UWE Estates and Facilities Design Guide

Chapter 6: Mechanical Engineering Design

UWE Bristol | University of the West of England

SOUTH WEST BUILT ENVIRONMENT AWARDS 2017
CLIENT OF THE YEAR
WINNER

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6.1 Change Control

Version Number	Date of Issue	Chapter Ref	Brief Description of Change(s)
1.4	01/05/19		Numerous updates throughout.
1.5	Nov2019		Numerous updates throughout.
2021	Jan 2021	6	Various updates to General section; to Domestic Hot & Cold Water Systems; & to Mechanical Cooling sections.
2021	Jan 2021	6.9	Metering section replaced by Energy team to align with the software and hardware used across UWE, ensuring that accurate and up to date metering can take place.

6 General Mechanical Design Principles

Designers must read Chapters 1, 2 and 3 of this Design Guide, as well as this Chapter, before commencing any mechanical design work.

This chapter provides designers with an insight into what should be taken into account when preparing their designs and the issues that should be considered to ensure that a building services installation can be practically installed, efficiently maintained and will meet the client's written and implied aspirations for the short-, medium- and long-term.

This chapter sets out the minimum standards of engineering services to be applied throughout the estate, they are not intended to stifle innovation or technical advances.

It is the objective of the Estates department to adopt low carbon principles within its design in line with UWE target to be net-zero carbon by 2030. A fundamental requirement is therefore to design out any avoidable energy requirements, particularly fossil fuels. Demand reduction takes priority over covering energy requirements through low carbon or renewable sources. The design should apply the principles of Low Carbon Design:

- Understand energy use in the building type
- Use the form & fabric of the building to minimise energy demand
- Focus on insulation and air tightness
- Use high efficiency building services with low carbon fuel
- Manage energy within the building
- Use low carbon and renewable energy systems

The Building Services design should follow the principles of the energy efficiency hierarchy:-

- Reduce demand by using passive measures
- Use energy efficient equipment and controls
- Use low carbon and renewable technologies

The Building Services design should consider implications of a changing climate as detailed elsewhere. UWE use their buildings throughout the year and therefore all buildings shall be thermally modelled as being occupied during the summer months.

The building services design should comply as a minimum with any local building planning conditions, but this should not be considered as the design standard, but improved upon where possible to meet the University's maintenance requirements, energy performance and carbon targets.

6.2 Management of Mechanical Design

Chapters 1 and 2 of this guide states that all designers must consult with a range of stakeholders including end-users and the Estates and Facilities department, during design development. This may be in the form of structured liaison meetings organised by the internal or external project manager.

Mechanical designers, depending on their exact discipline and the nature of the project, will need to take the following actions:

6.2.1 Initial Survey and review of existing asset information

- Survey existing services and ascertain the implications of any new works. A condition survey may be required for works within existing areas. The designer is responsible for checking the suitability of all existing water supplies, drainage capacity etc. at project inception.
- Consideration and review of case studies and technical papers of similar applications.
- Consider energy conservation and energy reduction requirements for new and refurbishment projects

6.2.2 Design Co-ordination

- Analysis of the building's façade in conjunction with the building designer and structural engineer to assess thermal performance and ultimately to increase energy efficiency.
- Liaise with all members of the design team including the building designer and structural engineer to provide an integrated building/ structural / services installation. This must include coordination of mechanical builders work requirements, plant space and significant apertures within the structure.
- Coordination is also required with the electrical services designer regarding the power and control requirements for the mechanical services.
- When trenching, coordination is expected to provide suitable and sufficient excavations to accommodate mechanical, electrical, and data requirements. A minimum 50mm data duct at 350mm depth should be considered to be provided in any trenching work.
- External Shading should be considered in conjunction with the building designer to consider the full implications including minimising the effects of unwanted heat gain to occupied space. This should be done from project inception.

6.2.3 Initial Load Assessment

- This is required for early assessment of the plant space requirements for co-ordination with the building designer.
- CIBSE guides and publications, and BSRIA rules of thumb can be used as a check.

6.2.4 Plant, System Selection and Location

- Selected to maximize operational efficiency and availability.
- To suit ambient conditions (thermal & noise) during all seasons.
- Continuity with existing plant and manufacturers where appropriate, particularly any district heating network on site.
- Business Continuity and resilience with regard failure of main services and / or utilities. For example the consideration of dual fuel burners in the event of gas interruptions versus the provision of valved tee connections for connecting a temporary hired boiler.
- Consideration of maintainability and the minimisation of impact within occupied spaces
- Consideration and review of case studies and technical papers of similar application.
- UWE prefers all major plant to be located at Ground Level. If this is not achievable then approval will be required from the UWE Estates Team. Refer to the Access and Maintenance Strategy section for further information.

6.2.5 Statutory Guidance and Practice Recommendations

The Building Services design is to be carried out and presented in accordance with all relevant and current Regulations, Guidelines, European and British Standards and best-practices, which includes, but is not limited to:

- UWE Water and Gas Policies.
- Bristol Water Regulations.
- Building Services Research & Information Association (BSRIA) Publications
- Chartered Institution of Building Services Engineers (CIBSE) Guides & Technical Memoranda;
- NJUG Vol 1-6 National Joint Utilities Group Guidelines.
- CESWI 7th Edition Civil Engineering Specification for the Water Industry.
- Heat Network (Metering and Billing) Regulations 2014

The designer shall inform and advise UWE of any conflict between the above, and seek UWE approval of proposed resolution.

6.3 Schedule of Statutory Notifiable Plant:

The mechanical designer must consider the statutory requirements for all of the following installations and advise the Estates CA\Engineer of their project implications via the reporting process detailed within the appendices of this design guide:-

- Legionella Risk Assessment, schedule of legionella susceptible plant.
- Bristol Water, notifications.
- Refrigerant plant.
- Boilers
- Pressure vessels and MPHW calorifiers (heating, CHW, refrigerant or CWS), schedule of plant.
- COSHH tests, schedule of plant.

Certificates for the factory pressure testing of boilers, calorifiers and other pressure vessels should be specified at tender and provided at handover stage

6.4 Commissioning: Mechanical

The designer should ensure that systems are fully commissionable (and self-balancing where economically viable).

Commissioning devices should be installed to manufacturer's recommendations and accessible for future use.

CIBSE commissioning codes, BREEAM and BSRIA guides should be adhered to.
10-15% of all values should be checked by the mechanical designer.

100% of all safety interlocks (and all fire dampers' operation) should be witnessed by the designer in conjunction with the site supervisor and the UWE Clerk of Works.

6.5 General Principles Governing the HVAC strategy

The Building Services Consultant should:

- Note that UWE expects the maximum use possible of natural ventilation in all its buildings.
- Ensure that the thermal mass of the building can be used to minimise summer overheating.
- Evaluate the use of mixed-mode ventilation systems with heat recovery
- Consider the use of external solar shading to minimise summer overheating

The following hierarchy shall be adopted for the avoidance of summertime overheating:

1. Natural Ventilation
2. Mechanical Ventilation
3. Mechanical Ventilation with phase change medium
4. Other passive cooling methods such as ground coupled ventilation
5. Forced Refrigerated (mechanical) cooling

The European Energy Performance of Buildings Directive Article 9, in conjunction with the UK Building Regulations Part L has imposed strict limits on forced cooling.

To avoid the need for cooling systems the following principles should be adopted as appropriate:

- Heat releasing equipment should be sited in areas with openable windows, free natural ventilation or naturally cool areas e.g. basements etc.
- Heat releasing equipment should therefore be located close to external walls (or externally), to facilitate natural cooling. The equipment should not be positioned where it could be susceptible to solar gain.
- A large population of heat releasing equipment should not be installed in a single area or in areas where there are large occupancy levels.
- Only the necessary quantity of machines/equipment should be installed.
- Local extract ventilation systems used to remove heat from source wherever possible

In areas not mechanically cooled the Building Regulations Approved document L2 performance standard for avoidance of summertime overheating for learning, teaching and office areas shall be adopted. The performance standard shall be extended to include all internal building spaces which will be utilised by staff and students e.g. corridors and stairwells. UWE use their buildings throughout the year and therefore all buildings and all rooms shall be thermally modelled as being occupied during the summer months.

The above refers to comfort cooling only. When the function of an area requires specific operating conditions i.e. processes, specialist equipment, chemical storage etc. then such areas will be assessed independently. If it is concluded that cooling or air conditioning is necessary then these shall be in addition to Local Exhaust Ventilation systems.

When designing mechanical cooling for IT Comms rooms this needs to be selected with energy efficiency in mind and consideration of PIR sensors with higher set back temperatures to save energy when the rooms are not occupied.

Adequate double-sided cross-flow ventilation is difficult to achieve in buildings with widths greater than about 15 metres, (offices 6 metres deep with openable windows on either side of a central 3 metre corridor). Buildings which rely on natural ventilation can have high summer ventilation rates with no energy penalty. Summer ventilation rates may need to be ten times greater than those achieved in winter to avoid overheating. There is some evidence that natural ventilated buildings can be "healthier" than some air-conditioned or mechanically ventilated buildings.

Buildings can be designed to use a mechanical ventilation system with heat recovery during the heating season, and natural ventilation from opening windows during summertime.

During the heating season, the windows should be locked shut or have interlocking controls to avoid heating when the windows are open. This type of servicing arrangement is termed 'mixed mode' and recent data from the Building Services Research Establishment has shown that office buildings with mixed-mode systems can use less energy than either continuously mechanically ventilated or air-conditioned buildings.

Natural ventilation can be provided from windows, ventilation slots in window frames, solar driven stack-effect or from purpose-made controllable through-wall systems. Thermal comfort may also be influenced by the exposed thermal mass of the building: a lightweight building will respond rapidly to changes in external conditions, whereas with a heavyweight structure a noticeable damping effect on internal temperatures may occur. The use of suspended ceilings effectively removes the thermal mass of the floor slab from the thermal response of the building, allowing more rapid variations in temperature. Figures from the BRE suggest that for naturally ventilated offices with internal blinds overheating can be reduced to 10 days per year or less. Where external blinds are used, overheating would occur on average for only 3 days or less per year.

Re-use of low grade heat, such as heat rejection from chiller plant should be fully considered both with respect to the building under design and/or buildings in the vicinity.

6.6 Pumped Water and Air Circuits

Water pumped circuits should have at least 100% standby (excluding HWS secondary, where a spare pump shall be provided).

+10% to be added to all pump duties (head & flow) to make allowance for commissioning tolerances.

In the first instance variable volume pumps/fans with static pressure control via the BMS should be considered. This is also important when future expansion of the installation is envisaged.

Variable speed drives should utilised where possible and have differential pressure sensors rather than switches.

Local visual indication via temperature and pressure gauges should be provided in addition to BMS sensors (BMS sensors alone are insufficient).

6.7 Acoustics

Please also refer to the appendix addressing Acoustic performance requirements.

Noise from building services should not exceed the noise rating (NR) values listed below. This includes noise from the normal operation of heating, ventilation and air conditioning plant. Higher levels may be permissible during purge ventilation. When planning ventilation duct runs, they should as far as possible avoid crossing partition walls, and where this is inevitable a crosstalk silencer must be incorporated so that the sound insulation requirements listed in section 3.6 are met.

Designs should aim to ensure that plantrooms operate at 78db or less. If sound pressure level is between 79db-82db then a warning sign should be installed on the door stating that hearing protection should be worn if individuals are in the room for more than half a day. In addition, visual and auditory fire alarms should be installed. If sound pressure will exceed 82db then a detailed risk evaluation is required to provide details of the required management strategy. Plant rooms must not operate at 88db or above.

Type(s) of room	Maximum NR Value
Academic staff and admin offices	NR 35
Cafeterias, coffee bars etc	NR 40
Class rooms, lecture rooms, seminar rooms and tutorial rooms Audio visual and video conference rooms Language laboratories	NR 30
Drama studios, music practice rooms	NR 30
Entrance halls, corridors, stairwells, atria and circulation spaces	NR 40
Halls and rooms for music drama and other live performances	NR 30
Large lecture theatres and flagship conference rooms	NR 30
Lecture theatres up to 100 seats	NR 30
Library circulation and media storage areas	NR 35
Library study areas	NR 30
Recording studios	NR 30
Rooms intended for clinical examination and treatment, confidential interviews, psychotherapy, speech therapy etc.	NR 35
Science laboratories, art and design studios, graphics workshops	NR 30
Sports halls and gymnasia	NR 35
Swimming pools	NR 50
Workshops	NR 35

6.8 Metering

Metering is an essential component of projects, in particular where spaces are being divided for separate or tenanted usage or where replacement or new heating or cooling systems are being installed or zoned. The expectation for all metering is as follows:

- Meter data shall be recorded at half hourly intervals
- All meters will be clearly labelled with serial number and end use
- Renewable energy generation will be sub-metered
- A thorough set of meter schematics will be provided, as well as information on maintenance and use of meters

Metering and sub metering of utilities shall be installed as per CIBSE guide TM39, Heat Network Regulations (2014), BREEAM requirements, and The Building Regulations 2000 part L Conservation of Fuel and Power. For the sub-metering of mechanical systems (HVAC and Mains Water Services), the following principles should be followed:

- Major plant that consumes more than 10% of the building energy should be sub metered.
- Sub metered per floor (particularly for water services).
- Sub metering any lettable spaces e.g. leased spaces to shops or businesses within UWE.
- Any cooling loads shall be metered separately.

Metering of electricity supplying mechanical plant shall be installed to all distribution boards either in the main switchboard or integrally in each distribution board.

Mechanical meters shall be appropriately sized to accurately measure the characteristics of the associated load throughout normal expected operating conditions. Introduction of a meter must not affect the performance of the plant or equipment in any way.

Mechanical meters shall be positioned to facilitate ease of maintenance and manual (visual) meter reading without any access restrictions and include isolation valves either side of the meter for safe removal.

Where heat metering is to be installed, all flow measurement elements must be of ultrasonic measurement type (but not retro-fit clamp on ultrasonic for new builds and refurbishments) and not a standard mechanical hot water meter. Temperature probes must be of the immersion pocket type for new builds and refurbishments.

Where meters are to be used for tenant billing purposes, these should be approved by the Measuring Instrument Directive (MID) or certified under UK national legislation as required.

Metering units shall be linked to the Estates Energy Metering system, communicating to the Tridium Niagra system. Discussion with the UWE Energy Team must take place to agree the types of meters to be installed and metering systems to be utilised.

Where communication is to be via a radio link, an analysis study shall be completed for the buildings to ensure that radio signals can reach the existing transmitter/receiver of the Estates Energy Monitoring Package and that there is spare capacity on the system. Where the signal strength is weak or not present then number of additional transmitter/receiver units shall be installed as required, at Project cost.

All necessary equipment required to ensure that each metering unit can be connected onto the Estates Energy metering systems including data points and power supplies shall be provided. Where required, allowance shall be made for modifying and/or extending the existing system as required ensuring that it is sufficiently sized to accommodate the additional metering units within the buildings and an additional 25% spare capacity.

Where the system needs to be augmented then a complete system shall be installed.
All meters must be fully installed, commissioned and operational at handover.

6.9 Disposal Systems

All drainage pipework must not be routed in locations (distribution boards, MCC's etc.) where it is possible a leak could cause a health and safety hazard.

HDPE or Stainless Steel shall be used for drainage.

6.10 Laboratory/Industrial Waste Drainage

Vulcathene pipework shall be used for chemical drainage including laboratories etc
In engineering/science all drain runs which will carry hazardous or radioactive substances, must be labelled accordingly.

Waste traps/catch pots are to be labelled with appropriate warning signage and contained in locked and labelled cupboards.

Please find a list of substances as given by the UWE sewerage provider. These substances cannot be put down the drain without notifying the sewerage provider, who then needs to notify the Environment Agency:

Mercury and its compounds	Dieldrin	Tributyltin compounds
Cadmium and its compounds	Endrin	Triphenyltin compounds
Gamma-hexachlorocyclohexane	Carbon tetrachloride	Trifluralin
Pentachlorophenol and its compounds	Polychlorinated biphenyls	Fenitrothion
DDT	Dichlorvos	Azinphos-methyl
Hexachlorobenzene	1,2-dichloroethane	Malathion
	Trichlorobenzene	Endosulfan

Hexachlorobutadiene Aldrin	Atrazine Simazine	Trichloroethylene (above 30kg/year) Perchloroethylene (above 30kg/year)

The use of these substances shall be avoided where possible. Where the use of one of these substances is proposed by a faculty the designer shall inform and review the full implications with the design team and UWE faculties.

6.11 Pumping of Drainage

UWE preference is to use gravity drainage. Sewage pumping, including of condensate, must be avoided. If a pumped solution is deemed unavoidable then approval for its use must be obtained from the UWE Estates mechanical team. UWE will need detailed justification and assurances that the system offers adequate reliability and resiliency (e.g. through provision of back up pumps).

6.12 Piped Supply Systems

Distribution pipework should generally be to match the existing installation.

The use of plastic pipework is generally not accepted (excluding overflows and warning pipes etc.).

All water services pipework must not be routed in locations (close to distribution boards, MCC's etc.) where it is possible a leak could cause a health and safety hazard.

Low level copper pipework to radiators is prohibited without prior agreement with Estates

Adequate allowance for system expansion should be made in pipework design rather than use of expansion bellows.

Services for open plan accommodations should be designed on a grid basis.

ALL new plant and pipework/ductwork jointing gaskets in existing buildings must be asbestos-free with confirmation plastic tags (which extend beyond adjacent joints for ease of future identification).

Unless identified as indicated above, ALL existing gaskets should be assumed to contain asbestos until known otherwise. Therefore, if they are to be exposed or removed during the contract works they must be treated as hazardous and dealt with in the appropriate manner.

6.13 Heating Pipework

All heating pipework up to and including 125mm shall be installed using mild steel pipes to BS1387, heavy grade, black varnished finish.

All heating pipework 150mm and over shall be installed using carbon steel grade 430 pipes to BS3601 ERW, dimensions to BS3600 table 1, standard mill protective coating finish.

All heating cold feed and open vent pipework, and safety valve or vent cock discharge pipes, shall be installed using mild steel pipes to BS1387, heavy grade galvanised finish.

All pipework off air bottles or AAV's shall be copper to BS2871, part 1, table X or Y.
All black steel pipework up to and including 50mm shall have screwed joints to BS21 taper thread, using hemp and jointing compound to BS5292.

All black steel pipework 65mm and over shall have welded joints or flanged joints throughout.

Joints shall not be permitted within any part of the building fabric.

Screwed fittings on black mild steel pipework, other than sockets, shall be malleable cast iron to BS6681, having ends to BS143 or BS1256, black finish manufactured by Crane Ltd.

Screwed fittings on galvanised steel pipework, other than sockets, shall be as for black mild steel pipework, but galvanised finish.

Fittings on welded pipework shall be carbon steel grade 430 seamless, to BS1965, part 1, heavy, having bevelled ends, varnished finish.

Joints shall be provided as necessary to enable all pipework to be dismantled without cutting.
All heating pipework throughout shall be adequately thermally insulated everywhere.

6.14 Hot & Cold Water Services

6.14.1 General

The designer is responsible for checking the suitability of all existing supplies at project inception. If record information is not available the designer shall either survey or request and provide a brief for any surveys required. The designer if required shall contact the relevant statutory supplier to establish suitability of supply capacity.
The Designer shall formally notify the statutory supplier (Bristol Water) of new installations and alterations as per the Water Regulations. Formal approval from Bristol Water shall be received prior to works starting on site, and included in all handover documentation.

All water services shall be carefully designed to eliminate or minimise aerosol production and excessive water retention. They must also be designed to be readily drained and cleaned.

No materials used in construction shall include those that are known to harbour or provide nutrient for bacteria. Any materials that come into contact with water in a hot or cold water installation shall comply with the requirements of the Water Supply (Water Fittings) Regulations 1999, only using the list of products and materials listed in the Water Fittings and Materials Directory.

Prior to working on any domestic water service all tools must be suitably cleaned and chlorinated. All new fittings must be suitably clean and chlorinated. All new pipework must be chlorinated by a competent Contractor within a 7 day period prior to use. Chlorination certificates must be provided prior to use.

All hot and cold distribution pipework, cold mains and cold tank down feeds, and hot pipes shall be located to minimise heat gains to and from their environment. Pipework shall not be routed through hot ducts or run adjacent to heat sources, such as radiators.
Ensure the hot water pipework is installed above the cold water pipework.
All hot and cold water pipes throughout must be adequately thermally insulated everywhere.
All plant and distribution pipe-work shall be clearly labelled throughout.
No rubber fittings nor any flexible hoses are to be installed in any domestic water system.

A mains water service with no tanked supplies should be utilised wherever possible.
If cold water storage is required it should have a minimum of two independent, fully hydraulically balanced tanks to minimise down time during times of maintenance.
To minimise the risk of water stagnation or bacteriological growth, storage capacity shall be minimised to ensure sufficient turnover.
The design shall ensure that the cold water system inlet, outlet and stored water temperatures of cold water storage tanks are not greater than 2°C above that measured at the main water intake. At cold water draw-off points, a temperature of not greater than 2°C above the temperature measured in the source Cold water storage tanks shall be reached within one minute.

Cold water storage tanks shall be constructed from non-deleterious materials which must be WRAS approved.
Cold water storage tanks shall be designed and installed in accordance with the current Water Supply (Water Fittings) Regulations 1999 and installed in appropriate and suitable locations to allow easy and safe access to facilitate routine inspection and maintenance.
Sectional Cold Water Storage tanks shall be designed with external assembly flanges and self-draining profiles, since this arrangement facilitates easy cleaning of internal surfaces.
Externally located cold water storage tanks shall be suitably protected from environmental conditions.
Cold water storage tanks shall be protected from the ingress of light, insects, vermin, birds, etc.
Delayed-action ball valves shall be fitted wherever possible in order to help avoid stagnation of water.
The feed to each tank shall be fitted with a water meter in order to allow for confirmation of equal and uniform usage from all tanks in any configuration.

Where booster pumps are to be installed, a break cistern will be required between the mains supply pipe and the pumps. This is required to comply with the Water Supply (Water Fittings) Regulations 1999 with regard to prevention of backflow. Control of the pump(s) should be fully automatic in operation and controlled by pressure sensors. Where two or more pumps are installed, the design flow should be achieved with one pump for resilience. Automatic control shall be provided to cyclically and sequentially control all pumps to ensure that each is regularly brought into service.

Cold water outlets in kitchens, tea bays and vending areas should be mains fed or fed from a suitable potable supply.
Kitchen Taps are to be Armitage Shanks Sandringham 21 with no flexible tails. Suitable equivalents to this may be accepted in agreement with the Estates Operations team.
Infrared Sensor Taps and Infrared toilet flushes are not to be fitted.

Thermostatic Mixing Valves (TMV's) and Taps (TMT's) are not to be fitted. Only high risk areas such as Doc M Accessible Facilities, Childcare facilities, open public Sports Facilities supported by the completion of a scald risk assessment, should have Type 3 TMV's fitted. These must be fitted to be fully accessible for routine maintenance. Populations that are most vulnerable to scald risks include children, older people, people with reduced mental capacity, mobility or temperature sensitivity, and people who cannot react appropriately or quickly enough to prevent injury. All other public facing areas can have separate hot & cold taps, or mixer/blender taps installed with no integral thermostatic mixer.
No remote TMVs shall be used on water systems.

Communal drinking water should be dispensed via proprietary refrigerated units with carbon filters, bottle filling as a well as drinking facilities and gravity drains (see approved mechanical suppliers).

The design of the pipework shall ensure that there is no possibility of a cross-connection between installations conveying potable water and an installation containing non-potable water or water supplied from a private source (untreated). There shall be no possibility of backflow towards the source of supply from any tank, cistern or appliance, whether by back siphonage or otherwise.
Labs and workshops such as Science Labs for example, should have fluid category 5 supplies to non-domestic appliances. Category 5 Back flow protection devices shall be provided to comply with Water Regulations.
To prevent future cross-connection of Cat 5 and domestic pipework, Cat 5 pipework shall be clearly labelled and insulated with a different surface finish to domestic (preferred method ISOGENOPAK).
Irrigation systems shall not use untreated water or untreated grey water and water shall not be dispersed using sprays.

All components must be cleaned and disinfected prior to installation, or the entire system completely cleaned and disinfected prior to re-instatement to service. Sampling of sentinel and representative outlets shall be taken 48 hours later to prove efficacy of the disinfection.

Temperatures shall be recorded at all outlets and storage to prove that the system is capable of delivering the correct temperature water within the correct time period in accordance with the UWE Legionella Policy. Disinfection, sampling, and temperature certificates shall be provided. Where substantial modifications or new systems have been installed, an independent review of the Legionella Risk Assessment shall be carried out and funded by the Project.

Domestic washing machines and dishwashers to have appropriate back flow protection to current Water Regulations (nominally Cat 3).

External taps for irrigation / washdown purposes is prohibited without prior discussion with Estates. Provision of external taps for window cleaning purposes is prohibited without prior discussion with Estates as these can usually be designed out as 'reach-and-wash' contractors provide their own water supply. Where unavoidable, appropriate back flow protection to current water regulations should be provided (nominally Cat 4 or 5).
All outside taps and bib taps will need minimum Fluid Category 4 backflow protection (with specific higher risk areas being FC5). These can be risk assessed by the water supplier and only downgraded by the local water company. Category 3 bib taps are only those considered "domestic", such as in the middle of soft landscaping rather than roads, for watering the grounds, with no permanently attached hoses and higher than 150mm above ground level. Bib taps in higher risk areas such as car parks plus anywhere lower than 150mm from ground level, will need fluid category 5 backflow protection.

RPZ non-return valves should not be used without the approval of UWE Estates PM/Engineer.

6.14.2 Hot Water Service

All methods of hot water production should be evaluated. An assessment should be made of the most efficient method of hot water production, including instantaneous, and the separation of heating and hot water.

Hot water storage calorifiers or Heat Interface Units shall be assessed for buildings with the potential to connect to the district heating system. This should not be used for hot water generation without the approval of the UWE Building Services Engineer.

Two pipe (Recirculatory) type systems are preferred, approval should be sought from the UWE Estates Engineer before installation of any other type. Where hot water use is expected to be low, the use of electric instantaneous heaters, or low volume electric storage heaters for localised supply should be considered.
A single circulating pump shall be installed in the return. For reasons of reliability, two pumps can be proposed, with one pump fitted in the pipe with the second pump provided as an immediate spare within the plant room. They should not be installed in parallel as this introduces areas of stagnant water.

Central water generators should have a minimum of two generators to minimise down time during times of maintenance.
All equipment shall be installed in appropriate and suitable locations to allow easy and safe access to facilitate routine inspection and maintenance.
Where more than one generator is used, they shall be connected in parallel, taking care to ensure that the cold feed, the hot flow and the hot return are all fully hydraulically balanced to ensure equal flow through each.
The combined storage capacity and heater output must be sufficient to ensure that the flow temperature, at continuous design flow of at least 20 minutes from calorifiers or other heaters, shall not be less than 60°C. This applies to both circulating and non-circulating hot water systems.
The positioning of the control and high limit thermostats, cold feed and return water connections must ensure that these temperatures are achieved.
All HWS should be stored at 60°C and warning labels provided at all outlets where there is a risk of scalding.
Storage calorifiers should be selected and designed to be capable of raising cold water from 10°C to 65°C, with a two hour recovery period.
Temperature gauges / temperature indication are to be provided to hot water flow and hot water return to all calorifiers. Immersion sensors are to be used in preference to strap-on sensors.
Vents shall be arranged to discharge over a separate tundish with visible Type A air gap, sited at a level that takes account of the hydrostatic head of the system. The calorifier or water heater shall be provided with a suitable safety valve of appropriate size and vacuum release arrangement.
Where water quality indicates the need, cathodic protection from galvanic action by means of sacrificial anodes shall be provided.

Hot water return shall be routed to the base of the calorifier to ensure the full contents of the calorifier are moved. Where the return is not at the base of the calorifier then all Calorifiers should have anti-stratification pump circuits, controlled to the dictates of ACoP L8.
All Calorifiers are to have fully accessible drain points, directly off the lowest point of each Calorifier, with minimal dead-leg, in order to take a sample.

Means shall be taken to prevent warm water entering the cold-feed. A check valve shall be provided in the cold feed, as close to the calorifier as practicable, to prevent such circulation. However, the installation of such a check valve shall not be carried out in systems that use the cold feed for expansion. In these cases, U-bend or S-bend shall be installed in the cold-feed, sufficient distance from the connection to the calorifier, so that water which is warm is not displaced (on heating up) beyond the bend and the vertical pipe rise.

Expansion vessels used on potable water supplies shall be of a flow-through type such as Flamco Airfix D or Airfix DE models. Where pressurisation vessels are of the single entry type, they must be fitted with appropriate flow-through valves or drain valves to facilitate flushing of the unit.
Expansion vessels shall be located on the cold feed rather than on the hot water side of the system

Thermostatic Mixing Valves (TMV's) and Taps (TMT's) are not to be fitted. Only high risk areas such as Doc M Accessible Facilities, Childcare facilities, open public Sports Facilities supported by the completion of a scald risk assessment, should have Type 3 TMV's fitted. Populations that are most vulnerable to scald risks include children, older people, people with reduced mental capacity, mobility or temperature sensitivity, and people who cannot react appropriately or quickly enough to prevent injury.
All other public facing areas can have separate hot & cold taps, or mixer/blender taps installed with no integral thermostatic mixer.
No remote TMVs shall be used on water systems. The pipe-work length from the TMV to the outlet shall be minimal.
All TMVs/TMTs shall be fitted with strainers, isolation valves and non-return valves on both the hot and cold feeds. All TMVs shall be fully accessible.

Surface (i.e. non-intrusive) scale-prevention plant should be provided when performing extensive works to existing central HWS generators.
New plant should have probes mounted within the pipework (see approved mechanical suppliers).

All above ground Water Services pipework up to and including 133mm shall be installed using copper tubes Table X, uncoated or current equivalent. Flexible connections to any appliance is prohibited.
Above ground Water Services pipework 159mm to 219mm shall be installed using copper tubes to temper annealed, Table 5 up to 7 bar working pressure, and Table 6 up to 17 bar working pressure.

6.14.3 Sustainable designs

An assessment should be made of the use of rain water and grey water harvesting systems. UWE Sustainability Plan has a target to increase rainwater and greywater systems at all campuses. The aim of this target is to improve the University's water resilience in the event of water scarcity in the future.

Low flow water fittings should be installed for all appliances particularly wash hand basins, urinals, WC's and showers, using BREEAM criteria as values to be achieved.

6.15 Natural Gas

All gas services shall be in accordance with all relevant British and European Standards, IGEM Series and references, The Gas Safety (Installation and Use) Regulations 1998, this UWE Design Guide, and the UWE Gas Safety Management Policy HSP_003 and all Appendices. Pipework to be installed to IGEM/UP/2 by competent persons and keeping mechanical joints to a minimum and initial tightness tested to IGEM/UP/1 or IGEM/UP/1a. All external gas pipework shall be yellow MDPE to all relevant current BSI approvals and Kitemarked. All gas pipework must be selected from suitable materials conforming to IGEM/UP/2 and suitable for pressures above maximum operating pressure.

All gas pipework to be clearly labelled GAS.

The designer is responsible for checking the suitability of all existing supplies at project inception. If record information is not availability the designer shall survey or request and provide a brief for any surveys required. The designer if required shall contact the relevant statutory supplier to establish suitability of supply capacity.

Gas installation line diagrams for new installations and all amendments to existing must be provided. They shall be mounted on site plus a copy given to the Estates Contract Administrator at handover.
The Gas DSEAR Risk Assessment must be reviewed and updated with details of any new installation and amendment.

Gas detection systems linked to gas solenoid valves shall be provided within all new remote boiler houses, and those integral within the building, and any installation over 300KW, and wherever possible linked to the BMS.

Where Gas solenoid valves are provided the system must be designed to ensure they do not auto-open upon power re-instatement, plus control provision should be made such that its power supply is not interrupted during the university's regular fire alarm testing regime.

Gas pipework shall not have any joints that are above the high level ventilation provision, and absolute minimal joints within 500mm of ignition source. Within plant rooms and enclosed spaces, gas pipework should have no joints upstream of the solenoid / isolation valve.
Adequate isolation valves and purge points shall be fitted to enable annual pipe tightness testing.

Emergency Isolation Points and gas proving systems shall be provided in all laboratories and kitchens.

Hard-wired interlock of gas supply with supply air for all main kitchens is essential.

6.16 Medical/laboratory gas

Designers of faculty gas installations or specialist services (e.g. laboratory gases) must co-ordinate their designs with the rest of the design team, the faculty and vice versa, even if this installation is being procured as a separate package.

6.17 Refrigerant Pipework

The entire refrigerant pipe work installation shall be installed using copper tube to BS 2871, Part 2, Table 2 designation C106 or equivalent, suitable for the type of oil and refrigerant used.

Refrigerant Pipe work up to and including 3/8" (12mm), shall be installed using tube to specification standard ASTM280, DIN 1754/8905 or equivalent, annealed, having plain ends, finished uncoated, tested by Eddy Current method, all fully de-greased, dehydrated and capped, all internal surfaces being absolutely free from scale and dirt.

Refrigerant Pipework for sizes ½" (15mm) and over, shall be installed using tube to BS 2871, Part 2, half hard condition or specification standard ASTM280, DIN 1754/8905, half hard temper or equivalent, having plain ends, uncoated finish, tested by Eddy Current method, all fully de-greased, dehydrated and capped, all internal surface being absolutely free from scale and dirt.

Where there is a likelihood of mechanical damage it shall be protected by inverted cable tray including all external refrigerant pipework.

The F-Gas DSEAR Risk Assessment must be reviewed and updated with details of any new installation and amendment.

6.18 Mechanical Heating/Cooling/ Refrigeration Systems

6.18.1 General Temperature Performance Requirements

6.18.1.1 Heating Season (air temperature)

Winter ambient: - 5.5°C db/100% RH
100% outside air ventilation ambient: -7.0°C db/100% RH
Allowances for intermittent heating: See CIBSE guides.

6.18.1.2 Cooling Season (air temperature)

Summer ambient: 28°C db/20°C wb
Summer ambient (heat-rejection plant): 30°C db/21°C wb

Mechanical cooling shall only be considered by UWE Estates once the use of natural cooling has been fully considered in accordance with TM52. TM52 shall also be used to establish the set point of any mechanical cooling system utilised.

6.18.2 Heating

Heat source: An assessment of low/zero carbon heating sources should be conducted before specifying fossil fuel boilers. This assessment should include consideration of connecting to the proposed district heating network at Frenchay Campus, and any other known, existing or, proposed district heating systems in the proximity to the specific site whether UWE-owned or by another. Where gas boilers are used, atmospheric gas fired boilers should be used in preference to forced draft boilers.

Water Regulations define Fluid Category 4 for all non-domestic heating systems and chilled water systems, and especially where there are quick fill connections and/or any dosing chemicals. Mikrofill units meet Category 4 requirements.

Spare capacity: Except in individually served housing units, a minimum of two heat sources must be installed: 150% total nominal capacity.

Three or more heat sources: 120% total nominal capacity

Heat source control: As HM Government: Non-domestic Building Services Compliance Guide

Pumped circuits: Each pumped circuit must have dual pumps (i.e. run and standby). Pumps should be specified with variable speed drives.

Design Margin: A minimum of +10% of heat out-put should be added to all terminal/(heat emitting) devices. Adequate allowance for heat loss from distribution pipework should be made.

Electrical Heater Batteries: Must be agreed in advance with UWE Estates.

Use of storage tanks: If storage tanks are to be used for providing heating fuel (e.g. bio-fuel), tanks should be fitted with a fill indicator which is to be clearly visible at the filling point and the tank should also be fitted with an overfill alarm, linked to the BMS. Secure filling point to be located on accessible external wall. Tanks are to be double bunded. Handover documentation must contain details of the refilling strategy (including required traffic management controls etc.).

Zoning: Appropriate heat zoning and controls should be defined to maximise system efficiency, and to accommodate differences in end user needs.

6.18.3 Cooling

6.18.3.1 General

The emphasis of good design must always be on minimising internal summertime temperatures. This should be approached in two stages. Stage 1 should evaluate the suitability of natural or mechanical ventilation. If during this preliminary period it becomes apparent that suitable conditions will not be achieved with natural ventilation, then Stage 2 should be to investigate the use of mechanical cooling (see General Principles of this design guide).

The use of Mechanical Cooling is to be avoided, where it cannot be avoided, approval for its use should be sought from UWE Estates. Passive rather than active systems should always be prioritised e.g. the use of chilled beams in preference to fan coil units.

Water Regulations define Fluid Category 4 for all non-domestic heating systems and chilled water systems, and especially where there are quick fill connections and/or any dosing chemicals. Mikrofill units meet Category 4 requirements.

The refrigerant proposed shall be agreed in advance with the Estates Operations team in order to comply with the F Gas Regulations taking into account phase-out and phase-down timescales. In accordance with the F Gas Regulations, the designer must carry out a formal documented Risk Assessment with regard the specified F-Gas, quantity, and location.
The Project design team shall provide occupancy categorisations with respect to the safety of persons who may be directly affected in the event of abnormal operation of the refrigeration system in compliance with BS EN 378.
The limit for a refrigerant is the highest concentration allowed in the categorised space which will not result in any impairment effects or create a risk of ignition. The maximum charge that will be permitted is calculated by the category of the space into which the refrigerant could leak. The Project design team will provide these calculations of refrigerant volume by location exactly in line with BS EN 378.
The Project Design Team shall carry out a formal written Risk Assessment in compliance with DSEAR. The Risk Assessment shall assess all potential risks of the use, application, and presence of a dangerous, flammable, and/or explosive substance such as refrigerant.

The system/s shall also comply with the following:

6.18.3.2 Large-scale

- Cooling towers or other spray units will not be accepted.
- Number of chillers: A minimum of 2 chillers should normally be installed: nominal System total nominal capacity: 125%.
- Chillers must have dual safety valve configuration to minimise loss of refrigerant during maintenance procedures.
- Larger computer rooms which require comfort cooling will require sensible coolers selected with minimal latent cooling capacity, N+1 cooling provision shall be provided, consideration shall also be given to future expansion of the cooling requirement, a report shall be submitted to Estates for approval, detailing the level of cooling to be provided and method of calculation.

6.18.3.3 Small-scale

- Local DX Cooling
- Heat pump – The use of reverse cycle heat pump shall be evaluated.
- Ducted Fresh Air via Fresh Air spigot to external
- BMS / controls Requirement: Remote Start/stop
    - Common alarm
    - Room temp sensor

- Auto-restart upon power reinstatement

The mechanical designer should ensure the details of the amount of refrigerant used and source of power supply is provided on a trafolyte label screwed to the condensing unit.

6.18.3.4 Design Margin

A minimum of +10% of cooling out-put should be added to all terminal devices.
Adequate allowance for heat gain from distribution pipework should be made.

6.19 Ventilation/Air Conditioning Systems

The fresh air supply rate, calculated in litres/second/person, should comply with CIBSE guides A and B, and Part F of the Building Regulations. The chapter of this design guide dealing with space standards provides minimum space allowances for some spaces. This will allow maximum occupancy (and therefore air supply rate) to be calculated. This should be used for initial assumptions about HVAC strategies and plant sizing (at RIBA Stage 2). However, the Space Planning team should be consulted, especially where specialist spaces are concerned, about anticipated occupancy. The project team must establish the exact processes to be undertaken in the space (e.g. use of LEV systems) which will influence design.

6.19.1 Mechanical Ventilation

Ducted supply **ventilation**: Major supply AHU's (above 0.5m3/s) should have the following:

- Pre filter: panel to EU3
- Main filter: Bar to EU6
- Magnahelic and BMS pressure sensors across both filters.
- Filter selection to be according to BS EN ISO 16890

Facility for recirculation of air where possible via motorised dampers. Where full fresh air is essential, other methods of heat recovery shall be evaluated.

Automated windows and Ventilators: Where installed, they should be complete with position indication or contacts**.**

Variable speed **drives**: Use of these drives to be assessed to maximise efficiency of the system.

Direct drives: Fan power should be of the direct drive type as opposed to belt drive.

Fire damper type: To be specified and installed for ease of annual testing, external resettable fire dampers shall be used wherever possible. The mechanical designer should make provision to witness the operation of all fire dampers as part of their witnessing of the commissioning process.

Displacement Ventilation: Use of this principle is preferred where practical and cost effective.

Intake and discharge locations: These should be considered at an early stage in the project whilst applying good design principles and CIBSE guide B recommendations. Consideration of discharge and intake pollution must also be considered. External weather louvers should be selected and specified by the mechanical services designer.

Where cost effective, a ground coupled fresh air supply system shall be used.

In all cases, the legionella risk of passing intake air over water should be considered and low level air intakes should be sited to avoid any accumulation of floor washing or rain water.

Ducted supply & extract fans: Differential Pressure Switches to be mounted across all fans.

VAV supply & extract fans: These should have differential pressure sensors rather than switches.

Humidification: Use of humidifiers is not generally accepted and approval should be sought from the Estates Team for the use of central plant for dehumidification with reheat.

6.19.2 Fire Strategy

As detailed in Chapter 3 an updated fire strategy is required for any major changes to the building. This must include the ventilation provision, fire dampers, compartmentation and fire stopping.

The fire strategy should identify the requirements for smoke ventilation, dry risers, hydrants etc. The Design team and the Mechanical Consultant shall design the systems to meet current regulations and good practice, where any ambiguity exists between the requirements the design team should contact Estates for advice.

6.20 Central Control/Building Management System

The UWE Building Management System to be used at Frenchay and Bower Ashton should be Schneider StruxureWare. Reference Appendix 2 BMS Standards.

A Trend 963 system is installed in several buildings and the entirety of the Glenside campus, all new controllers to be BACNet compatible.

BMS monitoring and control shall be provided to all significant items of Mechanical Plant items, unless agreed with the Estates Team.

UWE is an advocate in the use of condition based maintenance (CBM) regimes. This requires specific hardware and complementary control algorithms. This must be discussed at an early stage (RIBA stage 3) with the Estates BMS Manager to ensure all requirements are met at handover.

Provision should be made within the construction programme for client witnessing of the BMS controls prior to handover.

Graphics and software shall be created in accordance with associated UWE Design Guide Appendix 2 documents:

- BMS Graphics Standards
- BMS Software Standards

A copy of all BMS graphics, control philosophy and bespoke software programming should be issued to the Estates CA\Engineer for approval, with sufficient time period (two weeks) for comment.

All safety interlocks must be hardwired (i.e. temperature, pressure, airflow etc.) with indication only to be provided via the BMS where applicable.

All plant's MCCs must be linked to the sites fire alarm system, with a provision to over-ride this link for regular fire alarm testing.

As a rule of thumb, room sensors should be located 1.5M AFFL, 0.5M from corners and vertical protrusions, away from draughts e.g. doorways, avoiding heat emissions and other thermal hot-spots. They must be representative of the space being controlled.

Fridges/freezers that are considered business or research-critical must be monitored by the BMS.

All motorised dampers and valves should have their 'open' and 'closed' positions clearly marked on the side of their respective actuators and/or damper linkage prior to handover.

As discussed elsewhere, it is critical that actuators, sensors etc. can be accessed from a position of safety (avoiding the need to work at height if practicable) and without the need for dismantling. Schneider Building Analytic software to be installed during the BMS commissioning stage (covering all plant provided under the contract) with the objective of providing a 'defect-free' installation at handover. Furthermore the contractor shall include for the monitoring, analysis and defect rectification of all BMS components, and software engineering of said equipment through-out the entire defects liability period, culminating in a totally defect-free BMS system at end of DLP.

Critical alarms shall be agreed at handover and included in the Bureau remote monitoring system. Email alerts shall also be configured.

6.21 Approved Mechanical Suppliers

Heating Plant	
Boilers up to 70 kw	Caradon/Ideal Baxi Potterton Vaillant
Boilers over 100 kw	Hamworthy Hoval Clyde Combustion Wellman Robey
Burners	Riello Nuway
Radiators	Stelrad (or to match existing) Runtal / Hudevad in specifically agreed locations
TRV's	Oventrop TRV's. Model Series AV6 (TRV Body). Uni LGH (Sensing Head), Combi 4 (LSV).
Pumps/Pressurisation Units	
Pumps	Armstrong Grundfos Smedegaard
Water Conditioning	
Water Conditioning	Hydrotec (UK) Ltd Enigma - Environmental Treatment Concepts Ltd
Fire Stopping	Quelfire Rockwool

Cooling Plant	
Chillers	Daikin Carrier Trane
DX/VRV	Daikin Mitsubishi
Ventilation Plant	
AHU	ABB Flakt Dalair Senior Moducel
Fans	ABB Flakt Nuaire Howden Group Elta
Building Management System	
BMS	Schneider
Water Generators	
Instantaneous electric	Heatrae Sadia Santon
Direct gas fired	Lochinvar Andrews
Drinking Water Dispensers	
Drinking Water Dispensers	Cooleraid MIW

6.22 Approved Mechanical Contractors

The designer should advise and/or recommend to the Estates Project Manager of suitable contractors. Estates Project Manager will make the final selection.