stagnation, contamination and microbial growth.

2.26.4 Back-up Water Supply

In all cases, a mains fed back-up water supply shall be provided to ensure that demand can be met during dry periods. In all cases, suitable air-gaps conforming to BSEN13076 or BSEN13077 will be used in order to prevent any possibility of contamination of mains potable water with rainwater in accordance with the Water Fittings Regulations.

The back-up water supply shall be arranged and controlled to ensure that the amount of water supplied is minimised to that required for immediate use.

Consideration shall also be given to the appropriate use of the rainwater system during dry spells when certain uses (such as irrigation) may not be appropriate when the system is being supplied by mains back-up rather than rainwater.

2.26.5 System Arrangement and Distribution

The system arrangement, including collection, storage and distribution systems, shall be such that there are no deadlegs and an adequate turnover of water is achieved to avoid stagnation.

All storage tanks shall be provided with an overflow outlet of equal or greater capacity than the inlet to allow discharge during extreme rainfall periods. Where an anti-surcharge device is fitted it shall conform to BSEN13564.

Rainwater shall be distributed from the storage tank using a pump located outside the tank and suction pipe arrangement, the latter being arranged to minimise the possibility of sucking in air, sediment or debris through the use of a floating suction filter. The flow rate and pressure head of the pump shall be determined in accordance with BSEN12056-4. A non-return valve with isolating valve shall be incorporated into the suction line to prevent drain down of the water column. Where multiple pumps are used, the system shall conform to BSEN12056-4 (as amended).

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

2.26.6 Controls and Metering

Controls shall be designed to minimise energy consumption and operational wear, to activate the back-up water supply automatically and with suitable connections to allow the system to be connected to a BMS.

Flow meters shall 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 shall be capable of being monitored remotely through connection to the ION system.

Consideration should be given to incorporating status monitoring which provides additional information for example; how full the tank is, any plant faults, which supply is being used.

2.26.7 Testing

The system shall be flushed and tested as part of the normal commissioning of the building services systems. Pipework shall be tested in accordance with and meet the standards of BS6700.

Commissioning certification shall be provided once all system components have been tested and comply with any relevant legislation, regulations and standards.

On hand-over, a legionella risk assessment and monitoring programme for the system shall be provided.

2.26.8 Access for Maintenance

The system design and installation shall ensure that suitable access for maintenance, repair or replacement of consumable parts is provided.

2.27 Ground Source Energy Systems (GSES)

2.27.1 Design and Specification Phase

GSES within the University must be designed, installed, controlled and interfaced with other systems with the primary purpose of reducing Carbon emissions. The control strategy for carbon emissions reduction may be different from those for cost savings. The programming of the GSES controls must make reference to the actual efficiencies of the installed conventional plant (if installed) so that the plant only runs when it is more (carbon) efficient than the alternative.

Systems should 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 which is especially limiting where buildings have deep basements.

The designer will need utility cost and tariff information from Estate Services sustainability section and will be forced to make assumptions of future costs (it is important that the assumptions of future costs are agreed by all parties otherwise the design/payback rationale could be misunderstood). Savings should be calculated using the seasonal energy efficiency rates of the chillers and boilers selected for the project and not a typical figure for relevant plant.

The designer must set out clearly in the Stage reports of 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. The heating and cooling data will be based on a model which makes many assumptions. The assumptions must be well documented and approved by the PSG.

The interface of the GSES with other control systems needs to be considered carefully. The extent and speed of data transfer should be minimised. Data traffic increases as systems mature so what works at handover may not continue working for long. Detailed consideration must be made of how GSES interfaces with building Trend BMS.

The designers must ensure that there is separate metering so that the GSES actual performance can be verified independently. The heat meters should be in the best possible positions (appropriate lengths of straight pipes up and down stream) to give accurate readings. Note there will be discrepancies between the meters but the designer should agree with the Contractor what the acceptable error should be before measurements start. All meters must be connected to the ION system. The designer must clarify which meters will be used to assess the system performance. Buffer vessels must be carefully sized to minimise starting cycles. The designers must ensure that heating and cooling outputs from the GSES are metered separately and that the GSES's electrical consumption in heating and cooling respectively can be separately identified. They should ensure that all parasitic loads e.g. ground loop pumps are also metered.

The designers must ensure that conventional systems do not take away load from GSES. Dead bands and control set points must be carefully considered.

The project manager must get a quotation for comprehensive 5 year maintenance as part of the project costing. Current experience is that critical components - compressors expansion valves and header valves are inherently unreliable so comprehensive contracts are essential.

The project manager must engage with the University's IT services to ensure that a comprehensive remote monitoring system is available to the **contractor before the start of commissioning**. The frequency of monitoring and reporting must be agreed.

The project costing must include for regular and seasonal reviews of system performance post handover. Seasonal commissioning must be built into the contract price. The number of years of commissioning should be based on the complexity and criticality of the system. Consider the use of a specialised validation engineer to review the performance at a detailed level and the interface with the BMS controls.

2.27.2 Installation

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

Ensure that (client) IT infrastructure for the remote monitoring of the system by the supplier is available before commissioning. It is important to start discussions early as there are potential security considerations.

Ensure that meters are only reset to zero after **all** meter readings have been taken.

Both the BMS and the GSES will have to be tuned and some of this will be interdependent. Both systems will also require seasonal commissioning post

handover and this should be coordinated. The avoidance of short cycling is important but neither do you want to keep bringing on auxiliary heating and cooling.

The description of operations (DESOPs) needs to be written in sufficient detail and structured so as to be useful for witnessing. The BMS DESOPs must be coordinated with the GSES DESOPs, and any other relevant third party controls e.g. chiller/ boiler sequence controllers. The system needs to be witnessed jointly with the BMS after both systems have been commissioned fully.

All systems must be installed so as not to let the conventional systems take away load from the GSES. A refrigerant leakage detection system must be installed in appropriate locations around the GSES and connected to the BMS system.

2.27.3 Handover

The GSES needs to be handed over to the following groups all of whom have a role to play in the successful operation of the system:

The department building manager;
Estates Services Mechanical Engineer;
Estates Services Energy Manager;
The DLO Mechanical Supervisors.

The handover of the system should be coordinated with the handover of the BMS. Suitable and sufficient training, instruction and documentation (including the DESOP for both the GSES and the relevant sections of the BMS) must be provided.

2.27.4 Operation

Ensure that meters are only reset to zero after **all** meter readings have been taken. If you are trying to interpret the information that is obtained from the system to assess either carbon saving or energy savings it is critically important that very good records are kept of anyone working on the system and what they have done or are doing be it remedial, repairs replacement etc---without this and knowing for example when meters have been off it is impossible to have faith in the readings and hence faith in the energy / carbon saving results. Meters should be read locally and cross checked against the metering system periodically.

The maintenance of the system must be overseen very closely. Ensure any problems picked up by the contractors maintenance engineers are reported to the projects team and rectified under defects liability.

The contractor and designer should produce regular (monthly) reports of performance post handover which should be reviewed by Estates Services Repairs and Maintenance and the Project team. Major reviews should be carried out to assess seasonal performance and used to inform the fine turning during the soft landing period. The project manager should coordinate these meetings with participation from designers, GSES contractor and Estates Services Mechanical and Sustainability teams.

The system must be operated so as not to let the conventional systems take away load from GSES.

SECTION 3 – ELECTRICAL SERVICES INSTALLATIONS

3.0 General

It is an absolute requirement that all systems are designed to be easily and safely accessible, are straightforward to operate, maintain, extend, replace and allow the carrying out of periodic test and inspections with the minimum of disruption to the 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).

All work within listed or historic buildings requires careful consideration and all proposals must be agreed with the Head of Building and Conservation before any work is carried out.

Whilst surface mounting of electrical services is preferred, it is recognised that prestigious areas within buildings will require a more sympathetic approach. Within such areas the method of concealment of electrical services should be agreed with the Electrical Engineer.

There is an on-going rationalisation and standardisation of the electrical systems and associated equipment within the University and, therefore, it is essential that the principles outlined in this document are strictly followed.

The selection of equipment, particularly main switchboards must be discussed and agreed with the University Electrical Engineer at the earliest opportunity.

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

Systems shall be designed, specified and supervised to ensure full compliance with BS7671 as well as other relevant Regulations, Codes of Practice and HSE Directives to ensure the provision of a suitable electrical system to the satisfaction of Estates Services.

Circuit protection shall be by circuit breakers – **fuses must not be used**.

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 shall be provided with sufficient flexibility to enable load analysis. Current transformer secondary connections shall be brought out to terminals (with appropriate shorting links) to enable instruments to be connected without having to switch off the supply – see the Metering Section 6 of this document for details.

All indoor cables shall be LSOH type whether armoured or not.

All parts of the electrical installation shall be sized to have a minimum of 25% spare capacity to cater for future growth.

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 Electrical Engineer. All work must be carried out in accordance with Estates Services Code of Practice 'Electrical Safety on Low Voltage Systems'.

Only electrical contractors who are on Estates Services Approved List of Inducted Contractors will be allowed to work on the University's fixed electrical systems.

3.1 External Network General

The University owns and operates several external networks in and around Oxford. These networks generally comprise 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 required because of additional electrical loadings for new or refurbished buildings must be funded by the individual building project(s). The reinforcement work will 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 advise values of fault level and earth fault loop impedance.

3.2 HV Cable Networks

For all University Networks containing two or more substations it is expected that the University 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. The routing of each cable shall be such that no other cables forming part of the same network shall be laid together. The open point on a ring shall be determined by the load and building types. This is of particular concern for those buildings containing essential supplies where it may be appropriate that the adjacent substation is on a separate part of the network. This is to enable a quick resumption of supply following an HV failure.

All cables shall be laid directly in the ground in accordance with part IV of the ESQC 2002 regulations. Ducts should be avoided accept during road crossings. Cables shall not be located under buildings. In the event of new buildings being placed across cable route, cable shall be diverted.

The cables type shall be PVC Insulated, Armoured, with Copper conductors complying with BS6622. All the cables in each part of the network shall be a minimum of 185mm^2. Consideration shall 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 shall have a minimum capacity of 8MW. All systems shall be designed for a 50 year life.

All networks shall comprise of ring circuits with no spurs or tees. Joints shall be kept to a minimum.

All cables shall be accurately mapped, including joints onto University Standard drawings maintained by the Estates Space management team.

3.3 LV Cable Networks

In order to carry out future maintenance or for dealing with local HV faults, all University Networks containing two or more substations shall have each substation connected to at least one other substation via a LV System with a capacity not less than 500kVA.

Each interconnection shall comprise of a 2* 4c 185mm^2 PVC/SWA/PVC cables run in parallel. In addition each interconnector system shall incorporate a supplementary earth conductor with a minimum size of 95mm^2.

All cables shall be laid directly in the ground in accordance with part IV of the ESQC regulations 2002. Ducts are to be avoided except during road crossings and entrance to buildings. Consideration shall be given to grouping factors in trench. Cables shall not be laid under or through buildings; in the event of a new building being constructed all affected cables shall be diverted.

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

All cables shall be accurately mapped, including joint locations, onto University Standard drawings maintained by the Estates Space management team.

3.4 Building Supply Cables

For all buildings with a proposed demand greater than 250 kVA 2 circuits are to be provided from the local University Substation. Each circuit shall be connected to a separate transformer and sized such that each circuit can provide a minimum of 70% of final connected load.

All cables shall be laid directly in the ground in accordance with part IV of the ESQC regulations 2002. Ducts are to be avoided accept for road crossings and entrances to buildings. Cables shall not be laid under or through buildings; in the event of a new

building being constructed all affected cables shall be diverted. Consideration shall be given to grouping factors in trench.

Building switchboards shall be located on ground floor and positioned such that supply cables do not pass through significant parts of the building.

Each supply cable shall incorporate a supplementary earth conductor with a minimum size of 95mm$^{2.}$

3.5 Substations General

All substations that are owned and operated by the University and located on University land shall be as follows:

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

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

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

LV switch room shall be suitably sized to allow a minimum of 1000mm of clear space around rear of switchboard.

All equipment including switchgear shall be suitably placed so as not to impede emergency evacuation from the site.

Entrance access doors to switchrooms will be sized to allow for unimpeded installation and replacement of switchgear.

Each switch room shall be provided with a suitably sized 3 phase distribution board located in a suitable location on the switch room wall. The distribution board shall be fed from the centre section of the main Switchboard via a suitably sized 4 pole MCCB.

Thermostatically controlled frost protection electric heating shall be installed in all LV switch rooms. Heating shall be fed from the local distribution board.

Adequate ventilation shall be provided in all LV switch rooms to prevent condensation.

Suitable RCD protected 13A sockets are to be provided in both LV switch room and HV compound.

Adequate energy efficient lighting shall be provided in all HV compounds controlled by a suitably placed switch.

Adequate precautions shall be taken to prevent water ingress in the cable trenches from incoming ducts.

External ground work shall comprise of a covering of loose pebbles/gravel complete with weed control fabric.

Internal floors shall be constructed so as to provide a non-slip dust proof surface.

In circumstances where the LV switch room is not adjacent to the HV compound, consideration shall be given to zoned protection systems including HV/LV inter-tripping.

All substation LV switchboards shall be provided with a generator connection point. The connection point shall be connected to the centre section of the main LV switchboard and sized to allow for the connection of a 1MW generator.

The connection point shall comprise of a suitably sized ACB mounted in a weather proof enclosure in a suitable location external to the LV switch room. The location of which is to be agreed by Estates Services Electrical Engineer.

Lighting to a minimum of 200LUX shall be provided in all LV Substation switch rooms using high frequency fluorescent lighting.

Emergency lighting to a minimum of 100LUX shall be provided in all LV Substation switch rooms.

3.6 High Voltage Switchgear

Each item of HV switchgear shall comprise of a 630A (21ka rated) Ring Main unit from the Schneider Ringmaster C range mounted directly on the transformer.

Protection of transformer shall be provided by Schneider VIP300 Protection relay.

Restricted Earth fault protection shall be provided on all systems where the Transformer is not located directly adjacent to LV switch room. System shall be designed to open both HV and corresponding LV switches.

Pfisterer sockets shall be provided on all HV switchgear.

Each Transformer switch shall be provided with a shunt trip connected to an emergency power off switch. Each switch is to operate both Transformer HV switch and corresponding LV Switch on main LV switchboard. Each switch shall comprise of a break glass unit located inside the LV switch room adjacent to the main door. A suitably sized wall mounted battery and charger shall be provided to power the system.

All HV switchgear shall be normally mounted directly on their respective transformer.

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

A minimum of 1000mm unimpeded access shall be provided around all the equipment.

3.7 Transformers

Standard substation configuration shall comprise two suitably sized transformers with associated HV switchgear.

All transformers shall be 11000\415V extra low loss, ground mounted free breathing, KNAN Midel 7131 fluid filled.

HV Tappings shall be +-2.5% to +-7.5%. (6 position switch)

Air cooled transformers shall not be used.

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

Each transformer shall be sized to suit the required load, but shall be not less than 500kVA. The designer should allow for each transformer to be operating at no more than 75% capacity on completion, for transformers greater then 2MVA agreement shall be sought from Estates Services Electrical Engineer.

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

An emergency power off switch shall be provided to enable all local transformers to be isolated in an emergency. Switch to be suitably located such as to prevent unintended operation. Switch shall isolate both HV and corresponding LV switch

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

Adequate access will be provided to allow unimpeded transformer replacement.

HV termination box shall be dry type with gasket sealed lid suitably oriented to accept local cable connection.

LV termination box shall be dry type with gasket sealed lid suitably oriented to accept local cable or busbar connection.

Buchholze type protection shall be considered for all transformers greater than 1500KVA.

All labelling shall be as detailed in Labelling section of this document.

No load and load loss data shall be provided by the manufacturer.

3.8 Trip Batteries

A 30V trip battery manufactured by PB design shall be provided at each substation. The trip battery shall be Valve regulated Lead Acid with a 10 year life @20 degrees C.

The charger shall be constant voltage, current limited type with solid state controller. The voltage control shall be within 1% of setting at+- 10% mains supply variations. Supply voltage shall be 230V single phase from local DB with full recharge within 24hours.

Charge transformer shall be double wound with earth screen to BS7671.

Rectifier shall be full wave controlled thyristor/diode bridge type.

Charger shall be compliant with BS6231.

System shall comprise a composite facia with LCD display and LED indicator.

All output terminals shall be DIN mounted.

The system shall be fitted with an audible alarm with additional volt free contacts to enable connection to the remote alarm system provided through the metering system.

3.9 Earthing General

The earth system shall comply with BS 7430.

The earth system shall be TN-C-S.

Prior to installation the earth resistivity shall be measured as described in BS7430 and local conditions checked for suitability of installing earth rods. If conditions and/or resistivity are not suitable advice shall be sought from Estates Services.

An earth electrode nest system shall be provided within the substation boundary. The system shall comprise as a minimum 4 no 2400mm*16mm^2 diameter copper rods arranged in a pattern 3m apart. Each rod shall be driven vertically into the ground to finish just below ground level. An inspection cover over a suitably constructed housing shall be provided at the top of each rod. All rods shall be connected by a copper strip not less than 25mm*3mm section buried at least 500mm below the surface. All connections to rod shall be bolted.

The earthing resistance test measurements for each rod and the total system shall be provided to Estates Services on completion of installation.

A hard drawn copper earth bar with a minimum section size of 50mm*6mm shall be provided in the substation. The bar shall be wall mounted on shock resistant insulators in a suitable location adjacent to the LV switchboard. The earth bar will have minimum 25% spare ways on completion.

The external earth electrode system shall 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 cable shall be buried 500mm below ground and enter the substation via a suitably sized sealed duct.

The transformer neutral/earth link shall be provided in an accessible location at the low voltage switchboard.

Each transformer and associated High Voltage switchgear shall be separately connected to the substation earth bar with a suitably labelled green/yellow sheathed copper conductor not less than 150mm^2.

All external and internal metal work shall be connected to the substation earth bar using a suitably labelled green/yellow sheathed copper conductor not less than 25mm$^{2.}$

The LV switchboard earth bar shall be connected to the substation earth bar using a suitably sized green/yellow sheathed copper conductor not less than 150mm$^{2.}$

The metallic armour on all incoming/outgoing SWA cables shall be connected to the switchboard earth bar.

No cables shall be routed across the floor.

All earth cable connections to the substation earth bar shall be hydraulic crimp lugged and connected by a suitably sized nut and bolt torque fastening.

3.10 Low Voltage Switchboards

3.10.1 General Requirements

For the purposes of this guidance the following definitions will apply:

A substation LV switchboard:

Is a switchboard that is supplied directly by one or more HV transformers and supplies one or more University buildings.

A building LV switchboard:

Is a switchboard that 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, and Rising Main Panels and any switch board or control panel containing protective devices

(Note mechanical plant switchboards are covered elsewhere in the Philosophy document).

3.10.1.1 Construction

Unless otherwise specified the following section applies to all types of switchboards.

All switchboards shall conform to BS EN 61439-1:2009 , BS EN 61439-2:2009 Type Tested and partially type-tested assemblies.

Where top entry switchboards are located below ground floor they shall be mounted on a suitably constructed plinth with a minimum height of 100mm. Where appropriate the switchboard shall be protected against ingress of water from above. Sufficient headroom should be allowed for to terminate the largest foreseeable size SWA cable (Nominally no greater then 185mm^2) taking into consideration the containment routing and bend radii. Additional side entry glanding boxes are to be avoided.

Switchboard busbars shall be designed to withstand the maximum fault current. The PSC value shall be determined after taking account of all incoming supply characteristics as well as contributions from connected loads. The fault rating shall be determined by calculations but it shall not be less than 65kA for one second in substations, 50kA in buildings.

All switchboards shall be designed and constructed in cubicle form so that they can be extended and erected by an approved contractor. Prior to despatch, the switchboard shall be factory tested in accordance with BS EN 61439-1:2009, BS EN 61439-2:2009. The board shall be fully assembled for testing prior to splitting for transport. All test record documentation and 'as built' drawings shall be provided at the time of despatch. As built drawings to include control panel wiring diagrams.

When re-assembled onsite, the switchboard manufacturer shall inspect and test the switchboard in accordance with BS EN 61439-1:2009, BS EN 61439-2:2009, and certify that it represents the factory-built assembly. All site test record documentation shall be provided at the time of completion. All joints shall be fully torque tested and marked with an indelible pen.

All exposed external metalwork shall be finished by an electro statically applied epoxy powder primer and paint finish. Colour - Oxford Blue to BS 3381.105.

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

The switchboard frame shall be fully welded manufactured from Zintec steel of not less than 2mm thickness. Panels and doors shall be dished and manufactured from Zintec steel having minimum thickness of 1.5mm.

All 3phase cable gland plates shall be hex bolted removable with plates made from Zintec steel of minimum thickness 3mm. Gland plates for single core cables shall be non-ferrous.

Where top and bottom covers are removable from the cable way, access through the cable way must be unobstructed. If support angles are required across the opening, then these shall be designed to enable them to be removed during installation works, without detriment, to facilitate future cabling.

Cables shall be terminated on horizontally mounted gland plates within the cable way. The location of the plate shall ensure that future cables can be installed and removed. A drawing detailing the glanding facility and indicating how a pair of 4c cables up to

185mm^2 XLPE/SWA/LSF can be terminated at each position shall be submitted at tender stage.

Where bottom entry is to be utilised, the base infill panels of the cableway of the switchboard shall be constructed of 12mm varnished Marine ply or equivalent material and fixed from above to ensure that they can be easily removed from within the switchboard. Means shall be provided to gland off cables within the cableway to enable easy connection onto each of the switch devices within a particular section.

A minimum of 25% spare ways are required on all new switchboards. As a minimum, one spare way of each size subject to the minimum 25% rule shall be allowed for. Where the number of spare ways proposed dictates that a single spare way would necessitate a further cubicle section this will be brought to the attention of Estates Services prior to manufacture.

All tenderers shall submit a drawing at the time of tendering. This shall show a general layout of devices, their rating, the configuration of busbars and compartmentalisation arrangements to meet required form of separation.

The minimum frame capacity shall be 160A TPN.

3.10.1.2 Busbars

All busbar assemblies shall comply with BS EN60429-2: Particular requirements for busbar trunking systems.

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

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

The earth bar shall be run the full length of the switchboard. Each cubicle section shall be positively connected to it. The bar shall be positioned to ensure that connections can be taken easily from it. The section of the earth bar shall be a minimum of two-thirds of the section of the primary busbar.

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

3.10.1.3 Switching Devices

All switchgear and control gear shall comply with BSEN60947 and unless otherwise specified shall be as follows:

All switching devices shall break all incoming phase conductors including the neutral simultaneously.

Switchboard devices up to and including 630A shall comprise of a suitably sized Plug in Moulded Case Circuit Breaker (MCCB) from the Schneider NSX type H range. The trip unit shall be from the Micrologic 5/6 A or E range and sized to suit application. There should be adequate discrimination between the MCCB and upstream devices.

The fault rating for all switching devices shall not be less then 65kA for Substation switchboards, 50 kA for Building switchboards and 36kA for all other switchboards.

Switchboard devices above 630A shall comprise of a withdrawable Air Circuit Breaker (ACB) from the Schneider Masterpact NW range rated to suit application. The circuit breaker shall comply with BS EN60947-2 and IEC947-2. The trip unit shall be a Micrologic 6P sized to suit application.

For both operational and maintenance reasons, it is required to have interchangeability between the fixed and moving assemblies on the A.C.B`s

The contact assembly of the circuit breakers and all associated live metalwork shall be double insulated from the operator. For Substation switchboards the operating mechanism shall be spring assisted via an auto-charged spring: manual charging shall also be provided. The closing time and spring charge times shall be advised at the time of tendering.

The status of the main contact is to be indicated and shall be such that the Off position can only be indicated when all contacts have been parted and separated.

When the moving portion is removed, safety shutters shall automatically cover the incoming and outgoing main circuits and auxiliaries. The shutters shall have the facility for padlocking the circuit breaker capable of meeting requirements for isolation as set out in IEC947-2.

The auxiliaries shall isolate all outgoing control circuit wiring when the circuit breaker is in the isolated position.

A test facility shall be provided to allow the auxiliaries to be closed with the main contact open.

All out-going circuits shall be equipped with over-current and short circuit protection from the Schneider Micrologic 5/6 A or E range of trip units. The protection shall have a wide range of time adjustment to permit flexibility of grading downstream. All units shall be designed to recognise true RMS current and be able to discriminate against system disturbances.

The trip module for all switching devices shall be visible without the need to remove switchboard panelling.

All outgoing circuit breakers shall 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) shall be fitted to all spare ways.

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

All switching devices shall be capable of being padlocked using a University of Oxford 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 are to be determined beforehand and set during commissioning. All trip setting details to be recorded and issued to Estates Services prior to handover.

3.10.1.4 Metering/Instrumentation

A suitably rated CT shall be fitted to each phase and neutral on all incoming and outgoing circuits. See the Metering Section 6 of this document for further advice.

All incoming circuits and active outgoing circuits to be metered in accordance with the Metering Section 6 of this document.

3.10.1.5 Labelling

All Switchboards, and all circuits shall be labelled in accordance with the Labelling section of this document.

3.10.2 Substation LV Switchboards

This part of the guidance sets out requirements for switchboards that are to be installed in University Substations. It is based on the standard substation arrangement which comprises 2 No 1500 kVA liquid cooled (KNAN) transformers. A typical general arrangement for a two transformer sub-station LV switchboard is shown on drawing E400987.1. A copy of this drawing is attached.

3.10.2.1 General

All switchboard incoming and outgoing arrangements shall conform to BS EN 61439-1:2009, BS EN 61439-2:2009 Form 4b type 6.

The IP rating shall be a minimum of IP43.

There must be no pipework of any kind or other unrelated equipment (e.g. emergency lighting inverters) installed within the switch room.

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

The access door(s) must be secured by a Yale Security Products Limited, type GMK suite, ref no YN8114(Y) cylinder type 88 night latch barrel lock.

The switchboard shall be arranged to provide operation from the front with rear access for cabling. It shall be designed to provide for cables to enter from above or below as determined by site conditions.

Access into rear of panel shall be via lift off, padlockable hinged doors using 1.25" Pin tumbler padlocks as manufactured by Union Cat 3104 (Estates Services issue type B locks).

LV supplies shall be arranged and suitably rated, to permit short term parallel operation of the transformers. No interlocking mechanisms are to be fitted.

All switchboards will require a minimum 1500mm front clearance. Rear access switchboards will require 1000mm perimeter clearance

3.10.2.2 Busbars

Primary busbars shall be run vertically and horizontally and shall be fully rated to suit transformer but not less than 1600 Amps continuous rating throughout. Distribution busbars shall be used to connect to the outgoing devices. The distribution bars should be sized to meet load requirements but shall not be less than 800 Amps continuous rating.

3.10.2.3 Switching Devices

Protection shall be graded across the board. The rating of the HV 11kV fuse or equivalent shall be taken at 80amps on a 1500KVA transformer.

Incoming switching devices shall comprise of a suitably rated Air Circuit Breaker (A.C.B) as above.

The inline buscoupler switch device shall be a non-draw out manually operated A.C.B that meets all requirements for the incoming air circuit breakers, however the device shall be non-automatic and therefore will not require protection tripping. All devices must be capable of operating under load conditions and be fully fault rated.

For all sites where the transformer is remote from the LV switchboard i.e. where cables pass outside the substation boundary, Restricted Earth fault protection with HV inter-tripping shall be installed.

For outgoing circuits up to and including 630A a suitably rated pluggable 4 pole MCCB from the Schneider NSX type H range shall be used. The trip unit shall be from the Micrologic 5/6 A or E range of trip units selected to suit the application.

For outgoing circuits above 630A a suitably rated ACB and trip unit from the Schneider range shall be used.

3.10.2.4 Metering/Instrumentation

Refer to section 6 table 1.

3.10.3 Building LV Switchboards

This part of the guidance sets out requirements for main switchboards that are to be installed in University buildings.

3.10.3.1 General

The switchboard incoming arrangements shall conform to BS EN60439-1: 1999 Form 4b type 6. All outgoing arrangements shall conform as a minimum to BS EN60439-1: 1999 Form 4b type 6.

For buildings where the demand is expected to exceed 250kVA the switchboard shall 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 single incomer is shown on drawing E400987.3.

The IP rating shall be a minimum of IP31

For single incomer switchboards the designer shall allow for a future second incomer with corresponding bus-section. Sufficient space should also be provided within the switchroom for this extension.

All switchboards will require a minimum 1500mm front clearance. Rear access switchboards will require 1000mm perimeter clearance.

There must be no pipework of any kind or other unrelated equipment (e.g. emergency lighting inverters) installed within the switch room.

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

3.10.3.2 Busbars

Primary busbars on switchboards should be sized to meet load requirements but shall not be less then 400amps continuous rating.

3.10.3.3 Switching Devices

For switchboards up to and including 630amps the incoming device shall be a fixed unit non auto 4 pole from the Schneider NSX type H.

For switchboards above 630amps the incoming device shall be a withdrawable ACB as outlined elsewhere in this document.

For all outgoing circuits up to and including 630A the device shall be a 4 pole group mounted pluggable MCCB. All spare ways to be fully equipped with base portion.

For all outgoing circuits above 250 amps consideration shall be given to segregated sections with pluggable MCCBs as outlined in the substation switchboard above.

All trip units shall be from the Schneider Micrologic 5/6 Type E range and sized to suit the application.

3.10.3.4 Metering/Instrumentation

Refer to Section 6.

3.10.4 Final Distribution Switchboards

This part of the guidance sets out requirements for final, special, and rising main Panels generally up to 400A that are installed in University buildings. (Mechanical Plant switchboards are dealt with elsewhere)

3.10.4.1 General

The switchboard incoming arrangements shall conform to BS EN60439-1: 1999 Form 4 type 6. All outgoing arrangements shall conform to BS EN60439-1: 1999 Form 4 type 3.

The IP rating shall be a minimum of IP31.

3.10.4.2 Busbars

Primary busbars on switchboards should be sized to meet load requirements but shall not be less than 250A continuous rating.

3.10.4.3 Switching Devices

The incoming switch device shall be a suitably rated non auto 4 pole fixed MCCB from Schneider NSX range as above.

All outgoing devices shall be a suitably rated 4 pole pluggable MCCB from the Schneider NSX range as above, with the following exception:

When assembled into a multi way MCCB distribution board it is possible that in some situations 3P/1P devices may be used, this is acceptable providing the main device controlling the distribution board is 4 pole.

3.10.4.4 Metering/Instrumentation

See Section 6 Metering

3.11 Building Distribution Systems

3.11.1 Vertical Distribution

The layout of the equipment in all riser cupboards is a designer responsibility and must not be left to the installation contractor to sort out on site. The consultant/contractor must produce detailed drawings which show the precise layout of all equipment within the riser cupboard including the position of all busbar joints and the positions of tap-off units. The drawings 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 shall have solid floors, a level

threshold and doors secured with Yale cylinder type 88 night latch barrel locks to the same specification as the switch room locks.

The major distribution system shall be run vertically, to serve all floors, in a central position using busbars where appropriate. Only one 3 phase 4 pole tap-off at shall be provided at each level in an accessible position where it can be operated without the use of a ladder.

Risers shall have a minimum of 25% spare capacity to take account of future increases in electrical load growth.

Risers shall be located in circulation areas and shall be connected to 'riser' distribution boards located on each floor adjacent to the risers.

Sub-distribution shall be from the 'riser boards' to final circuit boards in research rooms and circulation spaces. Separate lighting and power distribution boards are preferred, but where this is not possible, separate isolation must be provided for the lighting and power sections of the distribution board. Distribution boards shall be positioned so that they are fully accessible and can be worked on without the use of a ladder or other aids. Distribution boards should not be located in mechanical services plant rooms unless they serve the equipment within those areas. Distribution board enclosures shall be from the Schneider Acti 9 range. Distribution boards constructed out of plastic or fibre glass material are not acceptable. Incoming supply cables to main isolator\switch disconnector shall be fully shrouded.

For metering instrumentation of the 'riser boards', see Metering Section 6 of this document for details.

3.11.2 Horizontal Sub-Distribution

All sub-distribution systems should be installed in accessible circulation spaces up to the point where cables terminate into final circuit distribution boards which shall be sited either in circulation spaces or rooms themselves.

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 available 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 shall be maintained throughout its length, reduced capacity links between walls and partitions are not acceptable. Dedicated cable trays or basket shall be provided for telecommunication and data cabling. Flexible conduits shall not exceed 500mm in length.

Each room and circulation space will be given an Estates Services space reference and these references must be used to label all circuits in accordance with the latest Estates Services standard.

3.11.3 Final Circuit Wiring

Listed buildings and other prestigious areas will require a more sympathetic approach and the method of concealment of the electrical services should be agreed with the Electrical Engineer and the Head of Buildings and Conservation.

Where practicable, all distribution equipment shall be run on the surface. Supplies to sockets, data, and telephones within the room should be run in multi-compartment trunking positioned at high level or dado height or using a combination of both.

Laboratories and research rooms shall be equipped with their own final circuit distribution boards which shall be complete with recording instrumentation and have facilities for metering if required – see Metering Section 6 of this document for details. The location of these distribution boards needs careful consideration and they should be positioned such that they are fully accessible and can be worked on without the use of a ladder. They should not be positioned above doors or above laboratory benches or any other position where access may be obstructed by user activities. Only power circuits within the room shall be supplied from these distribution boards.

Fridges and freezers should be connected using non-standard plug and sockets. Freezers should preferably be grouped together in freezer rooms and fed directly from the essential services panel in the main switch room.

Fume cupboards shall be provided with a dedicated consumer unit fed from the room distribution board.

No ring main or radial socket circuit shall supply more than one room, multiple circuits within the room are acceptable.

Flexible conduits should not be used, where circumstances dictate that a flexible conduit provides the only solution then it shall be limited to no more than 500mm in length.

3.11.4 RCD Protection

Passive RCDs with a sensitivity of 30 milliamps shall be provided on all 13A socket outlets, except those sockets serving fridges and freezers which must be protected by an appropriate breaker. Ideally, the RCDs should be situated within the dado trunking located within the body of the room to enable users to be able to reset them. RCDs shall not be located in the distribution board. Cleaner's socket outlets shall contain an integral RCD. Active RCDs shall only be installed with the prior agreement of the Estates Services Electrical Engineer.

3.11.5 Essential Services Switchboard

A separate essential services switchboard shall be provided to supply the fire alarms, intruder alarm, security monitoring equipment, data hub, freezer rooms and any other systems considered to be indispensable.

3.11.6 Inter-floor Services

This relates to services which require connection at more than one level, i.e. fume cupboards. A vertical containment system shall be provided and located adjacent to the main riser to accommodate all inter-floor electrical supplies.

3.11.7 Supplies to the Lift Installation

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

A consumer unit type distribution board fitted with suitably rated mcbs and controlled by a double pole lockable isolator shall be provided in the lift motor room to supply all the electrical services which are normally maintained and tested as part of the University lift maintenance contract. Each outgoing circuit shall have its own rcd – 30milli-amp sensitivity. The circuits shall supply the car lighting, the car emergency lighting, lift shaft lighting, pit lighting and any small power associated with the pit, shaft or car.

The lighting for the lift motor room shall be taken off the floor distribution system – it must not be taken from the lift consumer unit. Likewise, socket outlets in the lift motor room which are not part of the lift installation shall also be taken off the floor distribution system.

The principles given above still apply if it is intended to install machine room-less type lifts.

3.11.8 Electrical Supplies to Mechanical Services Equipment

Electrical supplies shall be via dedicated distribution boards which shall be fed from the 'riser boards or main mechanical services riser'.

Each individual item of mechanical services plant – pump motors, fume cupboard extract fans, boilers, pressurisation units, water heaters, etc., must be connected to the fixed electrical system via an interlocking plug and socket to provide safe isolation for mechanical maintenance. Plug and sockets should not be used for variable speed inverter drives.

Approved interlocking plug and socket isolators up to a maximum size of 32 amps shall be used wherever possible. For all other circumstances an approved lockable isolator shall be used. Isolators for electrical safety must have fully shrouded incoming connections which will permit a person to safely work on the outgoing circuits when the device is in the 'off' position.

All isolators shall be clearly labelled and shall be positioned adjacent to the equipment that they isolate. Isolators positioned external to a building must be waterproof.

Where an item of equipment or enclosure contains live parts that cannot be isolated by a single isolator (e.g. compressor crankcase heater) then a permanent warning notice must be fixed in such a position that any person intending to work on the

equipment\enclosure will be warned of the need to use additional isolation devices to make the equipment\enclosures electrically safe.

3.11.9 External Sockets

Where external sockets are to be used they shall be fully waterproofed with an IP rating of IP67.

3.12 Lighting

3.12.1 General Requirements

Generally internal lighting shall comprise of luminaires incorporating DALI control gear. The circuitry for the lighting shall be controlled and protected from local lighting boards, not the room distribution board. External lighting does not require DALI configuration

A method of electrically isolating the various lighting fittings and/or lighting circuits, other than using the MCB's within the lighting distribution boards, shall be provided to enable the building users to safely replace the fluorescent tubes and lamps. Where plug-in connection is not appropriate the designer shall contact Estates Services Electrical section for guidance. The method of isolation adopted must comply with the 'mechanical maintenance requirements' of BS7671 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 shall be specified in accordance with the SLL Code for Lighting and BS EN: 12464.

All lighting designs shall be submitted to the Estates Services Electrical section for approval at the earliest opportunity. No work should take place on site until the scheme has been approved. Lighting calculations to support the design shall also be provided where requested. All drawings submitted to Estates Services Electrical section shall have the following information:

- Luminaire description
- Luminaire efficiency
- Average lux level
- uniformity
- w/m2/100 Lux

3.12.2 Target Energy Parameters

The designer shall in all cases design systems to meet the following energy targets. If these cannot be achieved then the designer shall approach Estates Services Electrical section to discuss a suitable solution:

- Office Area lighting (recessed) 2w/m2/100 lux
- Office Area lighting (suspended) 2.5w/m2/100 lux
- Lab Area lighting (recessed) 2w/m2/100 lux
- Lab Area lighting (suspended) 2.5w/m2/100 lux

- Open area Circulation spaces (excluding display 3w/m2/100 lux
- Corridors 3w/ m2/100 lux
- Toilets 3w/ m2/100 lux

3.12.3 Control System

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

Lighting controls shall be provided to reduce energy consumption. All occupied spaces shall be provided with absence detection (manual on/automatic off) to ensure lights are switched off when the room has been left unoccupied for a preset period of 15 minutes unless otherwise agreed. Circulation spaces shall be provided with fully automated controls, circulation detectors shall be set for a dimming period of 15 minutes prior to completely turning off the luminaire when no presence is detected. Day light regulation shall be provided in areas where adequate natural light is available.

All lighting control sensors shall be of DALI type unless otherwise agreed with Estates Services Section, and located in a suitable position and shall be configured for Broadcast DALI. All sensors shall be configured by a remote IR device. A handheld programmer shall be given to the Building services manager (if required) after consultation with Estates Services Electrical Section.

The university preferred manufacturer for this type of device is **Ex-Or.**

Lighting control systems in specialised areas such as Lecture Theatres, Museums, exhibitions etc shall be discussed and approved by Estates Services Electrical Section.

Preferred Manufacturer: **iLight/Exor**

Plantrooms, Switchrooms and other areas where there are safety considerations shall either be traditional switched or manually switched via absence detector (set with 8 hour off delay).

The contractor shall allow for commissioning of the system. A repeat visit shall be made post handover to check the operation is correct and optimised. (Nominal period of three months)

3.12.4 Design Criteria

Illuminance levels shall be as outlined within SLL Code for Lighting and BS EN:12464. The designer shall ensure that the recommended average maintained lighting level recommended by the standard be provided by fixed lighting, task lighting, such as desk lamps shall not be used to meet the required level unless agreed with Estates Services Electrical Section.

The lighting design shall be provided to ensure that the lighting level is uniform across the space to enable furniture layouts to be flexible.

Lighting shall be designed to at meet a minimum of 420 Lux in offices and 500 Lux in Laboratories.

When selecting any LED products, the designer shall make allowance for the maintenance factor so that the correct lighting levels are still achieved after 50,000 hours.

In order to assist with good recognition of objects and visual communication, the volume of the space shall be provided with good illumination. To provide good illumination, the "mean cylindrical illuminance" shall be provided as follows:

For teaching spaces, meeting rooms and lecture theatres a "mean cylindrical illuminance" of not less than 150 lux shall be provided with a minimum uniformity of 0.3. This shall be measured on a horizontal plane of 1.6m above floor level.

- The calculation grid shall be set out in accordance with the requirements of CIBSE Lighting Guide 5

In all enclosed places, the maintained illuminances on the major surface shall meet the following requirements:

- Minimum of 100 lux with a uniformity of 0.4 on the walls
- Minimum of 75 lux with a uniformity of 0.3 on the ceiling

3.12.5 Luminaire Selection

General lighting (excluding display lighting) within Offices, Labs, Industrial and Storage spaces shall have a luminaire efficacy of not less than 75 luminaire lumens per circuit watt before any control factor is applied. This requirement also applies to all areas provided with a desk — for example classrooms, meeting rooms and Libraries

Display Lighting (excluding Museums) shall have a minimum luminaire efficacy not less than 45 luminaire lumens per circuit watt.

DALI Ballasts shall be fitted to all internal luminaires regardless of whether or not controls are to be applied.

Lamp types shall be selected to suit the application, energy efficiency requirements and to minimise maintenance.

Lamp colour temperature shall be discussed and agreed with Estates Services electrical section during the design phase. Lamps will generally be 4000K but building finishes need to be considered prior to selection. Lamp colour temperature in Listed Buildings will also be required from Estates Services building conservation section.

Circulation area lighting (except display lighting) shall have a luminaire efficacy of no less than 80 luminaire lumens per circuit watt before any control factor is applied.

If the efficacy requirements outlined above cannot be achieved due to design constraints of the building then the designer shall discuss and obtain approval from Estates Services Electrical Section.

Fluorescent Tubes shall be manufactured by one of the following suppliers:
Phillips Lighting
Osram
GE Lighting
Sylvania

The following lamp types shall not be used:
Incandescent
Tungsten Halogen
T8/12 fluorescent lamps

All LED products must meet the following criteria:

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

External lighting shall be LED type, luminaires will have their colour temperature selected by the location they are being installed into. Any external lighting to the circulation spaces of the ROQ and Science Area will be 3000K with minimum CRI of 80, other areas such as Old Road, Begbroke will require their colour temperature agreed with Estates Services Electrical Section.

The designer shall ensure light levels are in line with the University Strategic masterplan for these areas.

When Façade Lighting is required all designs will need to be submitted for approval to Estates Services Electrical Section and Estates Services Building conservation teams.

3.12.6 Historic Buildings

It is recognised that lighting of historic buildings requires further consideration, it is noted that many of the requirements of this document cannot be achieved without detrimental impact on the appearance of the building. The designer and installer shall have detailed discussions with Estates Services Electrical section and the Head of Building Conservation to provide an energy efficient system that is still in keeping with the buildings appearance.

3.12.7 Examples

3.12.7.1 Typical Corridor

Luminaires used within circulation spaces shall be selected to achieve the required efficacy requirements. Lighting controls within corridors shall consist of suitable movement detectors capable of detecting movement in all areas of the space. Detectors shall be set for a dimming period (approximately 15 minutes) prior to completely turning off the luminaire when no presence is detected. Automatic daylight regulation shall be provided in areas where natural light is available.

3.12.7.2 Typical Office

Where display screen equipment is used the lighting design shall comply with the requirements of CIBSE Lighting Guide 7.

Each office space shall be provided with a standalone lighting control system comprising manual on/off switches with absence detection and with daylight regulation where natural light is available.

Luminaires should be selected to ensure a minimum efficacy as detailed in this document before any control factors are applied.

No more than 4 desk positions shall be monitored by a single detector.

3.13 Fire Alarm and Detection Systems/Emergency Lighting

3.13.1 Fire Alarm Installation Criteria

This section outlines the design requirement of the Fire Alarm and Detection System within University buildings. The Fire Alarm System design must be submitted to the University Fire Officer for approval.

The fire alarm system shall be designed, installed, tested and commissioned to all requirements as detailed in BS5839 and BS7671.

The Fire Alarm Systems shall be designed for buildings as follows:

- Buildings with no sleeping risk – L2 as defined by BS5839-1
- Buildings with sleeping risk – L1 ad defined by BS5839-1

All systems must be analogue/addressable. All systems installed must be **Open Protocol**. Closed Protocol systems are not acceptable.

Fire alarm control panels shall be manufactured by Kentec Electronics.

All field devices must be manufactured by Hochiki Corporation UK.

The Fire Alarm system shall be connected to the University Security Services control room for 24/7 monitoring using Drax outstations to relay a fire alarm signal. All systems shall incorporate a 'Security Alert' facility. The fire alarm control panel shall be fitted with a dedicated switch labelled 'Security Alert'. This switch will activate all sounders on an intermittent basis through a timer fitted within the control panel and will also activate a separate output to the University Security Services control room through the Drax outstation. The fire alarm output will not be activated by the 'Security Alert' switch.

Final exit doors may de-lock upon fire alarm activation and by way of green break glass units for other emergencies. In addition, doors must be held secure from within either a night latch, panic bar or push pad and the door is also to be provided with a self-closing device.

All fire alarm systems shall be fitted with a radio paging system with monitoring facilities in accordance with the recommendations within BS5839-1. Two alpha-numeric vibrating pager units and chargers shall be supplied for each system.

Fire alarm detection devices located in vertical service risers or above suspended ceilings shall all be provided with means of identifying their precise location. Ceiling panels immediately below each device shall be provided with a label, disc or remote indicator and must show the device address.

Fire detection in any toilet area shall contain both visual and audible devices. Refer to 3.13.4

Fire alarm device location plans showing basic floor plans, zoning and the location and address of every device shall be provided and located adjacent to the fire alarm control panel.

The plans are also to show the following:
location of the incoming power supply isolation switch;
shutdown valves for incoming gas main and water supply;
foam inlets;
dry risers.

3.13.2 Lift Shafts

A single zone air sampling detector shall be installed outside the shaft with a short run of pipe work into the shaft. The aspirating device shall be connected to the fire alarm system via an interface unit.

3.13.3 Electronic Locks

Magnetic plate locks are preferred.

Latch plate locks are only acceptable if a lever handle or knob (to mechanically de-latch the door) is fitted on the escape side of the door.

All electronic locks 'upon total power loss' shall fail to an unlocked condition.

Plate locks must always be provided with a push switch to release together with a green break glass unit to enable total electrical isolation to the lock in the event of a push switch failure.

Plate locks incorporating power driven shoot bolts should be avoided.

Doors fitted with electronic locks on common escape routes should de-lock upon fire alarm activation but a physical punch bar may remain locked to provide security. Doors are also be provided with green break glass units.

3.13.4 Disabled Person Refuges/Facilities

Where disabled person refuges are required, communication should be through the fire alarm system. At each refuge point an addressable yellow break glass unit is provided, together with a reassurance lamp, all installed on the relevant system loop wiring. The location of the reassurance lamp is to be 300mm above the yellow call point. The fire alarm control panel shall have additional LED indicators and acceptance/reassurance switches fitted for each refuge. The break glass unit will activate the fire alarm control panel but **not the fire alarm sounders or any other system outputs**. The refuge location will be indicated on the control panel display unit and LED indicator. Operation of the relevant acceptance/reassurance switch will activate the reassurance lamp at the refuge.

All disabled toilets shall be fitted with an appropriate alarm system to comply with BS8300. The system shall have a remote alarm indicator within the main reception area of the building.

Fire detection in any toilet area shall contain both visual and audible devices. Fully enclosed cubicles shall be individually provided with visual devices.

3.13.5 Fire Alarm Cause and Effect

The buildings gas supply shall only shut down upon fire alarm activation by way of a device within the room in which the supply enters the building.

Air handling plant supplying essential make-up air to fume cupboards, biological laboratories or any other facility where an interruption to the air supply could be dangerous or damaging, must not automatically shut down upon fire alarm activation. A fireman's switch shall be provided in an agreed safe location to permit essential air handling shutdown at user/fire service discretion. A secure switch to resurrect extract only regardless of fire alarm condition is to be provided adjacent to the main fire alarm control panel for post-fire smoke purging at fire service discretion.

Atriums or void spaces provided with openable vents to control building temperature shall also be provided with a fireman's switch to enable vent opening or closing at fire service discretion.

Lifts shall upon fire alarm activation return to ground floor level with doors open. A key switch override shall be available at the fire alarm panel to rapidly revert lift operation by key managerial staff if it is considered safe to use for disabled person evacuation. The use of passenger lifts for this purpose must be approved by Estates Services and Safety Office.

3.13.6 Building Conservation

When fire alarm services are to be installed in a listed building, the installation details must be discussed and approved by the Estates Services' Building Conservation team and the Safety Office.

3.13.7 Fume Cupboards

No fire dampers must be installed in fume cupboard flues or within essential supply/extract ductwork for biological cabinets or laboratories.

Fume cupboards must be fitted with Firetrace or similar suppression systems wherever fume cupboard use could produce a fire risk within the enclosed cabinet and within the associated ductwork.

3.13.8 Fireman's Switch for Photovoltic Systems (PV)

The PV system shall be configured so that there is a fireman's switch located adjacent to the building fire alarm panel. On operation of the switch, the AC side of the invertor will be disconnected from the electrical system of the building. The switch shall be in the form of a white breakglass unit and wired through the fire alarm system. Only a manual activation of the breakglass shall trip the invertor, it is not to be activated through the fire detection system. The breakglass shall be clearly marked with the following description on a trifoliate label:

"**Fireman's Switch – Solar Panels Isolation**"

3.13.9 Other Items

Planned gas flooding/oxygen depletion fire suppression systems, together with suppression systems for kitchen ranges and hobs **must** have Safety Office approval.

3.13.10 Labelling

Every fire alarm device (including call points/interfaces etc…) shall be labelled with its full address (panel/loop number/address number).

Every fireman's switch shall be labelled to clearly indicate its precise function, including a plan, section or diagram where considered necessary to avoid confusion.

3.14 Emergency Lighting

3.14.1 General

This section outlines the design requirement of the Emergency Lighting Systems within University buildings. The Emergency Lighting design shall be submitted to the University Fire Officer for approval.

The Emergency Lighting system shall be designed, installed, tested and commissioned to all requirements as detailed in BS5266 and BS7671.

All emergency luminaires shall be LED type and have standby load of no more than 1.5W, connected load of no more than 5W and an efficacy of no less than 110 Luminaire Lumens per circuit watt.

3.14.2 System Design

Emergency lighting within building shall fall into one of the following installation:

- Several Low Power Invertors: Emergency lighting system will consist of several small powered invertors located around the building. This invertor will power, test and monitor the emergency lights.

- Self contained: 3 hour stand-alone self test LED emergency luminaires shall be used. Any stand-alone luminarie shall have the functionality for its internal clock to be programmed so it carries out its test at a specific time dictated by the University. The luminaire shall also have the capability of being monitored (if required at a later date or through discussions with Estates Services and Safety Office) Key switches are not required for testing of system. Batteries shall be NiMh and must able to be replaced without the use of a special tool.

The selected system design will need to be agreed in writing with the Project Manager, Estates Services Electrical Section, and Safety Office.

3.14.3 Building Conservation

When emergency lighting services are installed in a listed building, the installation details must be discussed and approved by the Estates Services Building Conservation team.

3.14.4 Labelling

Emergency lighting labelling shall be as detailed in the Labelling section of this document.

3.15 Generators

This section outlines the design requirement of the Automatic Generator System when connected to University buildings.

A separate generator change-over control panel shall be installed adjacent to the building main switchboard.

The system detailed design shall be submitted the University Electrical Engineer for approval.

3.15.1 General Requirements

3.15.2 Panel Construction

Please see Switchgear section in this document for details.

3.15.3 Switching Devices

Please see Switchgear section in this document for details. All auxiliary devices to be 24V DC.

3.15.4 Labelling

Please see Labelling section of this document for details.

3.15.5 Metering Type

Please see Metering section 6 of this document for details.

3.15.6 Change-Over Panel

The control panel shall 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 shall be fitted with a Deep Sea Electronics 8000 series Auto Transfer switch to control the operation of the circuit breakers.

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

The phase failure relays shall be fitted with a time delay to prevent immediate activation of the shunt trip coils on the incomers. (Adjustable from 1 second to 5 minutes). The default setting of the timer shall be 30 Seconds. All circuit breakers

that form part of the control system shall be controlled via 24V DC supplied from the Generator Batteries. Undervoltage release coils shall not be used; all tripping of circuit breakers will be via shunt trip coils.

An external bypass switch shall be fitted to all control panels of less the 500KVA.

3.15.7 Synchronisation

Generator sets of generation capacity of 350KVA and above (unless otherwise agreed in writing by Estates Services Electrical Engineer) shall be designed to synchronise with the mains supply. The system shall comply with all requirements as defined in Engineering Recommendation G59.

3.15.8 Control Principles

The following control principles are required on loss of supply.

When loss of supply is detected by any mains failure relay, they will activate the time delay circuit. After the predetermined time has elapsed and if the loss of supply is still present, the generator will start. However, if the mains supply has returned during the time delay period the system shall revert back to normal operating conditions. On reaching the correct speed and voltage the generator will send a `ready for load' signal back to the changeover control panel – this shall 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.

For restorations of supply the following principles shall apply.

Restoration shall be a manual operation. Automatic transfer back to mains supply is not permitted unless agreed with the University Electrical Engineer.

On turning the mains restoration key switch the following sequence should happen, Generator circuit breaker opens, after a delay of 30 Seconds the main incoming circuit breaker shall close. The generator runs for a three minute cool down period before return to standby.

The system is returned to normal operating conditions.

3.15.9 Testing Facilities

The simulation of loss of supply key switch shall initiate the following sequence of events:

Supply to phase failure relay is failed (facility will be required to test each relay if applicable).

Generator starts. On reaching correct speed and voltage it shall initiate the opening of the Incoming circuit breaker(s) then closing of the generator incoming circuit breaker.

The system is now on generator support.

3.15.10 Restoration

Return simulation key switch back to normal to reset the phase failure relays.

On turning the Mains Restoration key switch the following sequence should happen, Generator circuit breaker opens, after a delay of 30 Seconds the main incoming circuit breaker shall close. The generator runs for a three minute cool down period before returning to standby.

The system is returned to normal operating conditions.

3.15.11 Drawings

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

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

3.15.12 Fuel

3.15.12.1 Capacity

All generator systems shall be provided with a fuel capacity of 72 hours at full load of the system. If circumstances dictate a different arrangement this shall be agreed with the University Electrical Engineer and the Project Sponsor Group.

3.15.12.2 Fuel Level

Any fuel tank associated with the generators shall be fitted with floats to indicate fuel levels of 0-100%. A separate analogue full gauge will be required on both day tank and bulk tank.

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

Fuel level of 100% of the system capacity shall be provided with the system.

3.15.12.3 Maintenance Contract

A maintenance contract shall be placed with the generator supplier. This shall consist of two maintenance visits over a 12 Month period. The contract shall be inclusive of all parts and labour.

The contract start date will commence when the University electrical engineer accepts responsibility for the generator system (generator system is inclusive of all power changeover control systems).

An emergency call out shall be included within the contract. The response time for an engineer will be determined by the University Engineer and the Project Sponsor Group. The response time shall be no longer than 24 hours.

A copy of the maintenance contract shall be submitted to the University Electrical engineer for approval.

3.15.12.4 Bunding

The generator shall be provided with adequate bunding to prevent the loss of fuel either during filling or by damage or fault to the generator set.

3.16 Generator Set

3.16.1 PRP Prime Power Rating

The generator set may be run continuously for an unlimited operating time under varying load factors with an average load factor of not more than 70% or the Prime Power rating. An overload of 10% is required for 1 hour in 12.

Fuel should comply with BS 2869: 1970, Class A1/A2 ASTM D975 N02, SIS 55432, DIN 51601 or equivalent.

Engine Fault protection for:

- Low oil pressure
- High water temperature

3.16.2 Alternator

Shall be close coupled, single bearing, PMG excited, self-regulating, brushless, 4 pole, alternator generating 3 phase at 50Hz and 400V (ph-ph) with, class H insulation and class H rises and IP21 protection.

Radio suppression to BS800.

Alternator anti-condensation heater.

3.16.3 Base Frame

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

3.16.4 Control System

Set mounted, automatic start control system control cubicle comprising:
Deep Sea Electronics 8760 ATS/Auto Mains controller and 8721 colour remote display module (or equivalent and approved by Estates Services Electrical Engineer) Electronic Generator Control Module complete with:

- 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:

- Fail 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

Status Indication for:

- Remote Start
- Generator Running
- Fuel Pump 1 Running
- Fuel Pump 2 Running
- Generator Available

All Lamps to be of LED type.

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 Over-ride
- Remaining Time until maintenance
- Exerciser Function
- 25 event history log

Note: All Fault, Alarm, Instrumentation and History information shall be provided via a two line, graphic LCD display with back-lighting. Alarms and Faults shall also give audible indication.

3.16.5 Alarm and Status Signals

Volt free signals for interfacing to the ION 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 (also to be connected into Estates Services Metering system)
- Generator Running (also to be connected into Estates Services Metering system)
- Common Fault (also to be connected into Estates Services Metering system)
- Common Alarm (also to be connected into Estates Services Metering system)
- Fuel Transfer Pump Fail
- Low Battery Volts Warning

3.16.6 Alternator Circuit Breaker

Schneider Electric 3 pole, fixed pattern, lockable, Circuit Breaker complete with:

- Auxiliary Indications
- Protections for:
  - Short Circuit
  - Over Current

Fuel Transfer Pump Control Section complete with:

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

The control panel shall be equipped with controls for:

- Emergency Stop Button (Twist to Reset)
- Engine Heater On/Off
- Alternator Heater On/Off
- Battery Charger On/Off/Boost

The control panel will also be equipped with Panel Anti-condensation Heater(s). Auxiliaries Distribution System will be required for feeds to:

- Engine Heater
- Alternator Heater
- Starter Battery Charger
- Fuel Transfer Pumps

3.16.7 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 LVAC Distribution board. When the generating set has reached rated speed and voltage it will give a volt free "Ready for Load" signal. No load shall be applied to the generating set until this signal has been received. The generating set shall be equipped with a manual

Alternator Circuit Breaker. This breaker is normally closed and is used for the protection of the generating set.

Upon removal of the start signal the generating set will run on for a user configurable cool down period and then stop.

Any of conditions listed above as "Faults" will cause the generating set to stop immediately.

Any of the conditions listed above as "Warnings" will cause an alarm (visual and audible) to be displayed but will not stop the generating set.

Any of the conditions listed above 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 is stopped by any of the following conditions:

- Base Tank High Fuel Level
- Fire Detected
- Fuel in Container Bund Warning
- Fuel in Pipework Bund Warning

Signage: The generating set shall 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 are fully works tested in accordance with standard Diesel Engine Test Procedures these will include:

- Full functional test
- Load Tests and including:-

1. 25% Load Test to stability
2. 50% Load Test to stability
3. 75% Load Test to stability
4. 100% Load Test for 4 hour
5. 110% Load Test for 1 hour

3.16.8 Routine Testing

Generators below 350 KVA shall be programmed to run off load for duration of 5 minutes once a week. (Programmed for 9am on Wednesdays)

All sets of 350KVA and above shall synchronise with the mains and run **on-load** for 30 minutes once a week. (Programmed for 9am on Wednesdays).

3.17 Lightning Protection

All new and refurbished buildings shall have lightning protection systems which comply with the requirements of BSEN 62305:2006.

3.18 Earthing - Special Requirements

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

3.19 Electro-magnetic Compatibility

All systems shall fully comply with legislation on electro-magnetic interference. Details of the precautions that have been taken to comply with the legislation shall be provided to the end user of the building and Estates Services.

3.20 Power Factor Correction

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

3.21 Meters and Instrumentation System

Refer to Section 6 for metering requirements.

3.22 Labelling

3.22.1 Substation

3.22.2 Compounds/Buildings

All entrances to substation compounds and switch rooms shall be identified with a nameplate in the following form.

Min Size 160mm*50mm

PATHOLOGY S/S

All main entrances to substation compounds and switch rooms shall display an emergency contact number as shown below.

160mm * 60mm

IN CASE OF EMERGENCY PLEASE CONTACT
ESTATES SERVICES
THE MALTHOUSE
TIDMARSH LANE, OXFORD
TELEPHONE **01865** 278750

All entrances to substation compounds and switch rooms shall display a danger label in the following form.

Minimum size of Label 300mm*400mm

3.22.3 HV Switchgear

All HV switchgear shall be labelled as shown; the label shall detail the source of the connected cable.

OBSERVATORY S/S

The size of the label shall be dependent upon the label fixing plate located on the switchgear.

3.22.4 Transformers

Each transformer shall be identified as shown.

TRANSFORMER 1

Minimum size 200mm*50mm

The label shall be securely fixed on the side of the transformer in a position visible from the HV switchgear. Stencilled identification is acceptable.

3.22.5 Substation LV Switchgear

Adjacent to each incoming and outgoing circuit a label shall be fitted as shown. The number shall be incremental starting from 1 preceded by the substation letter (as issued by Estates Services).

40mm * 20mm

B1

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

In addition to the label above each outgoing circuit shall also be labelled as follows. The label shall identify the building supplied, the circuit reference in that building and the cable size.

100mm * 35mm

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

3.22.6 Buildings

3.22.7 Building LV Switchboards

All building LV switchboards shall be identified as shown below. The label shall be fitted in a prominent position at the front.

125mm*30mm

.

20/004/00

The label shall be made up of the following parts:

a) First part (2 digits) Level 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. It is expected that the main department/building switchboard number will 001.

The first and second part of the number will be provided by Estates Services space management team. The third part to be agreed with the University Electrical Engineer prior to label installation.

A numbered sequential label shall be fitted adjacent to outgoing circuits as shown. The numbering shall be top to bottom left to right.

45mm*10mm

Circuit 1

In addition to the label above a label shall be fitted adjacent to all incoming circuits as shown; the label shall display the Substation Name, the circuit reference and size and type of cable.

100mm*40m

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

In addition to the circuit reference above all outgoing circuit shall be identified as shown. The distribution board number shall be in the form shown above.

100mm*40mm

Distribution Board Number
Circuit ref
Cable size and Type

3.22.8 Distribution Boards

All switchgear and control panels containing one or more circuit protective devices shall be treated as distribution boards and shall be identified as shown below. Busbar systems shall also be treated as a Distribution board and labelled as below.

125mm*30mm

20/004/00

The label shall be fitted in a prominent position on the front panel.

The label shall be made up of the following parts

a) First part (2 digits) Level 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 would normally be provided by Estates Services space management team. The third part to be agreed with the University Electrical Engineer prior to label installation.

3.22.9 Final Circuits

All outgoing ways on all distribution boards shall be identified with a sequential tag number and circuit reference. The tag number shall identify the actual location of the protective device within the board with each single module being identified. The circuit reference shall comprise a way number and phase reference L1, L2 or L3. Where an isolator is fitted within the outgoing part of the board it shall be numbered within the sequential numbering above. Both the tag number and circuit reference shall correspond to the Distribution board chart. (See below)

In general the numbering sequence shall be configured to be read top to bottom, left to right, starting at the top of the left hand column, following down to the bottom of the column before commencing from the top of the right hand column.

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

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

1	2	3	4	5	6	7	8

Single phase (Vertical)
Phase reference marked on chart only. Tag and circuit reference shall 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. Column 1 and 4 correspond to tag number

1	Single pole device	1L1	7	3L1	3 pole device
2	Two pole device	1L2	8	3L2	\
3	/	1L3	9	3L3	\
4	\	2L1	10	4L1	Single Pole Device
5	3 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 shall be labelled using either:-

free issue paper labels as shown below (available from Estates Services). The label shall be completed using black indelible ink as shown.

CIRCUIT……DB32.1L123
LOCATION DIST.BOARD:-
SPACE……00/32……
ROOM……LIBRARY…….

Or following agreement with Estates Services Engineer.

Dymo/Computer label comprising circuit details as shown on top line of label above.

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

For single phase circuits (Single Pole) DB10.5L2

For single phase circuits (2 Pole) DB2.6L1N

For Three phase circuits (3 Pole) DB22.6L123

For Three phase circuits (4 Pole) DB7.10L123N

The space identifies the location of the distribution board i.e.10/20

The room identifies the actual location of the distribution board i.e. Corridor, Room 6 etc.

3.22.10 Cable Core Marking

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

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

The earth conductors shall be identified with their corresponding number detailed above.

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

Example 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	1 Pole Device	6L1	Brown	6L1	6L1
7	Spare	7L1			
8	1 Pole Device	8L1	Brown	8L1	8L1
9	Single Pole Device	9L1	Brown	9L1	9L1

For three phase boards the numbering shall be as follows:-

Example 3phase 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	3 Phase Device	1L2	Black	1L2	
3	/	1L3	Grey	1L3	
4	Spare	2L1			
5	Spare	2L2			
6	1Pole Device	2L3	Brown	2L3	2L3
7	Spare	3L1			
8	1 Pole Device	3L2	Brown	3L2	3L2
9	Spare	3L3			
10	Spare	4L1			
11	1 Pole Device	4L2	Brown	4L2	4L2
12	Spare	4L3			

Example 3phase 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	3 Phase Device	1L2	Yellow	1L2	1L2
3	/	1L3	Blue	1L3	
4	Spare	2L1			
5	Spare	2L2			
6	1 Pole Device	2L3	Red	2L3	2L3
7	\	3L1	Red	3L1	
8	3 Pole Device	3L2	Yellow	3L2	3L2
9	/	3L3	Blue	3L3	
10	Spare	4L1			
11	1Pole Device	4L2	Red	4L2	4L2
12	Spare	4L3			

For non standard type distribution boards contact Estates Services.

3.22.11 Submain Cables

Where multiple multicore cables are installed a label shall be fitted to each end of each cable detailing the location of the remote end of the cable.

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

The label shall display local distribution board reference followed by remote distribution board reference in the form shown

Local end

DB001-DB10

Remote End

DB10-DB001

3.22.12 Emergency Lighting Identification

All building Emergency luminaries and accessories shall be identified as shown below. The label shall be fitted in a prominent position, visible without the aid of steps etc.

Emergency Luminaries

Size determined by fitting

EL00/001

EL Emergency Light
Next 2 digits Level (i.e. 00, 10, 20)
Last Digits Unique Fitting number (by level)

Key Switch

Size determined by switch

K00/01

K Key Switch
Next 2 Digits Level (i.e. 00, 20, and 30)
Last 2 Digits Unique Key switch number (By floor)

Mains Fail Relay (Central Battery Only)

Size determined by unit

MFR00/01

MFR Main fail relay
Next 2 Digits Level (i.e. 00, 20, and 30)
Last 2 Digits Unique unit number (By floor)

Records

A detailed plan clearly showing the positions of all the emergency lighting locations with their unique identifier shall be provided for each floor in both Electronic (CAD and PDF) and paper form. The drawing shall also show location of Central battery if applicable.

A schedule of luminaries shall be provided in electronic form as follows

Bld Nos	EL Nos	EL location	Type of Fitting	Lamp Type	Key No	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

3.23 Distribution Board Chart

A protected paper chart shall be fitted adjacent to each distribution board. The chart shall be visible without the need to open the distribution board door or panel.

The minimum information for each chart is as shown on the standard University Chart shown below

A brief description of the University chart is as follows

<table>
<tr><td colspan="5">BUILDING NAME
Short description of location of DB</td></tr>
<tr><td>DB Nos
Bld Ref 10/13/008</td><td colspan="2">Designation i.e. Clean, Dirty, Plant etc</td><td colspan="2">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 colspan="2">Submain details

Type and size of cable between remote and local isolator</td><td colspan="2">Remote Isolator/Location

Type and size of remote isolator/CPD with location and reference number</td></tr>
<tr><td colspan="5">Zs and PSC readings at Distribution board</td></tr>
<tr><td>Way
Physical location of outgoing device
Counting top to bottom left to right</td><td>Size Amps
Protective device size and Type</td><td>Circuit Ref
Reference as seen on top line of Accessory label</td><td>Circuit Description of circuit, to include space number(if known) and local space identity i.e.
S/O: 10.24
Office 2
(60 Characters only)</td><td>Cable Size
Final circuit cable type and size</td></tr>
</table>

Contractors shall 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 Section 3.

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 TPN**

Local Isolator	Submain Details	Remote Isolator/Location
3 Pole 125A ISOLATOR INTEGRAL	**25.0sqmm PVC SINGLES**	**60A TP ISOLATOR** **00/025/029**

Way	Size Amps		Circuit Ref	Circuit Description ZS 0.22 ohms PSC 1.34 kA	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

Departments other than the Estates Services must not carry out, or cause to be carried out, any modifications or extensions of the systems defined as the responsibility of the Director of Estates without the prior knowledge and prior written approval of the Director . (University Policy Statement S1/00)

174 **University Estates Services - The Malthouse,Tidmarsh Lane, Oxford OX1 1N**

3.24 Cable Management Systems for Data/Telecommunications

Refer to Telecom's philosophy document.

3.25 Record Information

3.25.1 Asset Register

The University operates an electronic register based on the above labelling principles for of all distribution boards and final circuits. These records are held on an Access Database (part of the Microsoft Office suite). The contractor shall where possible provide a complete list of these assets along with all relevant test record information for inclusion on this register. On request Estates Services electrical section will provide a template detailing type and format of the information required.

3.25.2 Drawings – See also the separate O&M's Philosophy Document

The contractor shall provide on Practical Completion the following drawings in CAD DWG format. These drawings shall be provided directly to the University Electrical Engineer to enable the system to be handed over. Failure to provide these drawings may delay hand over of the electrical system. Copies of these drawings shall also be provided with the completion manual as outlined elsewhere in the Philosophy Document.

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.

Latest versions of the electrical drawings are available on the website.

3. 26 Photovoltaic Installations (PV)

3.26.1 System Requirements

All PV systems configurations shall be formally submitted to Estates Services electrical section for approval.

The design shall provide the university with the following information.

- year 1 output
- year 20 output
- annual degradation in efficiency
- outputs relative to kWp installed and capital cost
- all data used to form the calculation.

Two options for photovoltaic systems shall be designed for each installation,
Option 1 Provide the minimum size required to meet any planning / building regulation requirement and as detailed within this document. Option 2 uplift to a larger system to take maximum advantage of space available for the array.

The minimum PV installation size shall be no less than 4KW, unless agreed with Estates Services.

All PV installations shall comply with the following:-

BS7671 Electrical installation Regulations.

BS EN 62446:2009 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 G59.

PV systems shall be only installed by a MCS accredited contractor unless otherwise agreed with Estates Services.

3.26.2 PV Modules/Arrays

PV systems mounted above or integrated into a pitched roof should utilise products that have been tested and approved to MCS012 (test procedures used to demonstrate the performance of solar systems under the action of wind loads, fire, rainfall and wind driven rain).

PV systems utilising bespoke building integrated PV modules should utilise products that have been tested and approved to MCS017 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 carry a CE mark

The University has a strong preference for PV Modules from the following manufacturers.

- Sunpower (E20)

Any other modules offered must be certificated and listed on the MCS product database and must be equal and approved in writing by Estates Services Electrical and Sustainability Sections.

Any other modules offered will need approval from Estates Services Electrical section.

Unless otherwise specified or dictated by site conditions and Estates Services preferences, all PV arrays shall be oriented facing south at tilt angles between 30 and 40 degrees from horizontal for maximum solar energy exposure. Arrays should be located to prevent shading from trees, poles or other structures at anytime between 7am and 5pm solar time, any day of the year.

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

Mounting kits will be one of the following manufacturers:

- Schuco
- SolarWorld

Rooftop mounted arrays should have a minimum of 75 millimetres between the top surface of the module and roof surface, with no obstructions preventing air flow between (beneath) the array and roof surface.

3.26.3 Inverters

SMA Sunnyboy invertors shall be installed; the University preference from the SMA range is for transformerless unless otherwise required by the array. Size of unit is specific to the design requirements.

3.26.4 Remote Energy Management

Each invertor must be connected to the university data network via a SMA Webbox.

3.26.5 Metering

In addition to the OFGEM approved meter a separate Estates Services meter shall be installed on the AC side of the invertor. This shall be connected into the Estates Services metering system in accordance with the current philosophy document. Refer to Section 6.

3.26.6 Fire Protection

The PV system shall be configured so that there is a fireman's switch located adjacent to the building fire alarm panel. On operation of the switch, the AC side of the invertor will be disconnected from the electrical system of the building. The switch shall be in the form of a white breakglass unit and wired through the fire alarm system. Only a manual activation of the breakglass shall trip the invertor, it is not to be activated through the fire detection system. The breakglass shall be clearly marked with the following description on a trifoliate label

"**FIREMANS SWITCH – SOLAR PANELS ISOLATION**"

SECTION 4 - BUILDING MANAGEMENT SYSTEMS AND AUTOMATIC CONTROL SYSTEMS

4.0 General

Control systems are fundamental to the operation of plant by Estates Services. The Project Manager must consult with Estates Services Building Management System section at an early stage and throughout the project development. Standardisation of hardware software and installation is critical.

Control systems **must** be as manufactured and supplied by Trend Controls Limited. The control system shall be designed to suit the particular building services requirements and shall always incorporate sufficient features to operate the plant safely with the minimum of energy use. All parts of the control system, hardware and space, must allow for a minimum of 25% spare capacity.

Note: Digital input multiplexers must not be used.

Packaged plant controls shall utilise Trend controllers for their final control. Where Trend controllers cannot be fitted as standard, a full read/write interface shall be provided. The BMS should be used for sequence control of major plant.

Fire alarm interface should not drop out the plant during routine testing.

4.1 Control Panels

All controlled plant shall have a panel fascia mounted Hand/Off/Auto switch for maintenance / testing purposes. The position of each switch shall be monitored and a common VFC input shall connect to the Trend controller to alarm when any switch is put in the **hand** position.

Software override knobs shall be configured to allow maintenance personnel to test analogue controlled equipment, i.e. valve actuators, inverter drives etc. The override knobs should reset themselves back to auto after 30 minutes. (This is to prevent them inadvertently being left in manual override.)

Control panels shall generally be Form 2 with separate control and power sections where switching off the electrical supply to the panel does not unduly disrupt the building user. Form 4 type 6 should be used where it is necessary to maintain continuous operation of plant serving animal accommodation, computer suites, etc. All live conductive parts within the panel shall be shrouded. It should not be necessary for plant attendants to have to go into any control panels in order to make minor adjustments to time/s or set points.

All control wiring shall be adequately identified and protected where necessary. Wiring should be installed to BS7671.

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 BMS Fault Indicator Lamp will be provided. It will be connect to a controller output and will alarm when a software alarm is current. A fascia mounted fault reset button will connected to a digital input on the controller so that the software alarms can be reset.

Control panels must be fitted with LED lamps.

Control panels shall be complete with fascia mounted display panels, to enable local monitoring and operation of the plant. These should be installed at eye level and have the appropriate passwords and pin numbers active as per discussions with Estates Services.

4.2 Safety Interlocks

All safety interlocks shall be hard and soft wired. In the case of an AHU freeze protection circuit a BMS pulse output relay will required to allow the alarm to be reset remotely.

4.3 Connectivity

Where IP addressable outstations are used an Ethernet switch should be provided within the control panel. This switch should have a spare port for use by the BMS Service Engineer. A patch cable will need to be installed from this switch to connect to an external data point socket. If more than one network cable is wired to the control panel then a separate network enclosure should be provided which will be separately powered. Display panels are to be connected to the outstation RS232 port.

All remote connectivity should be via the dedicated BMS building network which connects back to the Building FRODO.

Where additions are made to the BMS the Estates BMS Engineer will advise the exact method and point of network connection.

4.4 Head End Supervisory PC

Head end site supervisory PC systems are to be installed on the larger sites only. Where these are installed a 3 user wet server version should be provided. Elsewhere building users should be provided with connectivity to web client into the 963 installed in the Malthouse. Temporary facilities for witnessing the operation of the BMS within the building may be required prior to handover.

The controls package shall include adding the graphics and user pages associated with the new control system on to Estates Services central Trend 963 supervisor. The format of the graphics and user pages added must be the same as those already on the system. **The appointed BMS contractor must visit the Malthouse to establish for himself the exact format of the graphics required by Estates Services.** A relevant extract from the description of operation shall be included on each graphic page within an info box and a jump button engineered for it.

Passwords and PIN numbers for any new addition to the Trend BMS network must be discussed and agreed with Estates Services.

4.5 Metering

Gas, water and heat metering shall be connected to the ION system NOT the BMS. Where metered information is required for control or monitoring then a duplicate connection must be made the BMS.

Electricity meters must **not** be monitored by the Trend BMS and they shall be monitored as per the requirements of the Metering section of this document. Refer to Section 6.

4.6 BMS Engineering

When engineering the system consideration should be given to keep communications traffic to a minimum. In general all common items of plant shall be controlled from a single outstation and not from two smaller ones.

Should a control sensor be in a remote location it should be hard wired back to the outstation which has the controlled device connected to it. In this instance it is not acceptable to use IC Comms.

To allow user operation data plots shall 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 setpoints
Demand bits
Hours Run Sensors

Alarms are to be configured/enabled but with the alarm transmission disabled. A list of the alarms will be issued to the Estates Services who will decide on the alarm classification.

Internal software alarms should be programmed for duplex plant to advise when both items of plant have failed.

Alarm Groups will 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 will be configured with each route having a software switch to disable alarm transmission. Once the project is fully complete the controls installer will verify that alarms are being received OK at the remote 963 supervisor.

All control software shall be fully tested and documented off site using set and simulation mode. Estates Services must be given the opportunity to witness this testing.

Retransmission of alarms via SMS is to be considered during the design phase.

4.7 Documentation

The control system including hardware, software and panels must be fully documented. At handover of the system the documentation must include but not be limited to:

1. LAN map,
2. Network schematic line diagrams
3. Panel wiring diagrams
4. SET files hard copy
5. SET file electronic copy
6. Component manuals

SECTION 5 – BUILDING INFORMATION AND OPERATING AND MAINTENANCE MANUALS

This is now a separate section in the suite of Philosophy documents.

SECTION 6 - METERING STRATEGY

6.0 Strategy Overview

The University has a large energy distribution system encompassing electricity (both HV&LV), natural gas, gasoil, water and heat energy. The management of these energy flows relies on high quality data supplied from numerous sources. This strategy is proposed to ensure that, as the University expands 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/installer believes that they may not achieve that standard then they shall contact the head of Mechanical & Electrical Maintenance at Estates Services for further guidance.

In all cases any new meters or changes to existing metering shall be notified to the Environmental Sustainability Team at:

Environmental Sustainability Team
Telephone: 01865 (2) 78780
Fax: 01865 (2) 88578
Email: sustainability@admin.ox.ac.uk

All meters need to be readable from the floor without the use of mirrors or access equipment. Where this is not possible, a permanent access platform shall be installed.

6.1 Electricity Meters and Instrumentation Systems

6.1.1 General

The University is supplied with electricity from the Scottish and Southern Electricity (SSE) local grid distribution system. This feeds directly in to Oxford University buildings or supplies the Oxford University's own High voltage (HV) and Low voltage (LV) distribution system.

All buildings that are fed from the SSE local grid or the Oxford University HV network are metered at point of supply. In addition there is a comprehensive sub metering network on many buildings. This sub metering network (ION) supplies and processes half hourly data on electrical consumption to Oxford University's Energy management system (TEAM). 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 is transferred to the TEAM system.

University sub-metering is also in place on LV distribution boards across the estate, the half hourly data from these is also available to the ION system and then to the TEAM system. In addition to normal electricity supplies the University also has a small quantity 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 that are explained in Section 6.4.

The following sections outline the requirements for Energy Metering and Monitoring of the Electrical systems with the University. They detail the metering/instrument requirements from the substation through to the final Sub distribution within a University building. The general principles as shown in the Standard University Metering and Instrumentation diagram E400978 Sheet 1. Refer to the Estates section of the website to obtain the latest revision of the drawings.

Metering requirements shall be read in conjunction with CIBSE Guide TM39 Building Energy Metering as required by Part L2 of the Building Regulations.

6.1.2 Current Transformer General Arrangements

Instrument Transformers (C/Ts) shall be to BS EN 61869-2:2012.

C/Ts shall be installed on outgoing circuits such that they can be replaced without disrupting other circuits.

All C/Ts shall be Class 1 with a minimum capacity of 2.5VA.

C/T Ratio shall be dependent on site. CT secondary shall be 5A.

C/Ts shall be fitted on all phases including the neutral.

All C/T secondary wiring shall be wired to separate terminal blocks (**Klippon** or equivalent) with shorting links such that connections and alterations can be carried out whilst switchboard is in use. See E400978 Sheet 2.

A label detailing the C/T type, size and ratio shall be fitted adjacent to this terminal block and fully accessible without the need to isolate the switchboard.

C/T configuration for metering shall take place from terminal block.

6.1.3 Voltmeter Monitoring General Arrangements

A fuse protected three phase and neutral reference voltage shall be provided for each section of the switchboard.

Fuses required for instrumentation and metering shall be not less than 10A rated and shall be sited such that they can be removed safely without the need to isolate any part of the switchboard. All fuses shall be labelled with size and circuit details.

All Voltage potential cables shall be 6mm LSF double insulated.

The voltage measuring arrangement along with instrument or meter requirements shall be as outlined elsewhere in this guide.

6.1.4 Meter and Sub Meter Types

It should be noted that the University currently operates an existing remote monitoring system using Schneider PowerLogic ION devices via the ION Enterprise power monitoring system and that all electronic meters and instruments shall be compatible with this system.

Table 1 below details the various meter types:

Metering	Location	Meter Type	Comments
1.1 Substation Transformers	Substation LV Panel	Schneider PowerLogic ION7550 or later complete with input\output module	Each transformer shall be metered. Each meter to be mounted in a separate enclosure adjacent to Substation LV panel. Meter to be networked onto Frodo system.
1.2 Substation LV Switchboard Submetering	Substation LV Panel	Schneider PowerLogic NSX Micrologic 5/6 Type E system using FDM121 Meters	Each device shall be equipped with communication function via the pre-wired connection system using modbus network interface. Using this system up to 15 meters can be connected to ION7500 series meter. Additional meters or RTU shall be provided as required.
1.3 Building Main	Building Main switchboard	Schneider PowerLogic ION7550 or later complete with input\output module 	The incoming supply to the building shall be metered. Where the supply comprises of 2 incomers, both supplies shall be summated onto single meter. Meter to be mounted in separate enclosure adjacent to main panel. Meter to be networked onto Frodo system
1.4 Building Main Switchboard Submetering	Main Switchboard	Schneider PowerLogic NSX Micrologic 5/6 Type E system using FDM121 Meters	Each device shall be equipped with communication function via the pre-wired connection system using modbus network interface. Using this system up to 15 meters can be connected to ION7500 series meter. Additional meters or RTU shall be provided as required.
1.5 Building Distribution Submetering	Riser boards, sub distribution boards, Panel boards etc	1. Schneider PM700 series meter; or 2. Rayleigh MRJ385 meter;or,	Each device shall be networked together using a screened twisted pair beldon type cable in the

		3. Schneider ION6200 (enhanced package 2) series meter **For existing buildings, submeter type will be dependent on existing system within building. Please check with Estates services Electrical Section.**  	form of a ring circuit. The networked ring circuit shall be terminated at the building main meter. Meter packages cannot be mixed Each active outgoing switchboard circuit rated 63A or above shall be metered (see adjacent). Each meter shall be mounted adjacent to a circuit switch in a compartment of the switchboard panel.

Additional 7550 RTU devices shall be provided where submeter systems exceed 15 meters.

A twin 13A RCD socket outlet shall be fitted adjacent to each meter. The socket shall be wired as a 16A radial circuit from the local distribution board. Each main meter will require a network connection (Frodo) adjacent to the meter, where meters are grouped in the same location only one Frodo connection is required. See section 6.1.6.

All meters (excluding Rayleigh) shall be provided by Schneider Electric Ltd as below:

Schneider Electric EMS UK Ltd,
Warren Court, Park Road,
Crowborough, East Sussex TN6 2QX

(Important Note: When ordering meters it is important that the order indicates that meters are for Oxford University.)

6.1.5 Earth Leakage Instrumentation

An earth leakage ammeter shall be fitted on all building switchboard outgoing circuits and sub-distribution panels. Instrument type shall be agreed with Estates Services.

6.1.6 Meter Networks

All main Meters shall be connected to the local LAN (Frodo) using a CAT 5e type cable as shown on attached drawing.

Where submetering is to be installed, up to 15 submeters can be connected to the main meter using the Modbus protocol with Beldon 9841 type cable (RS485 connector) type cable as shown refer to drawings. Where more than 15 submeters are to be installed additional ION7550 RTU devices shall be provided.

6.1.7 Metering - Substations

6.1.7.1 HV Metering

No metering/Instrumentation required.

6.1.7.2 LV Metering

For the purposes of this guide the substation LV switchboard is defined as being 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, mounted adjacent to all the incoming LV isolating devices shall be fitted, reading ph-ph and ph-n volts. A separate switch will select incoming volts or busbar volts. Potential fuses shall be placed such that connections can be made without the need to isolate any part of the switchboard.

A C/T shall be fitted on each incoming phase and neutral connection and wired to a terminal block as shown on drawing E400978 sheet 2. The location of the terminal block shall be such that access can be obtained without the need to isolate any part of the switchboard.

A main meter shall be installed on each transformer circuit.

The meters shall be configured to read all phases and neutral current.

The meters shall be correctly calibrated with all previous energy readings and maximum demand readings reset to zero. Thermal demand shall be set at 30 minutes.

6.1.7.3 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 shall be used.

All meters shall be networked together and connected using the Schneider Modbus protocol to one or both the Transformer meters above.

The network cable shall be terminated at:

a) Location which is accessible without the need to switch of power

b) Location that will allow an external cable connection

6.1.8 Department/Building Metering

6.1.8.1 Incoming Circuits

For the purposes of this guide the LV building switchboard is defined as being a switchboard which is supplied from either the local DNO or a University substation LV switchboard.

An analogue voltmeter and selector switch, mounted adjacent to each of the incoming LV isolating devices, reading ph-ph and ph-n volts shall be installed. A separate switch will select incoming volts or busbar volts. Potential fuses shall be placed such that connections can be made without the need to isolate any part of the switchboard.

The C/T's shall be wired as shown on drawing E400978 sheet 2. The location of the terminal block shall be such that access can be obtained without disruption to normal switchboard operation.

6.1.8.2 Outgoing Circuits

For all outgoing circuits that are to supply variable loads greater then 63A (50kW), a meter as outlined in table 1 section 1.5 shall be installed.

All meters shall be networked together and connected to the main meter using the Schneider Modbus protocol.

6.1.9 Riser/Tap Offs

The riser is defined as being 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 above shall be used.

The C/T's shall be wired as shown on drawing E400978 sheet 3 including earth leakage. The location of the terminal block shall be such that access can be obtained without disruption to supplies.

6.1.10 Sub Distribution Boards

For the purpose of this guide the Departmental sub-distribution board is a distribution board which 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 riser.

For all sub-distribution board circuits that are expected to supply a variable load greater then 63A (50KW) the meter detailed in Table 1 above shall be used.

A C/T shall be wired on each phase and neutral as shown on drawing E400978 sheet 3. The location of the terminal block shall be such that access can be obtained without disruption to normal switchboard operation.

All submeters are to be wired together using a Beldon RS485 type cable in the form of a ring back to main meter position located adjacent to the main switchboard.

6.1.11 kWh Metering

Each building/department switchboard shall have a single main meter (see Table 1 in this document) fitted in a separate enclosure adjacent to the switchboard.

Where switchboards comprise of two incoming circuits, C/Ts shall be summated onto single meter.

The C/T wiring shall be configured to read all phases, neutral and earth leakage current.

The meter shall be calibrated with all previous energy readings and maximum demands reset. Thermal demand shall be set at 30 minutes.

6.2 Standby Generators

The University has numerous standby generators installed at key locations to ensure a reliable electricity supply in the case of the HV distribution system failing. All standby generator installations shall have the following metering installed:

1. A suitable electrical meter (type to be confirmed by Estates Services electrical team) to dynamically measure and record the energy KWh output from the unit. This meter shall be connected to the Frodo system and linked to the ION automated metering system.

2. A flow-metering device that complies with BS 2869:2010 shall be fitted to the gasoil supply to record the gasoil usage of the unit. This device shall record dynamic flow and total consumption in litres and report via the Frodo network to the ION automated metering system.

6.3 Photovoltaic Panel Systems

The Feed-in-Tariff requires an OFGEM approved generation meter. In addition to this meter, a separate Estates Services meter shall be installed on the AC side of the invertor and connected back to Estates Services as described in section 6.1.

6.4 Combined Heat & Power (CHP) Plants

The university has numerous CHP plants installed across the estate to enhance the energy efficiency of individual buildings. All CHP installations shall have the following metering installed:

1. A suitable meter from table 1 shall be used to dynamically measure and record the energy KWh output from the unit. This meter shall be connected to the

Frodo system and linked to the ION automated metering system. Refer to Electrical section for advice on selection.

2. A suitable revenue standard gas meter (see section ref natural gas meters) shall be installed on the gas supply to the unit, this shall be in addition to any existing gas meter for the building or other installed plant. This meter shall be connected to the Frodo system and linked to the ION automated metering system.

3. A heat energy flow-meter (see section ref heat energy meters) shall be fitted to the flow and return pipe-work from the CHP to the final heat load. If the CHP is fitted with a separate heat energy 'dump' device, this shall be separately metered both on the flow and return. All heat energy meters shall comply with the following:

   The Renewable Heat Incentive Guidance, Volume 1, Chapter 7
   http://www.icax.co.uk/pdf/RHI_GuidanceConsultationV1.pdf

6.5 Natural Gas Service

The University has numerous gas meters, both revenue and sub-metering installed. Some of these meters are connected to individual building management systems. This arrangement is not consistent with a total energy metering strategy and gives limited scope for effective data management. To standardise the methodology of gas meter data collection the following standards are to be followed:

1. All gas meters installed on the University estate shall comply with the Gas (Meters) Regulations 1983, SI 684 and the Measuring Instruments (Gas Meters) Regulations (SI 2006/2647)
2. All gas meters installed shall be stamped in accordance with the gas Act 1986.
3. If the meter in question is a revenue meter owned by meter asset manager (MAM) or others, then an automated method shall be installed to ensure that half hour data is supplied to the Universities Sustainability Team (preferably via the ION system). All gas sub-meters shall be connected to the Universities automated metering system (ION) utilising the FRODO network.
4. The gas supply to areas such as kitchens and laboratories shall be separately metered from the heating boilers and hot water heaters.

6.6 Water

6.6.0 General

The buildings on the University functional estate and colleges are supplied either directly from a Thames water pipe fee or from a University water network that has been fed from a Thames Water pipe feed. Some buildings have data collection systems linked to the Building Management Systems (BMS). All water meter installations shall comply with the Water Supply (Water Quality) Regulations 2000,

The Measuring Instruments (Cold Water Meters) Regulations 2006 (S.I 2006 No.1268)

6.6.1 Controls and Metering

Controls shall be designed to minimise energy consumption and operational wear, to activate the back-up water supply automatically and with suitable connections to allow the system to be connected to the BMS. Consideration should be given to incorporating status monitoring which provides additional information such as; how full the tank is, any malfunctions, which supply is being used and so on.

Flow meters shall 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 shall be capable of being monitored remotely through connection to the ION system enabling the collection of consumption data dynamically. All water meters installed shall comply with BS EN 14154-3:2005+A2:2011 and OIML R49.

6.7 Heat Energy Metering

All heat meters shall have the following characteristics and be capable of meeting the following performance standards.

Heat meters shall 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
http://www.icax.co.uk/pdf/RHI_GuidanceConsultationV1.pdf

The following is an extract from the guidance note:

1. Shall consist of:

    - a flow sensor (or meter)
    - a matched pair of temperature sensors (such as two thermocouples) – the two temperature sensors shall 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 shall be provided with both Modbus and pulse output.

2. All heat meter installations must conform to EU MID Class 2 standard.
3. Digital integrators shall have an integral display which allows recorded parameters to be viewed locally.

Digital integrators shall also be provided with Modbus output for connection to the ION system.

Heat meters shall be capable of recording and transmitting the following data at a minimum regularity 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 commission heat meters. Heat meters must be calibrated in situ post installation. They must be checked prior to Practical completion and within a month after PC to ensure they are providing accurate data. Schematics showing how the meters inter-ralate must be provided.

Good quality Heat meter data must be in place before seasonal commissioning can take place.

SECTION 7 – HAND-OVER PROCEDURE

In order for Estates Services to 'take over' the mechanical and electrical installations within a building from a Contractor it is **essential** that certain requirements are in place.

The table below is an indication of typical items which require a signature to record that an action has taken place **before the project can be accepted by Estates Services Building Services Section.**

- The contents of the table are intended as a guide only and should be amended to suit the particular project. The final version should be agreed with Estates Services and should be included in the project tender specification in such a way that the Installation Contractors are left in no doubt that the project will not be considered practically complete until the listed items are completed and signed off by the appropriate person.

ITEM	DATE	SIGNATURE
		Consultants Signature
All tests, inspections and commissioning of the mechanical installations have been successfully carried out and the relevant certificates included in the O & M Manuals.		
All tests, inspections and commissioning of the electrical installations have been successfully carried out and the relevant certificates included in the O & M Manuals.		
		Estate Services Project Manager's Signature
The Project Health and Safety File has been approved and received from the CDM Co-ordinator.		
O & M Manuals have been approved and received.		
The Building Log Book has been approved and received		
The lift(s) has been inspected by the University's Insurers and passed safe for use and an inspection report is in Estates Services.		
A 'Written Scheme of Examination' has been received for each pressure system which falls within the Pressure Systems Safety Regulations 2000		
Labelling of the various engineering installations has been completed to Estates Services requirements.		
BMS system in line on the Malthouse BMS Head end		
Attached list of outstanding defects has been agreed.		
Completion of Electrical Test Database		
		Estate Services DLO Manager's Signature
Adequate training has been received by Estate Services and Department Maintenance staff in the use of all the relevant building engineering services		
Plant room keys have been received (provide list).		
Control panel and other equipment access keys have been received (provide list).		
Spares, tools, filters etc. have been received (provide list).		

SECTION 8 – CAD LAYER DETAILS, SPACE MANAGEMENT TEAM, DRAWING LAYERING CONVENTIONS

Estates Services has specific requirements about how drawings are set out and the layering conventions used. This applies to consultants and contractors. A detailed 'Information Requirement' policy document is currently being prepared. Until this document is published queries on the University's requirements on drawings should be discussed with the Information Manager on 278750.