The University of Newcastle

Infrastructure and Facilities Services

Project Briefing Document

HVAC Design Guide

Guiding Principles

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Document Control

This Document supersedes HVAC information identified in the Engineering Services Design Guideline. Any conflicts shall be resolved by consultation with the UON Asset Engineer (Mechanical).

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1. Guiding Principles

1.1 Purpose

The purpose of the University of Newcastle (UON) HVAC Design Guide - Overview is to provide clear UON expectations when designing Heating Ventilation and Air Conditioning services. This document will establish guiding principles that will describe the high level design requirements.

1.2 General

The UON strategy is to centralise CHW generation to get operational energy efficiency and reduce ongoing maintenance costs. There must be an energy efficient system design without compromise on occupant thermal comfort and space condition requirements. The guiding principles for HVAC systems are:

- Ensuring buildings within suitable precincts containing local mechanical plant can transition across to centralised services in future
- Costs are to include (but not limited to) capital, operational, purchase, installation, operating (including electricity, servicing, maintenance and breakdown repairs), infrastructure upgrades
- Building services installations and plant room layouts must allow appropriate, safe and easy access for the purpose of operations, maintenance, repair, and replacement of major components
- All mechanical items that need to be operable or maintained must be installed in serviceable locations. HVAC components requiring regular access service shall not be installed higher than 3m above finished floor levels. Areas with high ceilings shall be serviced from floor mounted plant cupboards or mezzanine cupboards/plant spaces with safe access.
- Generally two pumps/chillers/heaters shall be provided at 50% each to provide at least 50% capacity in cases of equipment failure. Critical systems may include the requirement for up to 100% redundancy depending upon the risk of loss of service and impact on normal operation.
- Mechanical plant shall typically be installed internally or be protected from early degradation and loss of efficiency with covers/roofs/louvred secure enclosures.
- consider the age, nature, building fabric and condition of the building and its status within the University strategic plan to accommodate the air conditioning installation
- structures are to be assessed to ensure that they are capable of housing the static & dynamic loads of mechanical equipment:
    - significant static loads from chillers, water storage vessels & boilers
    - significant wind loads generated by cooling towers, ductwork & fume cupboard stacks
- equipment shall be housed in safe, aesthetically and architecturally acceptable locations
- all plant shall typically be installed internally to extend equipment life and provide minimal aesthetic impact

- facilities with cooling loads < 50kWr shall generally be variable capacity standalone or VRF systems with multiple small circuits rather than a large refrigeration circuit
- facilities with cooling loads >200kWr shall generally be CHW-HW central plant, either dedicated or joined to existing nearby central plant
- facilities with cooling loads >300kWr shall be water cooled utilising evaporative cooling towers or fed from large central CHW systems
- provide capability for future extension or inclusion to a central plant system
- provide peak load reduction and low load operation through chilled water storage
- chilled water systems shall consider secondary and tertiary loops as required to minimise pumping energy. Variable flow systems are to be considered where appropriate.
- equipment sizing shall be selected to maximise efficiency, environmental impact, and longer term availability
- equipment to be lead lag or duty standby setup depending on project redundancy requirements and variable capacity equipment (where possible)
- consider suitability of energy saving technology such as radiant heating, passive ventilation, timers etc…
- consider emerging HVAC technologies only with comprehensive investigation and explanation of the proven performance, benefits and risks and with informed consent of the Principal
- include variable speed functions such as displacement ventilation, variable air volume systems and variable speed drives on pumps and fans where applicable
- consider earth pipe or intake labyrinth ducting systems for outside air intakes
- provide localised heating systems (per building rather than centrally distributed)
- utilise central steam plant for autoclave steam provision where suitable (avoid local electric steam production where multiple systems exist).
- packaged DX units/ small split units shall be avoided unless for isolated instances, hot spot cooling, network rooms and provided with variable capacity control if possible
- split systems (indoor and outdoor units) must be placed in appropriate locations to not adversely impact on aesthetics and user functionality
- ducted air distribution shall be used in preference to local high wall / under ceiling type spot conditioning solutions
- outdoor units are to be mounted at ground level on roof or in existing external plant spaces (units must not be mounted on ledges) and include adequate ventilation for heat rejection requirements (condensers should not be installed inside plantrooms within buildings)
- multi-zone AHU’s are preferred to multiple FCU’s

- when ducted air conditioning systems have higher than 1000L/s outside air, incorporate air to air heat exchangers for heat recovery (or air to water as applicable) and automatic outside air modulation in proportion to occupancy numbers
- Preference is to avoid using ceiling as return air plenum - use ducted return air connections from rooms to fan coil units or air handling units (PC2 requirement is to minimise). Return air plenum ceilings are not to be used under any non-air-tight ceiling space such as metal deck roofs or within laboratories.
- outside air intakes shall not be taken from over roofs or through cooling/ heating plant rooms
- in user spaces, outside air must not be directly supplied into a space without conditioning
- include dedicated HVAC systems to high occupancy rooms and including CO2 control of outside air volumes
- include dehumidification systems as required to achieve humidity requirements in spaces needing controlled humidity
- accommodate peak cooling and heating loads without causing draughts or temperature fluctuations within the space
- minimise extraction of conditioned air where exhaust systems serve conditioned spaces
- VRV shall include user features such as central control
- energy efficiency controls such as motion or timer control
- sensors must be suitably located (i.e. avoid direct sun exposure) to ensure accurate temperature readings
- critical control environments must be provided with certified sensors and must have 24/7 stable operation
- systems servicing multiple floors should consider differential pressures between floors
- AC motion detectors and after hours pushbuttons to large areas of infrequent occupancy (i.e. lecture theatres, timetabled teaching spaces, etc.)
- install local air conditioning override switches in small areas of intermittent occupancy (i.e. meeting and interview rooms)
- control supply air setpoint based on user demand and ambient conditions
- the water control loop volume must be sized for the minimum chiller/boiler requirements and preferentially should be a primary-secondary configuration and including low load storage
- provide capped branches for chilled water loops and underground ring mains where future use has been identified
- ensure stability of the entire flow range for variable flow applications
- install a minimum of two bypass lines (one for high loads, and one for low loads) and valves where there are multiple chillers and boilers

- all secondary pumped heating and cooling water loops should contain a three way valve or a bypass valve at the end of line and typically two way for all other valves
- all adhesive and sealant products used internally must have low Total Volatile Organic Compound levels (TVOCs)
- label HVAC equipment according to the rooms in which they are located (if ceiling mounted) or the rooms they are serving (if they are remotely housed in plantrooms)
- provide condensate traps with maintenance access ports
- Include safety drain trays for all in ceiling plant. Trays shall extend beyond all valves or potential sources of condensation
- air conditioning AHU zones which are proposed for VAV capacity control shall be grouped by orientation/similarity of load on the same cooling-heating coil to avoid VAV re-heat
- accommodate peak load diversification for each zone and air-handling system
- accommodate thermal comfort and ventilation rates when possible with economy cycles
- natural ventilation systems shall maximise thermal buoyancy by reviewing lowest and highest entry/ exit points and prevailing wind direction
- avoid stratification and conflict between different heating/ cooling systems in high ceiling spaces (control strategies to avoid lower units heating and upper units cooling) – specifically on atriums/foyers
- For systems with high outside air flowrates, modulate outside air volume via return duct sensors to achieve CO2 concentration targets
- include automated louvre controls with 'weather' control sensors (high wind-rain) and local timed open-close manual override
- appropriately install controls, thermostats and motorised dampers to allow for automatic operation on all outside air whenever conditions permit
- design and size air ducting and piping to minimise resistance
- arrange exhausts to avoid adverse effects on intakes, other buildings, surfaces etc… and consider impact of objectionable odours
- fully waterproof and appropriately drain ducts (air intake plenums) that are susceptible to PC2 negative pressure, driving rain, moisture laden air or condensation
- protect HVAC from external dust and odour sources
- ensure maintenance can be conducted whilst retaining operation of the remainder of the system i.e. supply isolating valves and demountable joints to reticulated water systems (to allow tanks/pumps/chillers/boilers/cooling towers/coils to be maintained without interrupting operation of other plant items)
- sleeves are to be provided on penetrations for mechanical equipment (pipes-ducts-cables) when mechanical services pass through building elements to stop from rubbing

- provide low maintenance intumescent fire dampers (preference for slim line blades or low pressure drop)
- a minimum distance of 600mm clearance must be provided between the roof surface and the lowest point of any equipment installed on or below a roof platform to allow roof cleaning and future sheeting replacement
- any equipment and services installed exterior to the building are to be within a screened and secured enclosure including weatherproof cover
- design duct systems with velocity and pressure drop characteristics that permit full design flow to all points, do not create excess noise, do not contribute to noise bridges between areas and do not adversely affect comfort (e.g. draughts, stagnant areas etc.)
- AHU & FCU outside air ductwork connections must be sized appropriately to achieve economy cycle
- main mechanical services switchboard is to supply and control power and metering to all mechanical plant equipment (supply sub-MSSB from main MSSB)
- variable speed drives (VSD's) shall be provided for all pumps and major fan systems with pressure volume capacity to minimize energy consumption

1.3 Maintenance

All mechanical services plant shall be designed to allow adequate maintenance of the item and its various components. Equipment must be located to allow easy access for maintenance purposes. Where multiple mechanical equipment items are available in the market with equally high energy ratings, preference must be given to locally manufactured equipment

- Conveniently locate maintainable equipment to permit inspections
- Locate serviceable items to avoid the use of ladders to lift equipment onto a roof
- Locate small condensing units a maximum of 2.5m from ground level
- Do not locate any equipment such that refrigerant containers, vacuum pumps etc…are to be lifted onto roofs via ladders
- Preference is to locate all mechanical items outside offices boundaries, laboratories and above tiled ceilings
- Locate AHU's a minimum 600mm from the walls to allow for maintenance
- Locate meters for mechanical plant in readily accessible plantrooms, service ducts or valve rooms and ensure that all devices requiring reading can be read from floor level without the use of ladders
- Mount exhaust fans in plant rooms or in accessible locations within the building rather than above roofs
- Provide access to all sides of items requiring maintenance in accordance with manufacturers recommended maintenance clearances

- Provide adequate working spaces for plant room servicing operations
- Mechanical plant items installed in ceilings that require maintenance, must be installed in a serviceable manner such that maintenance can be performed safely without use of man-lift, special platforms or other specialist lifting equipment.
- Install access panels in ceilings where serviceable mechanical items are located
- Install duct access panels where required for inspection and maintenance including the following locations: kitchen exhaust as per AS, outside air intake plenums/ louvres, adjacent to any slide filter frame or heating/cooling coil to assist in filter and sheet metal plenum inspections
- Install all air balancing devices to be accessible for both initial and future air balance adjustments
- Install fixed ladders and platforms with guardrails to allow adequate access the top of the cooling towers for cleaning. Proprietary cooling towers access ladders are not adequate.
- Install removable drains for service and inspection that include a tundish with visible air gap to allow any overflow/drainage of tower to be detected
- Allow easy access to all valves and fittings and mounted outside of the cooling tower basin splash zone
- Double stacked air handling units must be provided with raised mounting frames, such that the bottom units can be removed / maintained without impact to the operation of the units above
- All maintenance access through ceiling linings must be in compliance with SafeWork NSW

Maintenance schedule must be conducted as specified in the HVAC and Specialist Services Maintenance Scope Documents.

1.4 Acoustics

The system shall be designed to eliminate the transmission of noise and vibration from air-conditioning and mechanical equipment to the space and the building structure. This may be achieved by designing, selecting, sizing, and locating equipment and fittings to reduce noise transferral to occupied spaces:

- dampers or balancing devices must not be at diffuser or grille face
- control valves shall be appropriately sized to ensure that noise is not generated through the valve
- pipework is to be sized to minimise fluid velocity
- attenuate all suitably located equipment to reduce noise transferral to occupied spaces
- statically and dynamically balance equipment
- isolate active equipment from pipework, ductwork, and building structures
- control whistling, buzzing and humming velocities through appropriate location of dampers
- plant rooms shall not be located immediately bordering noise sensitive spaces
- install sound attenuators and/ or insulating ductwork where necessary to eliminate the transmission of fan noise

- isolate reciprocating or rotating equipment from the structure by using vibration isolators
- use additional acoustic enclosures where necessary
- provide balancing dampers on each floor and each major branch
- provide spigot dampers at each flexible duct connection
- provide an overall strategy for vibration isolation to all equipment with moving parts prior to finalising the design – provide 95% vibration efficiency via rubber or spring isolators

1.5 Labelling

Equipment labelling must be designed to be visible for at least 10 years. Therefore:

- MSSB Dead front type labelling engraved trafolyte mechanically fastened
- Mains and sub mains must be engraved on two colour laminated trafolyte or similarly suitable material
- Engravings must be fixed onto cables and show the cable size, type and origin/destination
    - All other cabling must be identified by slip on ferrules or other suitable means
- Ceiling access panels shall clearly indicate specific HVAC equipment locations by using engraved trafolyte labels

1.6 Pipework

Pipework must accommodate changes to future building as indicated on the campus Master Plan

- Any pipework reticulation must have appropriate insulation, run in a neat and tidy manner, include binder test points either side of all mechanical equipment, be installed with drains & vents at all low-high points and typically be sheathed with brushed aluminium
- Where future buildings are planned, provide valved take-offs for future connections located in services pits, adjacent to future building sites
- Install automatic air bleeds in all appropriate locations
- Pipework risers shall incorporate dedicated isolating and balancing valves at every building level take-off and at all other significant sub branch pipework runs
- Pipework shall be designed so that it is free to expand and contract without causing damage to itself or other works with due allowances for concrete shrinkage and deflection
- Avoid ‘dead legs’
- Transition from underground pipe material to above ground should be made adjacent to the buildings in a concrete services pit or in a serviceable location in an undercroft/plantroom including isolation valves
- All screwed valves, coils and fittings shall have unions for easy removal without cutting the pipework

- All sensors are to be installed in wells and pockets
- Have an adequate number and appropriate location of valving and isolation points to minimise future piping system outages
- Headers are to be designed as pressure vessels and include end plates suitable for the pressure rating (e.g. dome end bells – especially secondary pumps)
- All pumps and pipe work must be isolated via rubber flexible couplings
- A single motorised valve (condenser water bypass valve) should be installed between the CW flow & return lines to control very low CW temps in winter
- Balancing valves shall be selected to suit the design flow at a readable pressure drop without excessive throttling, control valves shall be selected at 100-200% pressure drop of the coil which they serve, combination stad/motorised valves are to avoided

1.7 Purging

- Energy Efficient Purging
    - For large individual areas with a large thermal mass, purge after-hours (where feasible)
    - Purge for summer mode (exclude during winter May-Oct)
    - Purging to be controlled by inside and outside temperature parameters and defined by BMS schedule
- Safe Ventilation Purging
    - Purging shall be initiated from either a manual timed push switch or when a low oxygen level alarm or high gas level alarm is activated
    - An emergency purge rate shall be double the design exhaust rate

1.8 Ventilation

All designs must take into account climatic conditions, the nature of the facility and the anticipated usage characteristics as per AS1668

- Supply air quantities must accommodate peak cooling and heating loads without causing draughts or temperature fluctuations within the space
- Naturally ventilated spaces (atrium voids) including passive ventilation strategies shall include BMS automated louvre controls with ‘weather’ control sensors includingmam175 max wind speed, rain sensor, external/internal temperature and manual override timed open-close operation
- Lowest and highest space entry/exit points to maximise thermal buoyancy
- Passive ventilation is encouraged where possible and practical

- Naturally ventilate general public spaces with automatic controls
- Naturally ventilate plant rooms unless mechanical ventilation is required to assist in temperature control or as required for code compliance
- High use public spaces (e.g. student toilets) are to have toilet occupancy sensors and PIR times used with 30 minute overrun after last detected movement
- Flammable storage rooms are to have flameproof or hazardous area fans for flammable gases
- Any critical temperature controlled spaces (where spaces cannot deviate from a set value) must be mechanically ventilated or air conditioned
- Any non-critical temperature controlled spaces (where spaces can deviate from a set value) may be mixed-mode
- Transient and high population density spaces are to be CO2 controlled
- Isolate occupied from non-occupied spaces
- High fresh air proportion areas must be considered for energy reduction strategies such as CO2 control / modulation air to air heat exchange and energy recovery
- Consideration to be given to security insect control of any openings if natural ventilation purging is used

1.9 Weather & Corrosion Protection

The level of weather protection is dependent on the environmental conditions. The University of Newcastle campuses are generally located in coastal areas. Weather protection can be addressed through equipment coating and workmanship. The considerations are:

- Any external elements exposed to weather should be constructed of non-corroding elements
- Mechanical equipment should be located under cover in plant rooms
- Construction methods and workmanship must ensure weather tightness of all HVAC components
- All porous materials should be protected from exposure to moisture
- Special emphasis must be given to joint seals and penetrations
- External exposed ductwork must be slanted to shed rainwater
- External mechanical plant items must be screened and under roof
- Improved sealing and insulation of cold surfaces
- Cappings over flanges and covers over flex connections & control equipment
- Small packaged chillers shall include stainless steel plate heat exchangers
- Water cooled chillers shall include stainless steel tube sheets on condenser vessels
- Where <5km from coast, chillers shall include stainless steel end bells
- Chiller water boxes must be coated with a five year guarantee ceramic coating

- Air cooled condenser coils shall include corrosion protection appropriate for the prevailing conditions, where <5km from coast condenser coil protection must be of e-coating for micro-channel coils and Blygold for standard tube and fin condensers
- Consider dissimilar metals and isolation methods required