University of St Andrews
Sustainable Design Guide

Aug 2011

This document is uncontrolled at the time of printing.
Introduction

The Estates Design Guide is intended to lay out design criteria for all those involved in building design, refurbishment and maintenance. It covers the following areas:

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1 HOW TO USE THIS DESIGN GUIDE

This document and appendices form part of the University of St Andrews building design requirements. It is issued with the design specifications for all building work. Architects, Quantity Surveyors, Structural Engineers, and Building Services Engineers should allow in their tenders for any additional work this entails, and incorporate the Guide into their designs.

Where appropriate, all new building and building renovation designs should include an Environmental Impact Assessment, which should include:

- Utility Assessment
- Waste Management Assessment
- Assessment of Parking and Travel aspects
- Resource Use and Sustainable Procurement aspects
- Biodiversity aspects

This Design Guide enables those involved in the project to consider environment and sustainability issues. Final designs will only be approved when it can be demonstrated that all aspects have been considered.

Building performance will be closely monitored during the warranty year to provide Energy Performance of Buildings Directive certificates, and to ensure that this matches the design performance.

Text in italics refers to items applicable for new build only.

This guide also contains information on maintenance techniques and safe working practices. Each section starts with an environmental analysis.

2 ARCHITECTURAL ASPECTS OF DESIGN

2.1 Design Concept

2.1.1 Strategy – aims and objectives

The University of St Andrews believes that social, economic and environmental factors are fundamental to holistic and sustained learning now and for future generations. Hence, we consider our buildings to be a public statement of our commitment to these principles of sustainable development. This strategy is also driven by the Sustainable Development Guidance Circular issued by the Scottish Funding Council on 10th March 2006¹.

To ensure all new builds and refurbishments have the least impact on the environment and the maximum benefit for society and economy we will:

1) Incorporate the following into all planning and design:

- BREEAM excellent standard as a minimum
- Minimum use of natural resources
  - Locally source where possible
  - Use natural materials rather than energy intensively manufactured
- Best practice energy efficiency
  - Design the building with passive energy savings

¹ CFC sustainable development guidance circular SFC17/06 on 10/3/2006 see www.sfc.ac.uk/library/06854fc203db2fbd00000109e4185300/
Design the building with minimum energy requirements
Best business options available
Best possible transport options
Best ecological options/opportunities
Best community options available

2) Ensure all consultants incorporate their professional/chartered codes of practice into our building design and demonstrate how this has been done. This will be especially relevant to engineers and architects involved with projects.

3) Aim to meet established benchmarks using all standards available. Schemes included are BREEAM, Green Guide to Specification, BRE Sustainability Check List, Forest Stewardship Council and other relevant standards/methods of assessment. All new-build projects will be required to achieve a BREEAM rating of ‘Excellent’ using the appropriate version of the BREEAM tool.2

4) Work with all stakeholders at the beginning of each project to establish what is needed rather than wanted. This will include all contractors brought in to deliver the project.

5) Aim to not lower the specification of environmental initiatives when there is a conflict of interest with price. Instead we will look at the total building and identify areas of trade off, for example, it may be possible to change a structural element of the design to keep a highly efficient energy reduction system.

6) Financial assessments of any project should consider the building’s Whole Life Costs, including its design, construction, running and eventual deconstruction, rather than focussing purely on initial design and construction costs.

7) Incorporate new technologies and concepts at the design stage.

The overall design objective shall be to produce a building and services which will provide high quality useable space within the Scottish Funding Council (SFC) cost allowances and which will rank alongside the best equivalent university buildings in terms of sustainability and energy efficiency.

2.2 Energy Conservation

All new buildings and buildings which are to be refurbished shall be designed to be energy efficient incorporating high performance fabric, construction methods and efficient building services to provide a healthy, comfortable environment for building users. Wherever possible, specified products should appear on the Energy Technology List. The University has joined the Carbon Trust’s SALIX Fund which means that energy saving design with a payback of not greater than 5 years can achieve additional funding. Designers are asked to make use of this fund in their design process to ensure that every opportunity to achieve savings is taken. More advice on this aspect can be obtained from Estates (tel. 01334 463995 or 01334 463976) and a list of fundable items with their ‘persistence factors’ (the higher the persistence factor, the better) is illustrated at Appendix 1.

The Design Team shall be required to evaluate the cost effectiveness of energy efficient technologies within their designs. All measures that provide a positive net present value (NPV) over their projected life shall be included (assuming Treasury discount rates), and where a choice must be made between alternative design solutions, the measure with the highest NPV shall be adopted.

http://www.breeam.org/  
http://www.eca.gov.uk
2.2.1 Evaluation of Energy Efficient Technologies

The following measures must be evaluated for all design projects: cogeneration of heat and power, the use of district heating or cooling schemes, heat pumps and renewable energy technologies including architecturally integrated devices converting sunlight directly into electrical or thermal energy. Designers shall also consider means of reducing energy consumption through high standards of insulation, by the use of natural ventilation and good daylighting generally preferred by building occupants, and through appropriate levels of automatic and user controls.

The Design Team shall also be required to consider the most efficient use of water and waste water services such as incorporating a scheme for recycling of rainwater from roofs, the use of sustainable urban drainage systems and the installation of water efficient appliances.

2.2.2 Energy Targets & Associated Emissions

All building designs are expected to perform to targets or benchmarks for fossil fuels and electricity that are appropriate to each space type on a university campus. Such figures are available from a range of sources including Action Energy⁴, HEFCE⁵, SFC⁶, EAUC or other UK organisations appropriate to Further and Higher Education Buildings. Emissions targets will also be set.

The Design Team shall be required to agree projected total energy consumption and costs with the University’s Environment & Energy Manager. The Design Team shall also be required to demonstrate after one year of operation of the building, allowing for weather conditions and anticipated use of the building, that their projected energy consumption figures have been achieved. If the observed energy consumption exceeds projections then the Design Team will be expected to identify reasons for such discrepancy, and identify any necessary remedial action.

2.2.3 Energy Performance of Buildings Directive

The information used to demonstrate energy performance compliance with Section 6 should be used to produce an Asset Rating for the building in accordance with the requirements of the Energy Performance of Buildings Directive. The Asset Rating should include the heating, HVAC, and lighting performance rating benchmarks to enable an energy certificate to be produced. After submission to Building Control, a copy of the SBEM or SAP model must be made available to the University.

The carbon dioxide emissions from the building should be calculated using the approved method as outlined in: www.ncm.bre.co.uk or equivalent software. The carbon performance standards should be determined using a whole-building calculation.

2.2.4 Metering

Metering is to be provided for gas, oil, heat and water supplies to each building in accordance with the current Building Regulations Section 6, CIBSE TM39, and GIL65. Submeters shall be installed to allow at least 90% of the

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⁴ Action Energy publication ECG054, see http://www.actionenergy.org.uk/ActionEnergy/products/product+detail.htm?cs_catalog=publications&cs_id=ecg054
⁵ HEFCE publication reference M 16/96, May 1996, see http://www.hefce.ac.uk/pubs/hefce/1996/m16_96.htm#appendixk
⁶ CFC sustainable development guidance circular SFC17/06 on 10/3/2006 see www.sfc.ac.uk/library/O6854fc203db2fbd000000109e4185300/
estimated annual heating energy consumption to be broken down into space heating, domestic hot water, catering and any other significant usage, and 90% of the estimated annual electrical consumption to be broken down into plant loads, lighting, and small power.

Heat meters are to be provided for each building on multi building heating systems.

Meters are to be located where they can be read easily.
Meters are to have pulse outputs and to be connected to suitable AMR data. Where not already available, a data network interface shall be provided to transmit data from the local LV network to a nominated PC at Estates.
The University currently uses Systemslink monitoring and targeting software, located on a central server, and any AMR system must provide meter data in a form that can be imported into this software. Receipt of correctly scaled data in the form of CSV files shall be demonstrated for each meter.

2.3 Orientation
The orientation and shape of new buildings should be decided including energy efficiency considerations.

Beneficial solar gains and daylights should be maximised, whilst the requirements for artificial lighting, ventilation and cooling should be minimised.

2.4 Integrated Passive Design
All redevelopments will be required to minimise energy consumption and maximise energy efficiency. This should be achieved through the sustainable design of buildings including; their location, grouping, orientation and layout, making use of passive solar heating and natural daylight and ventilation, and by using sustainable building materials and construction techniques.

The main elements of integrated passive design are:

- **Thermal Mass**: providing sufficiently exposed thermal mass to store heat from the sun in the winter and act as a heat sink for cooling in the summer. The benefits of thermal mass are often lost through excessive wall, ceiling and floor coverings.

- **Insulation**: specifying high levels of insulation to reduce unwanted heat loss or heat gains through the roof, walls, doors, windows and floors.

- **Natural Ventilation**: designing clear and robustly controlled air flows through buildings for daytime and night time cooling. Building air-tightness forms a critical component for achieving effective natural ventilation.

**Zoning**: providing thoughtful zoning to allow different thermal requirements to be compartmentalised. Substantial savings can be achieved.

2.5 Building Fabric

2.5.1 Building Fabric and Infiltration
Building fabric thermal performance shall be designed to obtain the optimal balance between heat losses, heat gains and the building's heating and cooling requirements.
The optimum glazed area of each face of a building shall be determined using the LT Method\(^7\), which estimates energy loads for heating, lighting, and cooling/ventilation for a range of building types.

Fabric detailing and on-site supervision should reflect the requirement for high thermal performance e.g. integrity of vapour barriers, detailing at junctions, etc.\(^8\)

Particular attention should be paid to interfaces between heated/unheated areas of the building. Unheated spaces within a building shall be regarded as external exposed spaces.

There is a particular need to take account of the rate of people flows entering and leaving buildings. Draught lobbies, automatic doors, revolving doors etc. shall be considered for all external doors to minimise heat losses. One of these measures shall always be adopted wherever entrances and lobbies are served by balanced mechanical ventilation systems.

Buildings shall be designed to meet air tightness levels of 5m\(^3\)/m\(^2\) of façade area, and pressure tested upon completion.


### 2.5.2 Insulation / thermal bridging

University buildings should be well insulated, not only from heat loss but also from heat gain. Insulation should be provided to achieve at least the \(U\)-values outlined in the University detailed design guide.

### 2.5.3 Air Permeability

The exfiltration of warm air can account for as much as 30% of the heat loss through a building's envelope. As insulation standards improve, heat losses and gains as a result of air exfiltration and infiltration will become more significant. Achieving good air tightness performance is also a good indicator of good construction practice.

Air leakage tests should be carried out on any new building with a floor area greater than 500 m\(^2\) in accordance with the guidance provided by CIBSE TM 23 to show that the air permeability of the building does not exceed 10 m\(^3\)/h/m\(^2\) at a differential pressure of 50Pa.

Designs should aim to achieve 5 m\(^3\)/h/m\(^2\) in line with best practice in the industry.

### 2.6 Materials

The University is keen for its service providers to consider and adopt the use of recycled materials in its specification for materials. This would include aggregate, concrete blockwork, plasterboard and so on. Locally sourced and/or reclaimed material should be used wherever possible.

In large scale developments, major building elements (i.e. upper floor slab, external walls, roof and windows) should achieve an overall 'A' rating as detailed in the Green Guide to Specification 'A' (BRE 1998).

Timber, including structural timber, cladding, carpentry, external joinery and panel products should be FSC (Forestry Stewardship Council) certified unless there are other overriding considerations for using alternative sources of timber.

Insulants should not contain, or require during manufacture, ozone-depleting substances.

In new build, paints and other wall coverings should be low or free of volatile organic compounds (VOCs), and in refurbishments where applicable.

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\(^8\) Robust construction details for dwellings and similar buildings. ISBN 011 7536121

The Stationary Office - Orders Tel:0870 600 5522 Fax:0870 600 5533
Floor coverings should use recycled products and should make use of natural products e.g. Marmoleum instead of PVC-based products.
Substances containing CFCs (chlorofluorocarbons) and HCFCs (hydrofluorocarbons) should be avoided. Fire suppression systems should not contain halons or penta/octa/deca-BDE (bromodiphenyl ether) flame-retardants.


3 SERVICES

3.1 Electricity
Any modifications to the existing electrical distribution infrastructure shall include necessary power factor correction equipment such that the site power factor shall be at least 0.98. Local power factor correction should also be considered wherever the distribution systems are approaching their capacity.

Where practicable, high efficiency electric motors shall be used on fans and pumps.

Where electrical appliances are to be selected, items with the lowest operating power consumption shall be selected through reference to categories of equipment that are published by the Market Transformation Programme. Where such appliances (e.g. IT equipment) have the facility to automatically revert to low energy mode, such facilities shall be enabled.

3.1.1 Incoming Supplies
Meter each building electrical intake, with a Socomec Diris multi function digital meter, or equivalent, and connected to an approved AMR system, enabling remote monitoring in Estates.

Submetering in accordance with GIL65 and the current Building Regulations shall be installed eg to allow at least 90% of the estimated annual electricity consumption to be broken down into lighting, fans, pumps, office equipment, cooling, large IT installations, catering etc. Submeters shall also be installed for each commercial outlet. Submeters shall be Socomec Diris and connected to an AMR system, enabling remote monitoring in Estates.

All electrical metering shall be installed so that all CT and pulse output connections remain accessible without the need to isolate power supplies. Generally, this will require that meters shall be installed in a dedicated accessible LV compartment or connections to the necessary terminals shall be made available via a suitable LV compartment.

All Socomec equipment shall be installed and connected in accordance with the manufacturer’s requirements.

Specify a free standing or wall mounted automatic Power Factor Correction unit with a capacity calculated to correct the PF to 0.92 lagging.

Specify surge protection at the building intake.

3.1.2 LV Switchgear
Specify main switchboards as extensible Form 4 Type 3 to BE EN 60439 with HRC fuses.

Operating handles to be no higher than 1800 mm and no lower than 600 mm.

Busbars shall be top mounted in switchboards.

9 see http://www.mtprog.com/
Minimum size of switchboard room is to be 2 metres by 3 metres. Switchboards shall be located with sufficient space for exit past them when the cubicle doors are open.

Specify switch-rooms with normal and emergency lighting. Emergency lighting to be initiated by key-switch, install warning notice. Install a minimum of two twin socket outlets at 1 metre mounting height at opposite sides of the room.

Provide a main earth bar mounted on insulators and with disconnection links for testing in the switch-room.

Install generator inlet on main switchboard with manual changeover switch and interlock system

Metering for all main electrical switchboard panels:
The main incomer should have Socomec Diris A40 meter with Ethernet / Modbus gateway module.
All outgoing ways should have Socomec Diris A20 meters with Modbus module.
All A20 meters to be daisy chain connected to the A40 meter with RS485 cabling.
The A40 meter to have cabling out of the panel to a local TCP/IP point.
All meters to be ID configured for remote interrogation through IP network.

If equivalent meters are used, all meters to have pulse output. Screened twisted pair pulse cables should be connected to every meter, and to a terminal block in an external marshalling box, for connection to an AMR system. A local TCP/IP point to be provided.

### 3.1.3 Lighting

The objective of the lighting design shall be to obtain the required illuminance and visual effect in the most energy efficient way consistent with minimum life cycle cost. The designer shall provide a life cycle cost calculation for all options covering capital cost, operating cost, maintenance cost and disposal cost.

Fluorescent lighting is the preferred choice for internal use. All fluorescent lighting shall be high frequency and shall use triphosphor tubes. All light fittings shall have a minimum DLOR of 60%. Preference shall be given to single tube fittings and specular back reflectors shall be incorporated where possible.

**GLS and halogen lamps may not be used. The University has adopted a zero halogen policy.** Alternatives such as LEDs and CFLs shall be considered where special effect lighting is required. Use of metal halide lighting shall be subject to the written agreement of the Electrical Services Engineer due to the high cost of lamps and the difficulty of applying lighting controls.

Minimum lighting efficacies shall be as Section 6, or 2.5W/m² of installed lighting power per 100 lux of maintained illuminance. High efficiency fluorescent luminaries shall principally provide lighting. Tungsten lighting shall not be used except in exceptional circumstances. Sodium discharge and/or metal halide lamps shall be considered for service and similar areas such as car parking.

Lighting design levels shall be stated for all areas, and shall generally be as recommended by the Lighting Industry Federation or CIBSE. Where possible, the use of daylight via “light tubes” should be considered.

The following minimum maintained illuminance together with the maximum electrical power consumption shall be achieved.

- Corridors 100 Lux and 8 W/m²
- Offices 300 Lux and 12 W/m²
- Classrooms and lecture theatres 400 Lux and 12 W/m²
- Laboratories 500 Lux and 12 W/m²
Lighting electrical circuits in all areas shall be arranged to facilitate the use of daylight, occupancy and/or time controls. In areas suitable for daylighting, light fittings shall be wired in banks parallel to the adjacent windows. Fittings adjacent to the windows shall be high frequency dimmable and shall be controlled by a programmable lux sensor with inhibition of lighting above a certain daylight level. All controls shall have a key switch in parallel to enable the lighting to be held on continuously.

Use presence sensors in corridors and rarely used spaces such as stores, archives and WC’s.

Sufficient local switching shall be provided to enable good housekeeping control by staff and students. Where multi switch panels are used, an encapsulated floor area diagram shall be fixed adjacent to the switch panels showing the areas controlled by each switch. Provision shall be made for switching on a limited number of fittings to provide a low level of lighting in walk through routes required for security staff.

Exterior lighting columns shall contain cut-outs with circuit protection, cut-outs shall be XX with double pole circuit breakers. Columns shall be painted with a coloured dot to indicate the phase to which they are connected.

Amenity lighting is standardised with SON lamps normally on 5 metre columns.

The importance to occupants of a perceived degree of control over the internal environment should not be underestimated. Manual light switches shall be provided in adequate numbers and in user accessible locations in each room. Controls shall be designed to encourage the maximum use of natural daylight and to minimise the use of artificial lighting in unoccupied rooms/spaces. Separate circuits shall enable group switching of lights e.g. next to windows. Pull cords (or equivalent) with time delay shall be considered for areas such as stores and library book stack areas.

Time controls for teaching/seminar/office areas shall be used to switch lights (by stages) at lunchtime and at the end of the day. The building user shall be able to manually switch on lights at all times.

Consideration should be given to the use of occupancy sensors in:

- Lecture theatres
- Areas such as Seminar Rooms which would benefit from sectional occupancy control. Lighting circuits shall be designed to permit sectional control of lighting in these large areas.
- Corridors and stairwells.
- Areas which are infrequently used.

In buildings sometimes occupied out of normal hours, separate ‘night’ lighting circuits should be provided to light circulation areas at low illumination levels.

Daylight detection controls shall be considered for lighting adjacent to windows. Time controls and/or daylight detection controls shall be used for external lighting.

### 3.2 Mechanical

#### 3.2.1 Heating and water services

Heating and hot water systems shall be designed to be energy efficient. Components shall be appropriately sized, being capable of operating efficiently across a range of outputs, whilst incorporating suitable standby capacity. They shall be installed with appropriate means for managing, controlling and operating equipment/systems.

Consideration (i.e. technical and financial evaluation) shall be given to the use of:
• Gas fired condensing and/or high efficiency boilers. (Electric heating only to be considered where no alternative exists, and under such circumstances the cost-effectiveness of heat pumps will be evaluated). Where condensing boilers are specified, a suitable control strategy shall be adopted (i.e. boiler return temperatures of ~50°C or less) to maximise the time that the boiler operates in condensing mode.

• Provision of biomass boilers as an alternative.

• The use of thermostatic radiator valves (TRVs) in areas of heat gain. Wherever TRVs are installed, their operating range shall be restricted within appropriate limits (maximum setting 24°C).

• Active and/or passive use of solar energy for heating, lighting and domestic water pre-heat.

• Heat/ice storage where this may be beneficial for load management, or where this provides an opportunity to reduce the capacity (and hence capital costs) of heating or cooling equipment.

• Variable speed drive control on all circulating pumps and fans, and an appropriate method of automatic control.

• Energy efficient methods of hot water generation for domestic hot water production, include direct fired water heaters where centralised production and storage is required, and point-of-use water heating where appropriate.

3.3 Water – Plumbing

3.3.1 Water saving measures

Water may be seen to be a recyclable resource, but the collection, purification and pumping all contribute to its increasing cost. The following technologies should be considered:

• Taps: should be self-closing and spray-headed. Timed-flow (e.g. percussion) taps and flow regulators should be used on all wash hand basin taps toilets with an operating period of 5 - 7 seconds and a maximum flow rate of 2 l/min, excepting cold water services require for scientific purposes.

• Wash hand basin taps in individual accommodation to have a maximum flow rate of 2 l/min.

• Toilets: should be low flush toilets.

• Urinals: install automatic flush controls provided by ECS England Ltd. www.ecsengland.com, T: 01670 731497. Water Controller; Part no. WC 1, Urinal Fittings ; Part No UF 1, specify pipe size, Eco Sleeve; Part ES 1

• Hot water: all hot water piping should be adequately insulated.

• Instantaneous electric showers are preferred. Where cylinder fed showers are used, shower flow rates to be limited to 6l/min using in-line flow restrictors which cannot be overridden to higher flow rates

• Cleaning: all dish washers, washing machines, and driers should be “A”, “AA” or “AAA” rated as appropriate.

• Grey water and rainwater harvesting: can rainwater be used in the buildings grey water system in the flushing of urinals and toilets, or collection for gardening / landscaping use?
3.3.2 Water Disposal

All laboratory wastewater systems should be segregated from domestic wastewater systems to permit the sampling of effluent by the Regulatory Agencies to assess Trade Effluent Consent conditions to comply with the requirements of the Sewerage Scotland Act 1968 (as amended). Sampling facilities should be provided at the exit point of laboratory waste water systems to permit the taking of samples of effluent by the regulatory authorities. External drainage systems should be based on SUDS (Sustainable Urban Drainage Systems) requirements to help manage run-off that might otherwise cause flooding and also help to preserve water resources.

3.3.3 Heating Ventilation and Air Conditioning

Every attempt should be made to reduce or eliminate the need for mechanical ventilation and air conditioning by the provision of natural ventilation. Plan forms should be shallow to facilitate use of cross ventilation and natural light (not more than 15m from window to window opening). Use of stack/buoyancy should be considered wherever appropriate.

Free cooling shall be used wherever effective. The use of the building’s thermal mass combined with a night ventilation strategy shall be evaluated. Where the performance of a building is modelled, this shall be using methodologies based upon CIBSE guidance.

Where mechanical ventilation is required in general areas (i.e. other than laboratories), one of the following targets shall be observed: the total specific fan power (i.e. the design power of all fans in the distribution system divided by the design ventilation for the building) shall not be greater that 1.35 W/s, or the target fan power requirement shall be less than 1W for each litre/s of air flow.

Lecture theatres shall be designed with upward displacement ventilation where practical.

Sources of heat production such as clusters of computers, laboratory, kitchen equipment, etc. which contribute significantly to incidental heat gains should be located either where this heat can be of benefit by contributing to heating requirements (e.g. in rooms with northerly aspects) or alternatively, where mechanical conditioning would be a requirement in any case (e.g. in the central core of a deep plan building).

In areas such as lecture theatres and seminar rooms, ventilation shall match demand through the use of occupancy sensing controls and/or air quality controls. This may necessitate the use of variable speed drives or recirculation dampers, allowing the volume of fresh air to be automatically adjusted dependant on the air quality/CO₂ content of extracted air. For laboratories that are fitted with multiple fume cupboards, extract rates shall be dependent on fume cupboard use, and the supply ventilation will be variable speed, automatically controlled to match extract rates.

3.3.4 Heating – Boiler plant

Primary heating water from a gas fired condensing lead boiler with low temperature condensing circuit with a return temperature always below 40C, typically used for DHW or AHU preheat. Andrews Model R300 boilers or equivalent shall be used. Circuit design shall allow for boiler flow temperature to be weather compensated. Steam, MPHWH and HTHW are not to be used.

Hot water (HWS) to be provided by dedicated condensing gas fired hot water boilers. Typically, Andrews Maxxflow units shall be used. The gas supply to the HWS boilers is to be fitted with a gas meter. Consideration shall be given to providing Point of Use electrical water heaters or local non-circulated under sink heaters for all washbasin hot water supplies. Life cycle cost comparison covering capital cost, operating cost, maintenance cost and disposal cost shall be used to compare electrical heating with gas fired heating.

All circulating pumps shall be high efficiency with variable speed drive and EFF1 rated motors. All VT circuits to have two port valves not three port valves - circuit pressure to be controlled by feed back to the variable speed drive.
All heating and HWS flow and return pipework to be insulated. All valves, flanges, strainers, unions, etc to be fitted with removable flexible insulation jackets. Binder points to be fitted in primary flow and return pipework. All hydraulic system bends to be long radius.

The operation of heating in large areas such as lecture theatres and seminar rooms shall be determined by occupancy sensors with some form of setback (typically a reduction of 2-3°C in space temperature setpoints) during times of non-occupancy.

Boiler/chiller sequence control shall be used to match the number of boilers/chillers required to the heating/cooling demand. Controls systems shall automatically ensure that boilers/chillers are not operational when there is no demand for heat/chilled water.

Insulation to all pipes and storage vessels shall comply with BS5422

Control of heating circuits utilising weather and solar compensation, optimised start/stop and separate/sectional heating zones by orientation and/or by user/department. In general, heating zones shall be no larger than 350m², although this will depend on plan layouts.

### 3.3.5 Ventilation

Fans in ‘extract only’ areas are to be normally provided with timelock control and/or to be linked to lighting controls e.g. in toilet areas.

All plant electric motors to be EFF1 efficiency rated. Where possible, motors to be located external to air handling unit air flow.

Ventilation systems to be low velocity. Maximum Specific Fan Power to be less than 1.5 watts/litre/sec. Fans to be BC with aerofoil section blades and to operate at the most efficient point on the fan curve.

Cooling and dehumidification will only be provided for computer suites or equipment rooms where an equipment specification requires temperature controlled conditions. Free cooling to be used as far as possible. As these areas should have no humidity gains, consideration should be given to dehumidifying the make-up air only.

Humidification equipment to be specified so that it can be shut down and restarted automatically by the BMS control system. Large systems should use gas fired steam boilers. For small systems, ultrasonic humidifiers are preferred.

### 3.3.6 Air Conditioning

The University wishes to avoid the use of mechanical cooling as far as possible and all other options ranging through building design, avoidance of additional heat loads, local extract ventilation etc shall be explored before chillers may be included. Where use of chillers cannot be avoided the most energy efficient chillers for the application shall be chosen, typically large chillers to be variable speed screw type and smaller units to have variable speed scroll compressors.

Air conditioning systems shall incorporate a heat recovery system to ensure the optimum energy efficiency at all times. The preferred means for heat recovery are direct (i.e. plate heat exchangers).

Consideration shall be given to the centralised production of chilled water as an alternative to individual stand-alone fridge/freezer/chiller plants where air conditioning or cooling is required. The choice between compression refrigeration and absorption refrigeration shall be based on energy and costs considerations, and the availability of primary energy sources (e.g. waste heat for absorption cooling).

Variable refrigerant flow is the preferred method of operation.
Vapour compression chillers shall be variable speed in operation, and shall incorporate automatic controls that ensure maximum efficiency at all stages of operation. This control shall be compatible with the BEMS system, and an interface shall be provided allowing the BEMS to monitor and control the operation of the compressor. Hot gas bypass and cylinder unloading shall not be used.

Chillers to be specified with electronic expansion valves, and zero ODP refrigerant. Non chlorinated refrigerants such as ammonia are preferred. The temperature difference between evaporator and condenser is to be minimised as far as possible. Consideration shall be given to liquid pressure amplification.

Chilled water flow temperature shall be compensated relative to ambient conditions or the demand for cooling where this is (or can be) monitored.

All domestic refrigerators and freezers should be “A+” or “A++” rated. Research refrigerators and freezers should be at least “A rated” or to the highest available standard in their category. Existing equipment should be fitted with Savawatt refrigeration controls (www.savawatt.co.uk) to bring the overall efficiency to equivalent of “A+” rating where appropriate.

3.3.7 HVAC controls
All controls for building services shall be compatible with the existing building energy management systems (Siemens or Andover). Such controls shall provide monitoring and control of the building environment and its services.

Controls systems shall be designed and installed so that they continue to function in the event of a failure of local LANS, or supervisory systems.

Wet circuits shall be controlled by the BEMS such that circulation temperatures for heating circuits shall be the minimum required to satisfy demand on all circuits. Similarly, circulation temperatures shall be maximised for cooling circuits. Control strategies will ensure that boilers or chillers shall not operate when there is no demand for heating or cooling respectively.

New control equipment shall be installed and commissioned such that time control of plant shall be achievable via current University BEMS software facilities.

For areas with cooling and heating facilities, the control strategies shall be designed such that there is no controls conflict. This shall be achieved by ensuring that the dead-band between cooling and heating is sufficiently wide, and supported by deadlocks where appropriate.

Software routines will be adopted that enable users to over-ride the automatic operation of plant through the use of software switches that automatically re-set after a pre-determined time – e.g. to allow heating pumps to be operated for a period of one hour.

The BEMS shall undertake monitoring and fault reporting of plant. Software shall be designed to ensure that repeated alarms are suitably filtered.

4 OTHER ASPECTS OF DESIGN

4.1 Alternative Energy Provision
All new buildings and renovations will use energy in their operation, so consideration should be given to the generation of energy on a local scale. Calculation methods for alternative energy provision should use the Low or Zero Carbon Energy Sources: Strategic Guide issued May 2006 by ODPM.10

10 Low or Zero Carbon Energy Sources: Strategic Guide issued by ODPM, May 2006
4.1.1 Solar Gain

Consideration should be made of the utilisation of natural light and heat to reduce the building energy usage. Well designed UK buildings that take advantage of solar gain can often achieve energy savings of 8% - 10%. The main factors that should be assessed in building design are: orientation, shading, window design, thermal mass, ventilation, and air tightness.

4.1.2 Solar Heating

Many companies offer systems which use sunlight to heat the hot water used within a building. There is also the opportunity to receive up to 40% Low Carbon Buildings (www.lowcarbonbuildings.org.uk) funding for the purchase and installation of these systems. A properly installed system may contribute yearly savings of around 50% of water heating costs. An initial study should be undertaken to ascertain the usage of domestic hot water within each new / refurbished building.

4.1.3 Photo Voltaics (PV)

Even in the UK there is increasing scope for the use of PV in domestic and commercial buildings (10m² of installation will save around ½ tonne CO₂ per year), and installation of such systems may also improve the likelihood of gaining planning permission. Although retrofitted solar panels have significant payback times, offsetting the cost against the standard cladding / tiling that will be used can dramatically reduce the payback times. Grants of up to 50% can also be obtained from the Energy Saving Trust (www.est.org.uk/solar/), and 50% from Low Carbon Buildings Phase 2 (www.lowcarbonbuildings.org.uk).

4.1.4 Other systems

Ground Source Heat Pumps use the earth's relatively constant temperature to provide heating, cooling, and hot water for homes and commercial buildings (www.heatpumps.co.uk/groundsource.htm). There is also the opportunity to receive up to 40% Low Carbon Buildings (www.lowcarbonbuildings.org.uk) funding for the purchase and installation of these systems.

Combined Heat and Power (CHP) systems can be tailored to specific design requirements, such systems may use a biomass generator for space heating and any excess heat is used to generate energy.

Small scale wind turbines can easily be fitted to new buildings and retrofitted to existing ones. Examples of such technologies are demonstrated at: www.renewabledevices.com or www.windsave.com

4.2 Environmental Assessments

Where appropriate, all new building and building renovation designs should include an Environmental Impact Assessment, which should include:

- Utility Assessment
- Materials Specification
- Waste Management Plan for construction and operation
- Assessment of Parking and Travel aspects
- Resource Use and Sustainable Procurement aspects
- Biodiversity aspects (where appropriate)
- Other aspects such as drainage (where appropriate)

www.odpm.gov.uk/index.asp?id=1165126
4.3 Waste

4.3.1 Waste Hierarchy
The University is keen to reduce waste arisings that are sent to landfill. This means minimising waste where possible e.g. reduced packaging; take-back schemes or reuse of materials. Failing this, effort should be made to recycle waste arisings where safe to do so.

4.3.2 Construction Waste Management Plan
Contractors should develop a construction waste management plan. Key waste streams should be identified at the start of the project and measures implemented to reduce these wastes. Good storage facilities for raw materials to minimise damage should be provided during construction works. During construction, every effort should be made to capture recyclable materials including wood, inert brick, rubble, soil, tarmac planings with a view to reusing and recycling these. Clear and accessible space for waste segregation should be provided and on large projects, targets should be set with the aim of minimising waste production on each project. Certain other waste streams including WEEE (Waste Electrical and Electronic Equipment) or Special Waste require special treatment and segregation and allowances should be made for this in Contractors’ ‘Prelims’.

Waste streams arising during construction should be measured and compared with established benchmarks (e.g. the BRE SMARTWaste web-based tool at www.smartwaste.co.uk). WRAP contains useful information on how to manage waste - http://www.wrap.org.uk/construction/

4.3.3 Operational Waste – Post Construction
Adequate and accessible facilities should be provided for the storage and collection of segregated recyclable wastes (including paper, cardboard, glass, plastic bottles and cans) and general controlled waste. For scientific and technical sites, additional consideration must be given to the provision of adequate facilities for the storage and collection of hazardous wastes (e.g. chemical, clinical, radioactive, waste oils).

4.4 Travel
The design process should look at how the building occupants will travel to and from the building, and aim to minimise the energy use of this transport, where possible. Aspects to be assessed include determining of there is a need for parking, safe footway and cycle access, and easy access to public transport. Sufficient secure covered ‘Sheffield’ cycle racks should be provided close to the building. Showers and changing rooms should be provided for buildings with a projected population of 50 or more employees. Drying rooms with lockers for hanging wet clothes and for keeping a change of clothes should be provided in all new buildings.

4.5 Biodiversity
Developments of greater than 1,000 m² floor space will require the completion of a biodiversity checklist where appropriate under the terms of the Nature Conservation (Scotland) Act 2004, providing details of how the development will seek to protect existing habitats and species, and an outline of mitigation, enhancement or compensation strategies.
Appendix 1 – SALIX FUND SCHEME FUNDABLE ITEMS AND PERSISTENCE FACTORS (PF)

Note that the persistence factors indicate how long the measure will continue to save energy.

<table>
<thead>
<tr>
<th>Project Type</th>
<th>Work Type</th>
<th>Current PF</th>
</tr>
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<tbody>
<tr>
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<td>Boilers - replacement condensing</td>
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<td>Biomass CHP</td>
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<td>Gas Turbine</td>
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<td>Electric to Gas - heating using CHP</td>
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<td>Electric to Gas - heating using condensing boilers</td>
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<td>Heating - TRVs</td>
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<td>Hot Water - point of use heaters</td>
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<td>Automatic speed doors</td>
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<td>Flood lighting to LED including changing the fitting</td>
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<td>Compact Fluorescent to LED using same fitting</td>
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<td>Incandescent to LED including new fitting</td>
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<td>Incandescent to LED using same fitting</td>
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<td>T12/T8 to LED including new fitting</td>
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<td>T12/T8 to LED using same fitting</td>
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<td>Low loss + voltage reduction (cost difference)</td>
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