MS01 Heating Installations

UNIVERSITY OF LEICESTER

Document Control

Rev	Date	By	Comments
A	Jun'16	J. Hoare	Technical Review Update
B	Oct'17	J. Hoare	Technical Review Update
C	Dec 17	UoL	Sign off for release
D	July' 19	J. Hoare	Technical Review Update
E	Mar'20	J. Hoare	March 2020 Issue
F	April 20	A. Singleton	General update to tracker and other minors.
G	June 20	A Singleton	Update with CPA and KRM
H	Feb 2023	A Singleton	ASHP and GSHP System Temperature Information Update

Design Guidance

1. This document shall be read in conjunction with the University Guidance Document "GD" series of guides which give greater information regarding the philosophies of passive design and the need to try to minimise the services plant footprint.
2. The University has declared a Climate Emergency and needs to reduce its carbon footprint. Buildings should be designed with a view to greatly reducing the capacity of heating plant and emitters.
3. Reference should be made to the detailed University's mechanical technical specification. Where there are discrepancies between this document and the University standards clarification shall be obtained from the University before proceeding.
4. Low Temperature Hot Water (LTHW) systems shall be implemented as a standard for fabric heating unless otherwise discussed and agreed with the University development and maintenance departments.
    a. On all new build developments systems shall employ low/zero carbon technology usually involving heat pumps of some type. These shall use low temperature water to maximise the system COP.
    b. On all refurbishment developments systems shall employ low/zero carbon technology usually involving heat pumps of some type. These shall use low temperature water to maximise COP unless this makes emitters too large in which case, and by exception, higher temperature water may be used.
    c. The heat pump systems shall employ low temperature water to make use of sustainable technologies to reduce carbon as noted above.
    d. Wherever low temperature water is used then the pipe heat losses must be taken into account such that the emitters are sized for entering water temperatures and not the heat pump leaving temperatures. A loss of even a couple of degrees on the network will greatly impact on emitter outputs.
    e. In general terms the quality standards and requirements for heat pumps shall follow those for water chillers as detailed in the chilled water design guide.
5. Systems shall be installed using traditional steel pipework and fittings as per the University standard specification. Pipework shall be screwed up to 50mm and welded for 65mm and above. Pipework shall be painted prior to insulation as detailed later.
    a. Copper, thin wall steel, stainless steel or plastic pipework systems must not be used.
    b. Pressfit, pushfit, clamped or compression fittings and systems must not be used.
6. Life cycle cost appraisals must be undertaken in respect of the preferred heating system selection, temperatures, emitter size, heat generation plant etc, to allow decisions to be taken as to the best overall choice in life cycle terms. This is to include energy, carbon, capital and maintenance costs. Refer to GD series for further Guidance.
7. Building fabric heating systems should always be zoned to reflect building fabric performance (lightweight and

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heavyweight), orientation, occupancy, usage patterns and likely internal heat gain profiles; all as generally required by the Building Regulations and good design practice. Zoning principles should be agreed at an early stage with the University.

a. Where the occupancy is to a differing profile but all other factors are the same then zone valves may be employed.
b. Where heat gains, solar thermal, fabric or orientation differ then separate circuits shall be used each with their own compensation routines.
c. Depending on the size of the building multiple compensated circuits may need to be considered and these shall be zoned based on the orientation of each façade, as opposed to using one large compensated circuit for the entire building.
d. Some judgement must be made on the above in terms of cost benefit. Clearly a separate pumped zone will not be warranted for a very small area. A life cycle cost analysis will be required to ensure that the zone proposals make good economic sense. See item 2 above.

8. Zoned weather compensated variable temperature fabric heating circuits shall generally be used to improve room comfort and energy and carbon efficiency. Local room control shall be by thermostatic valves on the emitters.
    a. Where possible direct weather compensation at the heat generating plant should be employed.
9. Variable speed pumps should be installed wherever possible and emitters should use two port control technology to all emitters to reduce water flow rates and thus save energy. Variable flow design principles should be adopted in line with CIBSE Knowledge series technical guidance notes and good industry practice.
10. The heating distribution networks should be designed based upon low pressure drop good practice. Spine circuitry should not exceed 200Pa/m at full load conditions and sub circuits down stream of differential pressure and flow control valves (DPV) to be typically 100 to 200 Pa/m to suit the DPV maximum differential pressure setting of 30 to 40 kPa.
11. Any pressure independent control valves (PICVs) shall not be operating within the upper 25% of their preferred maximum differential pressure.
12. System pipework sizing shall also be based on limiting water velocities in line with the requirements of CIBSE, whilst also considering the type of water:
13. Steel Non-Corrosive Water Velocity Limits: <Ø50mm = 1.5m/s; >Ø50mm = 3.0m/s
14. Steel Corrosive Water Velocity Limits: <Ø50mm = 1.0m/s; >Ø50mm = 1.5m/s
15. Copper Pipework Velocity Limits (where permitted by exception) <Ø50mm = 1.0m/s; >Ø50mm = 1.5m/s
16. System pipework sizing should be proportioned to account for the heat losses of the network.
17. As noted earlier the University has declared a climate emergency and therefore all heating systems should be designed to generate low flow and return temperatures to allow carbon saving technologies to be employed.
    a. As detailed earlier then the University preference on schemes is for heat pumps of some description.
    b. By exception and if used then any boiler plant installed must be designed for easy future conversion to a renewable source at a later date eg conversion to heat pump technology.
    c. See the other GD series of design guides for greater detail.
    d. In all new builds and buildings with a reasonable fabric standards then standalone systems shall be designed to generate primary water at a maximum flow temperature of 50 or 55c. Emitters should be sized at temperatures below this to allow for pipework heat loss.
    e. In new builds and buildings with a reasonable fabric then systems connected to the district heat network shall be designed to generate secondary water at a maximum flow temperature of 50c. This will allow simple conversion to standalone buildings when the district heating contract expires.
    f. In buildings with a poor fabric then a life cycle analysis needs to be undertaken to establish the way forward as low temperatures may mean overly large emitters of fan assisted emitters. This analysis is to also consider fabric improvement.
    g. Existing heating systems or refurbishment projects should be reviewed independently based on the level of Building systems and Building envelope thermal fabric upgrades applied. Detailed design

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proposals should be agreed with the University development and maintenance departments prior to design i.e. flow and return design temperatures.

18. Where systems are connected to the district heating scheme then the primary district to secondary building heat exchangers must always provide a return temperature to the network of below 65c.
    a. The heat exchangers must be unpackaged, that is to say a bare heat exchanger is required with all controls being provided separately by the BMS controls specialist.
    b. Separate controls valves will be required for each plate being a fully modulating temperature control valve and a high limit valve.
    c. Where plates are used, and because N+1 is always required by the University and therefore two plates are required, hydraulic considerations will necessitate water control valves on the primary network side such that only N primary water is pumped from the Engie network.
19. The above will of course mean that the domestic hot water needs can no longer be provided by the building heating systems. Therefore domestic hot water needs will need to be provided by standalone means. See MS04 for further details.
20. The total heat generating plant output should be calculated by assessing the maximum simultaneous heat demand of all heating emitters and ventilation loads (including frost coil loads assuming the largest heat recovery device has failed) served plus system heat losses and appropriate CIBSE recommended design and construction margins.
    a. All the heating plant, equipment and distribution should be insulated to better than Building Regulation standards to avoid unnecessary heat loss and improve thermal performance of the system and the comfort levels of the rooms served.
21. All items of equipment, branches and mains shall have independent isolating valves and commissioning regulating valves positioned as close as practical to their origin and to be located in easily accessible locations.
22. Where boiler plant is utilised on a project this should comply with Building Regulations and Clean Air Act requirements with primary heating sources being selected to provide maximum energy efficiency with low NOx Condensing boilers.
    a. The use of boiler plant will need to be in combination with the use of renewables. Refer to the GD series design guides for more information.
    b. A solution employing lead renewables with back up boiler plant is encouraged. Refer to the GD series design guides for more information.
    c. Where boiler plant is installed space and flexibility should be included, including pipe routes, for future conversion of the boiler plant to a renewables source eg ground source heat pump. This will enable easier decarbonisation at a future date.
    d. Where BREEAM credits are being targeted it will be necessary to install Ultra low NOx Boilers, the BREEAM Pollution criteria for 2 credits is. less than 24 mg NOx per kWh as advised for an AQMA area in Table 12.4.
23. Multiple heat generating equipment shall always be installed to provide N+1 redundant standby based upon full winter load. However always note that
    a. air source heat pumps will need to defrost at regular intervals and that they may not be as reliable as gas boilers.
    b. In assessing redundant standby always allow for one heat pump to be out of use for a lengthy period for a service fault.
    c. Remaining air source heat pumps may be in defrost regularly during inclement weather and the remaining plant should have the output to make good this defrost period heat output.
    d. Each heat generating plant item, including plate heat exchangers, shall be complete with its own primary pump set (in this instance single pumps ie one per plant item would be accepted) and non return valve
    e. The multiple plant items shall be installed on a primary pump loop pumping around a low loss primary header from which pumped secondary circuits are taken.

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24. Any boilers installed should aim to exceed 90% or more efficiency at part (full range) and full load capacity. 'A' rated boilers should be specified and all proposals are subject to development and maintenance departments' approval prior to installation.
25. Business continuity emergency connections should be included in the design of the primary heating system(s) and provided at agreed locations suitable for connection to temporary boilers, etc. to enable temporary heat generation equipment to be connected to the building with minimum of 'down time' to the end users served.
26. So far as the district heating is concerned
    a. Where connections are available the district system should only be considered after a full life cycle cost analysis considering capital costs, maintenance costs, energy and carbon costs.
    b. Where new buildings are not currently able to be connected to the City-wide district heating network or where it isn't currently economic, but availability of such a facility may be possible within the building's life expectancy plant space and distribution routing should be provided for these to be added to the plant configuration. This should be provided in the form of space for 2No plate heat exchangers (etc) where appropriate for all new and major refurbishment developments. This should be discussed with the University development and maintenance departments at concept design stage.
    c. The designer should liaise directly with the University where connections are proposed to the City-wide district heating system. Direct contact with the provider (ENGIE) shall not take place. Any opening discussions with regard to connections to understand the design and technical parameters associated with connecting to the systems and the information exchanges that need to take place between shall be under the supervision of the University to ensure the system parameters and restrictions are adhered to.
27. All buildings shall be metered fully in accordance with Metering Instruments Directive (MID 2004/22/EC). Any building that contains multiple clients as defined in the MID shall be sub-metered in accordance with MID.
28. Variable speed pumps should be installed and emitters should use two port control technology to all emitters to reduce water flow rates and thus save energy. Variable flow design principles should be adopted in line with CIBSE Knowledge series technical guidance notes and good industry practice.
29. Pumps shall be provided as follows.
    a. Single headed run and standby pumps should be provided on all heating circuits. Pump motors above 3kW shall be totally enclosed fan cooled (TEFC) whereas small micro systems less than 3kW may be canned rotor pumps.
    b. All pumps shall have inverters and pumps below 3kW may have integral inverters but pumps above this motor rating shall be provided with separate field mounted variable speed drives.
    c. All pumps shall be CE certified and fully compliant with Commission Regulation EU No. 547/2012, 640/2009 and 641/2009 in terms of energy efficiency.
    d. Circulating pumps shall vary flow rate via differential pressure transducers and a proportional pressure control methodology. Small systems below 3kW may have integral inverters and pressure control. Larger systems above 3kW shall be provided with inverters that are separate from the pumps.
    e. Inertia bases shall be utilised on every end suction or multistage water circulating pump set.
    f. Inertia bases shall be utilised on every inline pumps set unless it can be demonstrated that these are not required on low duty pump sets which are typically pipeline mounted and do not warrant this level of vibration control.
    g. The inertia bases are to be provided with spring anti-vibration mountings with a vibration efficiency of 98% minimum to limit vibration transmission to the building.
30. The design of frost coil provision on air handling units should be on a risk based approach to the space(s) served. By default, frost protection should be provided as standard unless otherwise agreed with the University development and maintenance departments.
    a. Very large AHUs, say above 1500mm by 1500mm coils, will need frost coil controls that employ

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variable temperature constant flow rate local heating water injection loops to prevent freezing under low load.

b. Frost coils should discharge at temperatures as low as practical whilst not allowing freezing of coil tubes.

31. All new heating installations should incorporate separate air and dirt separators to passively remove sludge and pipework corrosion and debris. For retrofit installations, the air/dirt separator shall be added back at the primary plant source. The manufacturers matched insulation sets shall be applied to the units.
32. When it is intended to connect onto / extend existing heating installations, the designer shall carry out a full conditional survey of the heating installations. The designer shall issue a concise report to the University detailing their findings.
33. All new / refurbished / modified heating installations shall be flushed and dosed by a BSRIA accredited contractor. All work shall be carried out in accordance with the relevant governing documents, as a minimum they should comply with the following documents:
    a. BSRIA Application Guide BG29/2012 - Pre-commission Cleaning of Pipework Systems.
    b. Water Treatment for Building Services Systems (AG 2/93)
    c. Water Treatment for Closed Heating and Cooling Systems (BG50/2013)
    d. Sampling and monitoring of water from building services closed systems. (BS8552/2012)
    e. Code of practice and the European Biocidal products Regulation (528/2012, commonly known as BPR).
    f. When existing systems are found to be fouled by corrosion, scale or debris resulting from lack of or incorrect treatment, an on-line cleaning programme shall be implemented, where non-aggressive chemical cleaning technology in conjunction with the flushing and inhibiting procedures used in pre-commissioning cleaning.
    g. During the flushing and dosing process the appointed design engineer shall attend site to review works being undertaken. Water samples by the appointed specialist shall not be taken direct from the dosing pot, these shall be taken further down the system to give a better indication of the water condition.
34. The use of dissimilar metals on a heating installation shall be avoided where possible. If these do need to be employed due to a choice in emitter, a physical barrier shall be provided to prevent electrolytic corrosion. This shall come in the form of a brass fitting or carbon inserts.
35. Thermal insulation
    a. All valves and flanges 15mm and above shall be adequately insulated utilising jackets. Valve boxes shall be avoided in all instances. The valve jackets shall be fixed over valves using Velcro straps with drawstrings at either end of the jacket. The jackets shall have a robust, waterproof fabric finish, fully stitched with flexible thermal insulation, that meets the overall thermal performance of the insulation applied.
    b. Phenolic foam insulation shall not be used on copper pipework.
36. Gas Installations associated with gas burning appliances.
    a. All new and existing gas installations shall follow the Gas Safety (installation and Use) Regulations.
    b. All installers shall be registered under the CAPITA Gas Safe Registration Scheme. No pipework shall be installed by an unregistered installer.
    c. All gas pipework installations shall be carried out and specified in line with the Institution of Gas Engineers & Managers (IGEM) standards. This is to ensure all systems are of high standard and follow the Gas Safety (Installation and Use) regulations.
    d. All new and existing gas installation that are either installed or modified shall be purged in accordance with the current ACoP published by Gas Safe as well as current gas regulations and HSE guidance. All certification shall be issued to the University to prove that this has been undertaken as part of installation works.
    e. Where gas is used in rooms such as laboratories then each room with a gas supply shall be provided

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with its own gas solenoid valve, local isolation control panel and gas proving system fully in accordance with BS6173:2009 and IGE/UP/II edition 2. All exits from the rooms shall be provided with knock off button (key switch operated to reset) so that only the gas to the individual room is isolated.

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Design Components

Item	Manufacturer	Comments
Boiler (Commercial)	Potterton Hamworthy Hoval Buderus Broag Remeha	Gas fired atmospheric fan assisted or pressure jet to suit application. To comply with BS 5978, BS 6644 and all latest Building Regulations including Part L2. Refer to notes on high and low water content boilers for NOx emissions. Boiler configuration shall be 3No @ 50% or 2No @ 66% each for resilient backup.
Boiler (Domestic)	Worcester Bosch Vaillant Hoval Glo worm Viessmann	All domestic boilers shall be of the condensing type
Boiler and CHP Flues	Midtherm A1 Bridge Flue Hamworthy Selkirk	Twin wall systems, with thermal insulation between walls. Constructed from Grade 304 stainless steel, minimum 0.71mm thick. To comply with BS 6644, BS 5978, BS 5440 and the clean air act (No flue dilution shall be employed)
Small Scale Packaged Combined Heat and Power Units	Bosch Ener-g Cogenco (Veolia) Senertec	Packaged units will include the following: Natural Gas Fired four stroke engine, Asynchronous Generator, Base frame, Heat recovery System, Control, protection and monitoring system, Acoustic Enclosure (including engine, generator, heat exchangers/distributors, controls and integral pumps). CHP Units shall comply with the following general requirements: Be selected to comply with all recommendations within CIBSE AM12. Electrical controls / systems to comply with all recommendations stated within the Electricity Association G59/3 – Recommendations for the connection of Embedded Generating Plant. Meet the following minimum performance criteria: 1) Power efficiency > 35% 2) Quality Index (QI) >115 3) Overall efficiency >85% 4) Availability >95% Unit shall have a 3-phase generator and be an asynchronous, 4 pole brushless type with a splash water protected enclosure. It is to be constructed to conform with BS EN 600034.

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Item	Manufacturer	Comments
Pumps	Grundfos Wilo Armstrong Lowara	All pumps shall be CE certified and fully compliant with Commission Regulation EU No. 547/2012, 640/2009 and 641/2009 in terms of energy efficiency
Commissioning Sets & DPCV's	Crane Hattersley Tour & Andersson Oventrop	15mm to 50mm bronze DRV 65mm to 200mm cast iron DRV 15mm to 50mm bronze metering station 65mm to 200mm cast iron metering station 15mm to 50mm bronze combined commissioning station 65mm to 200mm cast iron combined commissioning station
Isolation Valves	Crane Hattersley Tour & Andersson Oventrop	15mm to 50mm preference ¼ turn globe or butterfly or bronze gate valve 65mm to 200mm preference ¼ turn globe or butterfly or cast-iron gate valve
Check Valves	Crane Hattersley Tour & Andersson Oventrop	15mm to 50mm bronze swing pattern (low loss) 65mm to 200mm cast iron swing pattern (low loss)
Binder test points	Crane Hattersley Tour & Andersson Oventrop	Binder test points shall be installed across all plant items, coils, heat exchangers, control valves and strainers. Test points shall be extended stem type with twin lock facility.
Gas Isolation Valves	Crane Hattersley Tour & Andersson Oventrop	Pressure rating to PN16 Valves to be either ball valves or gate valves. Materials shall be either DZR, Bronze or Cast Iron. All valves to have Nitrile diaphragms and be Gas Regulations approved. The first isolating valve (AECV) on entry to a building or fire zone shall be Factory Mutual (FM) approved valve and must be fire resistant to BS EN 1775.

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Item	Manufacturer	Comments
Pressurisation Units	Aquatech Pressmain GM Treble Flamco Grundfos	Generally glandless in line circular type. Individual run and standby pumps with individual means of isolation and 'short circuit' NRV prevention. Pumps shall be continuously rated to allow system fill via the unit. Tank fill rate must exceed pump duty. The make up break tank to be complete with ball valve to provide an air gap separation between the system and potable make up supply. The "air gap" means a visible, unobstructed and complete physical air break to meet regulations. The potable supply to the pressurisation unit must be considered as a "dead leg" and as such must be loop connected to a main with good normal flow and use to prevent stagnation. The tee connection must be a short as possible with an isolation valve. This leg should be less than 200mm total. A pressurisation unit bypass quick fill system will be allowed in order to fill the system quickly following a drain down. It should however be noted it is the Universities preference to fill via the pressurisation unit, and a bypass quick fill should only be considered in larger systems. The bypass quick fill should consist of a "tee" connection from the looped potable main with isolating valve and double check valve normally capped off, again this connection must be as short as possible, less than 200mm total including valves. A suitable WRAS approved pressure rated hose should be provided loose. In an emergency quick fill situation, and only in such situations and with written agreement with the University, this hose can be connected to the non-return valve on the potable supply and used to connect to a suitable valved connection on the heating or cooling system to give a quick fill from system empty. After use the hose must be disconnected and the two connections capped off. The hose should be stored locally for emergency use and sterilised prior to connection and use.

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Item	Manufacturer	Comments
Heating Pipework	BSS	Reference should be made to the detailed the University's mechanical technical specification Part 2. Heavy Grade Mild Steel is the default material which shall be employed on all projects without exception. All to be painted two coats red oxide before insulation is applied. Copper, thin wall steel, stainless steel or plastic pipework systems must not be used. Pressfit, pushfit, clamped or compression fittings and systems must not be used.
Heating Pipe Fittings	BSS	Reference should be made to the detailed the University's mechanical technical specification Part 2 and described above.
Internal Gas Pipework	BSS	Reference should be made to the detailed the University's mechanical technical specification Part 2. Mild Carbon Steel Heavy Grade to BS EN 10255 and BS EN 10220 is the default material for all internal gas pipework installation. All pipework shall be screwed up to Ø50mm. Welded connection shall be used in all other cases. Every other length of pipework shall be flanged to allow removal of the pipework section.

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Item	Manufacturer	Comments
External Gas Pipework	Durapipe Wavin Fusion	Reference should be made to the detailed the University's mechanical technical specification Part 2. External Gas Pipework shall be installed in yellow Polyethylene pipework to SDR 17.6 Specification. BG PS/PL2- Specification for Polyethylene Pipes and Fittings for Natural Gas and Suitable Manufactured Gas. Part 4 Fusion Fittings with Integral Heating Elements. Part 6- Spigotted Fittings for Electrofusion and/or Buttfusion Purposes BG5556- General Requirements for Dimensions and Pressure Ratings for Pipe of Thermoplastic Materials. ISO/TC138/SO4 -Specification for Pe Fusion Fittings and Joints for Use with Pe Pipes for the Supply of Gaseous Fuels. Jointing system shall be by electrofusion or buttfusion methods. All fittings to match the tube and to be Gas Board approved standard and the fusion welding of fittings to be installed by Engineers with Specialist fusion welding equipment and shall be Gas Board Approved Contractors. In the case of electrofusion jointing, pipes should be cut square to axis and burrs removed. The surface of the pipe to be in contact with fitting shall be scraped to completely remove the surface layer prior to insertion into fitting. On all straight pipes above 180mm diameter welding clamps must be used to minimise the risk of accidental movement. Clamps also to be used on all sizes of coiled pipe and where correct pipe alignment is difficult. Each and every weld (butt or electrofusion) shall be recorded using fusion automatic welding kit bigger hard copies detailing each weld shall be included as part of the Operation and Maintenance Manuals.
Radiators	Hudevad ltd Zender ltd Stelrad ltd Myson ltd	Stand-alone heating systems to have radiators selected for appropriate working pressure. All radiators to be connected TBOE.

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Item	Manufacturer	Comments
Underfloor Heating	Warmafloor Heating Ltd Rotex Heating Systems Rehau Ltd Uponor Ltd	All underfloor Heating Manifolds shall be house in recessed cabinets or fully accessible boxings. The manifolds shall include the following: • Flow and return headers with each circuit having flow and return isolating and regulating valves with integral pressure reducers fitted in the flow valves and integrated regulating valves in the return. • The headers shall be capable of either left or right-hand end connection to the primary circuit and shall be supplied with 2 loose cap ends to facilitate handling of the header. • Each header shall come complete with KFE ball cocks and manual air vents • Where there isn't a dedicated underfloor heating LTHW circuit each manifold shall be provided with dedicated local pumps, 3 port valve arrangement and high temperature shut off valves. Water temperatures will need to be correctly blended locally. Underfloor heating manifolds shall be connected to seamless VPEc oxygen tight high-density polyethylene distribution pipework in accordance with DIN 4726. The pipework shall be electron beam cross linked code c to DIN 16892 and shall be DIN-tested 3 VO56 PE-X tube. Where necessary the system shall be split into multiple manifold circuits to ensure satisfactory control of the spaces served. Each pipe loop shall be controlled by an individual 2 port valve located at the manifold. Each room or zone shall be served via a number of loops with room sensor(s) controlling these valves to serve the same. Where underfloor heating loops are installed against areas of high thermal loss these shall be increased in density to approximately 150mm centres (i.e. adjacent to entrances and glazing). General areas shall be typically looped at approximately 300mm centres, or as calculated by specialist. A "Lap Arrangement" installation shall be adopted adjacent to full height glazing areas to provide higher output and combat condensation formation /down draughts from glazing systems. Where pipework distributes through heated spaces to serve adjacent rooms etc., pipework shall be insulated to prevent uncontrolled heating and overheating of the transient space. Underfloor heating within atria areas shall be capable of withstanding the weight of a maintenance MEWP. Where a BMS system is installed in the building the Underfloor Heating Controls shall interface with the BMS system. All underfloor heating pipework shall carry a guaranteed minimum (warranty) life expectancy of 25 years.

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Item	Manufacturer	Comments
Automatic Air Vents	Spirax Sarco Crane Hattersley	Valve isolation to be provided for servicing and maintenance.
Radiator Valves	Danfoss Drayton Oventrop Herz Tour and Anderson	Ensure suitability for medium pressure operation if fitted. Also, shall be 'tamperproof type' within teaching spaces. Valves to be adjustable KV type and low $\triangle P$ Consideration shall be given to flow limiting TRVs. All radiators shall be connected downstream of differential pressure commissioning valves. Under no circumstances shall TRVs be subject to a differential pressure greater than 20kPa.
Heat Exchangers and Calorifiers	Stokvis Hoval Rycroft Alfa Laval	Shall generally be plate type for use between MTHW and LTHW and must be fully demountable and be manufactured from stainless steel.
Bellows (Last resort solution)	Engineering Appliances BOA	Bellows shall be a last design resort and must be agreed with the university maintenance department prior to design. Where used bellows shall be naturally flexible. Expansion bellows shall be twin wall spirally wound. Multiply stainless steel, complete with treaded tie bars.
Air and Dirt Separators	Spirotech	Purpose made manufactures insulations sets to be utilised on all air and dirt separators. Vacuum degassers to be considered where systems are of low velocity, small temperature differentials and large-scale systems.

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Item	Manufacturer	Comments
Insulation		All steel heating pipework shall be painted with two coats of red oxide primer paint prior to phenolic foam insulation being applied. The Phenolic foam shall be bore-coated (impregnated) with a factory applied passive anti-corrosive agent. All thermal insulation shall be responsibly sourced and where applicable evidence shall be provided to the project BREEAM assessor/s. All thermal insulation shall be low embodied impact relevant to their thermal properties determined by the 'Green Guide' by achieving either A or A+ green guide rating. Insulation must be provided to the appropriate ECA recommended thicknesses and not British Standard requirements to satisfy the energy criteria for each development. Under no circumstances shall phenolic foam be applied to copper pipework (which itself must not be used unless requested in writing by the University)
Insulation Jackets	Thermotex Spirax Sarco (for steam services only)	Inner finish - Silicone coated glass fibre Outer finish - Woven glass fibre Insulation - Mineral fibre Stitching - Polyester cotton Draw cords Nylon All covers shall be certified Class 'O' Building Regulation British Standard, conforming to BS 476 part 6 (fire propagation) and part 7 (Class 1 rating surface spread of flame)

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