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1 PURPOSE

The CIS Mechanical Services Standard sets out the University of Sydney’s minimum requirements for the design, construction and maintenance of mechanical systems. It ensures new and refurbished systems are energy efficient, fit-for-purpose, made from durable good-quality materials, contain no or minimal environmentally harmful substances, and are cost efficient to operate and maintain.

Applicable requirements documented in Workplace Health and Safety legislation, Disability Discrimination legislation, State Environmental Planning legislation, Commonwealth and State legislation, National Construction Codes (NCC), the Building Code of Australia (BCA) and Australian and New Zealand Standards (AS/NZS) are the minimum and mandatory compliance requirements.
Where any ambiguity exists between this standard and the aforementioned mandatory requirements then:
   a. the highest performance requirements must apply
   b. applicable requirements must follow this order of precedence:
      i. Workplace Health and Safety legislation
      ii. Disability Discrimination legislation
      iii. State Environmental Planning and Assessment legislation
      iv. All other Commonwealth and State legislation
      v. NCC and BCA
      vi. AS/NZS
      vii. This standard and other University standards

2 SCOPE

These standards describe the minimum requirements for the design, construction and maintenance of all mechanical services throughout all buildings owned, operated and managed by the University of Sydney.
The Standard applies to planners, project managers, consultants, contractors, sub-contractors, tenants, managing agents and University staff involved in the design, construction and maintenance of existing, new and proposed University buildings and facilities.
The Mechanical Services Standard provides:
   a. A reference document to enable consistency with the design and engineering objectives
   b. Details of the minimum performance requirements for planning, architectural design and maintenance.
   c. Support of the University vision for the built environment and best practice.

The Standard addresses key objectives:
   a. Quality design which responds, enhances and complements the environment
   b. Appreciation of the heritage context and cultural history of the campuses
   c. Value for money in all aspects of the project
   d. The design of low maintenance buildings and environments
   e. Longevity of construction approach to design
   f. Standardization of key flashing and ancillary details
   g. Flexible design, to future proof building usage for expansion or adaption to new uses
   h. Safety in design
# GLOSSARY OF TERMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tr>
<td>BCA</td>
<td>Building Code of Australia</td>
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<td>CIS</td>
<td>Campus Infrastructure Services</td>
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<tr>
<td>EP&amp;AR</td>
<td>Environmental Planning and Assessment Regulation</td>
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<td>FIP</td>
<td>Fire Indicator Panel</td>
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<tr>
<td>NCC</td>
<td>National Construction Code</td>
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<tr>
<td>PC</td>
<td>Practical Completion</td>
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<tr>
<td>PUG</td>
<td>Project User Group or Project Working Group</td>
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<td>AS</td>
<td>Australian Standard</td>
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<tr>
<td>CFC</td>
<td>Chlorofluorocarbon</td>
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<td>MSDS</td>
<td>Material safety data sheets</td>
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<td>NATA</td>
<td>National Association of Testing Authorities</td>
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<tr>
<td>VOC</td>
<td>Volatile organic compound</td>
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<tr>
<td>HFC</td>
<td>Hydrochlorofluorocarbons</td>
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<tr>
<td>HFC</td>
<td>Hydrofluorocarbons</td>
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<tr>
<td>FC</td>
<td>Fluorocarbon</td>
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<tr>
<td>HC</td>
<td>Hydrocarbon</td>
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<tr>
<td>BMCS</td>
<td>Building Management control System</td>
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<tr>
<td>PPR</td>
<td>project principal requirements</td>
</tr>
<tr>
<td>RAC</td>
<td>Room Air conditioner (window mounted)</td>
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<tr>
<td>SMACNA</td>
<td>Sheet Metal and Air Conditioning Contractors’ National Association</td>
</tr>
<tr>
<td>VAV</td>
<td>Variable Air Volume</td>
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<tr>
<td>VRV</td>
<td>Variable Refrigerant Volume</td>
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<tr>
<td>VRF</td>
<td>Variable Refrigerant Flow</td>
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<tr>
<td>PMV</td>
<td>Predicted Mean Vote</td>
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<tr>
<td>UFA</td>
<td>Usable Floor Area</td>
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<td>EMC</td>
<td>Electromagnetic Compatibility</td>
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<tr>
<td>ODP</td>
<td>Ozone Depletion Potential</td>
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<tr>
<td>DDC</td>
<td>Direct Digital Control</td>
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4 AUTHORITIES AND RESPONSIBILITIES

This standard is issued by CIS. It is approved and signed off by the Director, CIS. CIS is responsible for maintaining the standard and keeping it up-to-date. The Standard must be reviewed biennially.

5 TECHNICAL REQUIREMENTS

5.1 INTRODUCTION

The mechanical system of a University building will include surrounding structures and annex buildings. In some cases components of the Mechanical system will be installed or are to be installed in other buildings. In these cases the word building in this document must be interpreted as inclusive of these structures, annexes and components.

5.2 DESIGN AND DOCUMENTATION

5.2.1 DESIGN APPROACH

The University expects consultants and designers to provide designs that meet the project briefs. The following are priorities that consultants and designers must consider in their designs:

a. Provide environmental conditions that meet the project brief
b. Take a long term balanced view of capital costs, energy costs, maintenance costs and longevity
c. As educational and research both progress at rapid rates, usage of buildings and areas within buildings are subject to multiple changes within the life of the building, systems must be designed to be adaptable for such changes
d. Ensure that plant and equipment are designed with access and visual impact taken into consideration

5.2.2 DESIGN INPUTS AND PROCESS

The University expects consultants and designers to proactively inform, advise and contribute to the design process. In particular, the following aspects:

a. Building Physics - provide advice to the project team, including other design team members that would improve the inherent building's thermal performance, which may lead to reductions in both capital and energy costs. This may initially take the form of simple advice, and subsequently backed up by thermal modelling or similar methods. The process may take a number of iterative steps. The consultant or designer is expected to advice, contribute and if necessary, lead such processes. Passive solutions and natural ventilation/mixed mode ventilation must be considered where appropriate.

b. Planning and Architecture – provide advice on the appropriate location of plant rooms and reticulation strategy to assist in both the planning of the building and the facilitation of better maintenance in the future. Such advice must be provided in the early stages of the design and planning process so that this is taken into consideration for the architect's design and to be incorporated into his planning. Late advice will lead to poor location of plant and lack of maintenance access, thus a building of poor quality that will suffer from either poor or lack of maintenance and high owning costs to the University.
c. The University of Sydney – provide advice on the availability of options, assist in assessing the advantages and disadvantages, provide analysis of life cycle costs and life expectancies, offer recommendations and assist in making decisions.

5.2.3 ENGINEERING PROCESS

The University expects consultants and designers to be fully qualified, experienced and capable of carrying out all engineering design, calculations, equipment selection and construction quality checks.

5.2.4 CALCULATIONS

Use of computer based load modelling/simulation/estimation programs that account for building elements thermal storage and diversification of peak loads for each zone and air-handling system must be performed. This must be part of the design advice to all services and inform the building performance.

Specifically, the University requires large areas such as congregation spaces, glue areas, foyers and linkage spaces not typically fully conditioned to be modelled to ensure thermal conditions are maintained within acceptable limits.

5.2.5 DESIGN CONDITIONS

a. Load estimations are to be performed using established weather design data for specific project location (such data as AIRAH or ASHRAE). A general square meter approach must not be used.

b. The University external design conditions for Camperdown/Darlington/Mallett Campuses are Summer 35.0°C DB/ 24°C WB, Winter 6°C DB.

c. For all other campuses, refer to the design consultants specified design conditions

d. For general office and teaching spaces, the indoor design conditions must be for a minimum condition of 20°C in peak winter and a maximum condition of 26°C in peak summer conditions, humidity is not controlled but the summer design condition must be 55% relative humidity.

e. For special spaces such as labs, animal houses and research facilities refer to specific PPR for internal space design conditions note that spaces are to be designed to maintain internal conditions during peak summer and winter conditions

f. Air conditioning of general public spaces used as student and staff congregation and informal meeting areas are to be considered on a case by case basis. Where temperature control is deemed necessary, the design conditions required are:

   i. minimum of 20°C in winter; and
   ii. maximum condition of 27°C in Summer.

g. Acoustics of a space must meet AS/NZS 2107, Designers and contractors must ensure they take care to attenuate all equipment and that equipment is suitably located to reduce noise transfer to occupied spaces

h. For high use public and student toilets, allow for exhaust ventilation rates 25% higher than code minimum requirements

i. The following requirement must be met, in relation to thermal comfort:

   i. For naturally ventilated and mechanically assisted naturally ventilated spaces, if the useable floor area falls within the acceptable Limits of ASHRAE Standard 55-2004 they are required to achieve to this standard during standard operating hours of occupancy for 98% of the year for internal temperatures within 80% of Acceptability Limit 1.
ii. For mechanically air-conditioned spaces, the Useable Floor Area (UFA) falls within the Predicted Mean Vote (PMV) levels, calculated in accordance with ISO7730, for standard operating hours of occupancy for 98% of the year using standard clothing and metabolic rate values for PMV levels between -0.5 and +0.5, inclusive for 95% of the UFA.

iii. For mixed mode buildings, the above mechanical and natural ventilation thermal comfort criteria must be met for the relevant useable floor areas where the systems are provided.

5.2.6 EQUIPMENT/SYSTEM SELECTION AND SIZING

The University expects consultants and designers to select products of proven and reliable quality, with reputable support and after sales service.

The University expects consultants and designers to follow good industry practice. Additionally, the following are some particular points of note:

a. Chillers and chilled water plant must be sized and configured to handle peak load, part load and minimum load conditions in a stable and efficient manner. This may include the choice of particular chiller types, capacity, buffer storage or dedicated low load chillers
b. Chilled, hot, condenser water and air systems must be designed as variable volume/flow systems to allow for turn down in capacity and energy usage reduction
c. Pumps and fans must be selected in their stable range and high efficiency points of the pump and fan curves, for variable flow applications, ensure that the entire flow range is stable
d. In applying diversity factor, consider if the building is used in summer months or not and apply accordingly. For buildings which only operate during university semesters, peak loads may not occur in summer as the building may be closed. Consider either applying diversity in the calculations, or analyse the loads on a whole year and select leaks at other times or configure the plant to allow for load steps to match
e. For critical environments such as animal houses, special laboratories, clean rooms, museums or the like, stable operation of chillers and/or other refrigeration systems are crucial. Thus chillers of the appropriate capacity and type with suitable part load and low load characteristics are required
f. Critical environments must have duty standby setup installed on its equipment to ensure stable operation 24/7
g. Products which are of closed systems and proprietary in nature, thus locking the University into exclusive dependence of one manufacturer must be avoided and only used if there are no other options and approval is provided as per section 10 of the Design and Dispensation Standard
h. The system designer during the design phase is to provide a pipe work schematic highlighting the system flow rates, velocities and friction rates.
i. Where there are multiple chillers & boilers a minimum of two bypass lines and valves must be installed. One sized for high loads and the other for low loads.
j. All equipment must be selected to ensure it complies with the CIS BMCS standard and can provide the required inputs\outputs that are called up in the CIS BMCS Standard

5.2.7 MINIMUM ENERGY, EFFICIENCY AND HEAT RECOVERY REQUIREMENTS

a. Ducted air conditioning systems with higher than 1000L/s outside air must incorporate air to air heat exchangers for heat recovery or automatic outside air modulation in proportion to occupancy numbers. Bypass dampers must be considered for incorporation on all heat exchangers to ensure reduction in energy usage when heat exchanger is not being utilised.
b. For ducted air conditioning systems or single rooms that have a higher than 35 kW cooling load, an outside air economy cycle must be incorporated

c. All motors for pumps and fans that have or may have the ability to change speed must be provided with variable speed drives

d. All compressors must be variable speed and vary speed with change in loads

e. CO₂ sensors must be installed on systems with a capability to modulate outside air volume. Each return duct (at a minimum) sensor must be installed and must maintain a CO₂ concentration of below 800ppm

f. Chilled water storage must be considered to provide building redundancy, peak load reduction and low load operation assistance

g. Automatic shutdown of plant when spaces are unoccupied must be provided as a minimum, where spaces form part of a larger air system then positive shutoff of the spaces supply air must be provided when the space is unoccupied

h. Central toilet exhaust systems must have VSD drive installed and toilet occupancy sensors connected to drop exhaust rate when toilets are not occupied

i. General toilets must have occupancy sensor linked to the toilet exhaust system to shut the system down when there has been no movement in the space in the afterhours period. Toilets are to operate off time clock during office hours and motion sensor afterhours.

j. An energy model and report using BCA Section J energy modelling guidelines and the small plug loads template must be completed as per UOS Sustainability Framework. The designer/consultant is to ensure the predicted energy consumption for each space type within the building and predicted total value for the Building’s annual energy use perform at least 20% better than the reference building when the proposed building is modelled with the proposed services.

k. All HVAC equipment are to have the highest energy rating available under the Australian Government’s Energy Rating scheme for each standard capacity range of the appliance. Where multiple products are available in the market with the highest energy rating, preference must be given to locally manufactured products.

5.2.8 SYSTEM TYPES

The following are application guidance for various system types:

a. Mixed mode ventilation for offices, meeting and teaching areas where operable windows are available. A reed switch must be provided to automatically switch off all fan coil units when the operable windows are open to avoid energy wastage.

b. Meeting rooms must have independent FCUs installed or VAVs with the ability to completely shut off air flow when not occupied

c. All VAV systems with variable speed air handling units have proved to be reliable and appropriate for most applications

d. Use of corridors/foyers as relief paths if possible and appropriate to reduce supply air to these areas

e. Passive chilled beams must not be used. Passive chilled beam systems have been problematic due to the changing nature of university buildings.

f. Active chilled beams are acceptable.
g. The University does not accept ceiling cassette units as an appropriate system type for installation in office spaces with ceiling heights lower than 2.7 metres.

h. Underfloor displacement systems have proved to be acceptable in large tiered and arced teaching spaces. Specific care must be taken to ensure disabled/wheelchair allocated spaces are conditioned. Lecture theatres must be provided with specific supply to ensure adequate cooling/heating is provided. The university does not accept secondary air as a means of conditioning the lecture theatre.

i. Within all spaces that have projector screens, care must be taken to ensure supply and return air do not cause movement of the screens.

j. Variable speed water cooled chillers and multi-stage air cooled chillers must be used.

k. Use of split systems must only be permissible for very small additions to existing buildings. When these are used, ensure that they are sited in appropriate locations and any pipework reticulation is not unsightly, with appropriate cladding and run in a neat and tidy manner. All precautions must be taken to conceal the outdoor unit such putting units on accessible roofs, existing external plant spaces or behind vegetation.

l. Use of RAC window units are not accepted.

5.2.9 FUTURE ALLOWANCES

The provision of spare capacities for future must be considered for all projects. In making such considerations, careful analysis of spare capacity against the application of diversity and the balance thereof must be considered. The practicality of equipment sizing and selection against its product range can be used appropriately if and when equipment is rated for given capacities which may provide spare capacity without upsizing. Where central risers are installed, they must be sized to accommodate the full building’s requirements. All infrastructure and plant rooms must be future-proofed to allow for readily accessible connection points to future precinct based energy and water distribution systems (e.g. hot/chilled water loops), ensuring that precinct buildings can transition across to centralised services as per UOS Sustainability Framework.

5.2.10 CONSTRUCTION INDOOR AIR QUALITY MANAGEMENT

The consultant/designer must develop an Indoor Air Quality Management Plan (IAQMP) which incorporates the following:

a. HVAC protection from both dust and odours

b. Source control of any materials that contain Volatile Organic Compounds (VOCs). The construction team must be required to recover, isolate and ventilate containers housing toxic materials

c. Pathway interruption, clean or occupied areas are to be isolated from areas of work

d. Housekeeping, cleaning activities are to be regularly undertaken to control contaminants. Maintenance team should protect all porous materials from exposure to moisture. Vacuum cleaners with high efficiency particulate filters should be used.

e. Scheduling - the IAQMP should outline the schedule of activities for cleaning prior to occupancy including flush-out activities

f. Ductwork cleaning - all new and existing ductwork serving the building must be cleaned in accordance with recognised standards or construction management processes have been set-up and adhered to that ensure all new ductwork, or ductwork that has been recently cleaned, remains free of moisture and debris until occupation.
5.2.11 OTHER DESIGN REQUIREMENTS

a. All adhesive and sealant products used internally must have low Total Volatile Organic Compound levels (TVOCs).
b. Where dedicated fume cupboard makeup air systems are utilised, makeup air must be tempered and to only be activated when the fume cupboard system is operational.
c. The water control loop volume must be sized for at least the minimum chiller/boiler requirements.
d. Plant rooms must be naturally ventilated and where not, capable mechanical ventilation must be provided to assist temperature control.
e. All roof installations and penetrations must comply with the CIS Roofing and Guttering Standard along with the CIS Essential Fire Safety Measures Standard. This particularly applies to fire dampers and the type of inspection hatch required.
f. The contractor must provide input to the Building Users’ Guide (BUG) for all mechanical systems as per UOS Sustainability Framework. Information must be provided about the building’s use, functional and environmental aspects, and special features of the building and systems.
g. A minimum distance of 600mm must be provided between the roof surface and the lowest point of any equipment installed on or below a roof platform.
h. In conditioned spaces, outside air must be supplied into a mixing plenum and not directly supplied into a space without conditioning.
i. For critical environments such as animal houses, special laboratories, clean rooms, constant temperature environments, museums or the like, the design must include redundancy built into the design. This may include duty/standby arrangements or selection of systems that are of a robust nature.
j. For photocopy and print rooms, allow for dedicated exhaust system or connection to base building exhaust system.
k. Sensors must be suitably located to ensure accurate sensing of the space temperature. Sensors must not be installed on locations that will provide a false readings.
l. Critical control environments must be provided with certified sensors.
m. Where systems are installed in heritage buildings, specific design/approval from the University on the system solution and location of equipment must be obtained from CIS Engineering and CIS Heritage advisor.
n. Floor Differential Pressure sensors must be installed on all systems that service multiple floors including supply air and chilled heating/condenser water.
o. Gas/cryogenic liquid Storage rooms or spaces containing these must be fitted with an exhaust system designed to exhaust the specific gases stored within the space, such as low level duct work for heavier than air gasses or spark proof fans and equipment for flammable gasses. Systems must be fitted with a boost feature to allow the capability of purging the space so that all oxygen levels must be maintained at a safe level. Purge feature must be initiated from either a manual push switch or when a low oxygen level alarm or high gas level alarm is activated. When safe levels have been achieved, then system is to reduce exhaust rate to design conditions. In addition:
  i. Typical emergency purge rate is doubled to double the design exhaust rate while in purge mode.
  ii. Low flow ventilation alarm must be included in system to activate warning alarm.

5.3 DESIGN AND CONSTRUCT CONTRACT

5.3.1 GENERAL

This section outlines the extent of the services to be provided by the mechanical contractor under a design and construct contract.
The contractor must be fully responsible for the complete design of the mechanical services installation, including the selection, sizes and quantity of equipment, and must provide calculations and drawings and other documentation as necessary to demonstrate conformance with the design parameters, industry practice, CIS requirements, codes, regulations and standards.

The contractor must allow to fully co-ordinate the documentation with the architect, structural engineer and all other services consultants and contractors.

The contractor is to size ductwork and pipework as per the requirements detailed in this document.

## 5.3.2 CALCULATIONS

As part of the contractor’s design, it is expected that the following design calculations as a minimum are produced for review by CIS for approval prior to finalising design:

a. Cooling and heating loads for every zone and system (computer based)
b. U-value calculations
c. Outside air quantity calculations
d. Ventilation systems
e. Equipment selections based on the overall capacities calculated
f. Fan/pump and static/head calculations
g. Duct and pipe sizing calculations
h. Electrical and cable sizing calculations
i. All other calculations necessary to illustrate equipment reticulation and components have been selected fully in accordance with the project requirements and this specification.

## 5.3.3 DRAWINGS AND DOCUMENTATION

The contractor must provide design, construction and as-built drawings, which may be either design drawings produced by the contractor or shop drawings produced by equipment manufacturers.

The mechanical services contractor is responsible for producing all design and as-built documentation, including, but not limited to:

a. Concept Design documentation (as required):
b. Detailed Design documentation, including:
   i. Layout drawings
   ii. Details
   iii. Schematics
   iv. Design certification
   v. Equipment details
   vi. Testing / commissioning procedures
c. Workshop drawings, including:
   i. Drawings for the purpose of system manufacture
d. As Built drawings, including:
   i. Detailed drawings demonstrating the as installed system
e. Operations and Maintenance manuals.
f. Training manuals

All design documentation must be approved by CIS prior to any works progressing onsite. Workshop, as-built drawings and operation and maintenance manuals must be submitted to for review prior to final sign off.
5.3.4 TECHNICAL SUBMITTALS

Technical submittals must be provided with the full technical and spatial requirements of each proposed plant item. The technical submissions must include, where applicable, but not be limited to:

a. Certified shop drawings of each item complete with sectional weights and point loads
b. Certified noise levels from each plant item
c. Electrical requirements including starting current, running current, operational voltage, power consumption, recommended protection devices, wiring diagrams, connection and terminals details. Also detail of how cables are terminated to the plant item and earthing requirements must be provided.
d. Fan or Pump Curves as applicable.
e. Recommended spares schedules and projected future availability (to ensure that redundant components are not used)
f. Requirements for specialist tools to maintain the plant item
g. Maintenance zones and requirements including weights of any replaceable components.
h. Energy Consumption at 25%, 50%, 75% and 100% duty
i. Manufacturer’s recommendations for installation including ventilation and thermal requirements.
j. Confirmation of product lifespan assuming maintained to manufacturers recommendations.
k. Acoustic performance characteristics. This must be submitted to the acoustic consultant complete with a statement as to the expected room NR/NC/dBa rating for internal equipment such as fan coil/condensing units
l. Where equipment model numbers/references are stated these are indicative only and the Contractor MUST ensure the selected plant fully complies with the entire services standard

5.3.5 TECHNICAL COMPONENTS

The following sections contain technical requirements on equipment, materials and installations. Consultants and designers are required to adhere to these. In the preparation of consultants’ specifications, they are required to ensure that those project specifications do not contain any conflicting requirements or information with this document.

5.4 AIR COOLED CHILLERS

5.4.1 APPLICATION

Air cooled chillers must be used up to total system cooling capacities of 500 kW. For applications where each chiller is rated at higher capacities, preference is given to water cooled arrangements. For total system capacities above 750 kW, water cooled systems must be used.

5.4.2 ACCEPTABLE MANUFACTURERS

The following equipment are deemed to comply with this standard:

a. Trane;
b. Carrier; and
c. Powerpax

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.
For process chilled water systems, Auqacool and Stulz are acceptable suppliers. Other alternative equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

5.4.3 GENERAL REQUIREMENTS

Chillers must be variable speed above 500kW, fixed speed machines will not be accepted above this capacity.

The chiller controls must be configurable for manual or automatic start up and shutdown. In automatic operation mode, the controls must be capable of automatically starting and stopping the chiller.

Controls must be capable of resetting and resuming normal operation after power outage.

Chillers must be rated for continuous operation of up to 46°C ambient without tripping. The selected capacity must be rated at the design outdoor condition.

They must be equipped with soft starters and electronic expansion valves.

Refrigerant isolation valves must be fitted for easy recovery of refrigerant. Isolation valves must be fitted to refrigerant dryer and oil filters.

Electronic expansion device must be used, permitting operation at a lower condensing pressure and improved utilisation of the evaporator heat exchange surface.

Additional acoustic enclosures may be required, subject to noise control requirements specific to the project and based on the advice of the project acoustic consultant.

Chillers must be able to operate at a minimum of 20% of rated capacity in a stable and continuous manner.

During construction, the chiller must be fully covered from dust and moisture.

5.4.4 CORROSION PROTECTION

All surfaces of chiller to come pre-treated and factory painted. Chiller and pipe work must be isolated via rubber flexible coupling.

5.4.5 CONDENSER COILS

Condenser coils must be aluminium micro-channel heat exchanger or capable of cleaning with high-pressure washers.

Condenser coil protection must be of e-coating for micro-channel coils and Blygold for standard tube and fin condensers.

5.4.6 CONDENSER FANS

Condenser fans must be multi stage, systems installed to run under low ambient and low load conditions, condensers must have variable speed fans to maintain stable refrigeration system operation.

5.4.7 CONTROLS

Manufacturer must ensure that they comply with the University’s control strategy for chilled water system, noncompliance with University’s control strategy will result in chiller being rejected.

All passwords, software and hardware must be provided to the University for service of chillers.

Chiller control systems must be BACnet High Level Interface compatible. Refer to the University’s BMCS standard for the complete set of required points.

Chiller units must incorporate devices to limit the number of starts to a maximum of four (4) per hour.

The design of the system and the sizing of capacity to match building load characteristics is an important factor and constants and designers must ensure that this has been considered in their design.
The chiller controls must be configurable for manual or automatic start up and shutdown. In automatic operation mode, the controls must be capable of automatically starting and stopping the chiller. Controls must be capable of resetting and resuming normal operation after power outage or flow failure. Repeated flow failure alarms within a set time period must lock the chiller out and manual reset must be performed.

Hard wired control inputs/outputs points to be available include:

- Contact for remote alarm for each refrigerant circuit
- Automatic chilled water reset hard wired signal to chiller from external source and HLI through BMS
- Outputs for driving chilled water pumps
- Cooling call
- External safety device loop (such as pressure and flow switches)

The following points are to be available from the local controller:

- Entering/Leaving chilled water temperature
- Ambient temperature
- Condenser fan operation
- Refrigerant pressures and temperatures
- Oil temperature and Pressure
- Automatic chilled liquid reset timer programmed locally at chiller controller
- Soft loading control by temperature or load ramping
- Power (demand) limiter
- Manual speed control (Variable speed Chiller)
- Chiller operating status message
- Cooling call mode ie: local or remote
- Power-on/off
- Pre-start diagnostic check
- Compressor motor amps
- Alert (pre-alarm)
- Alarm and description of fault
- I/O test function
- Safety shutdown messages
- Elapsed time (hours of operation)
- Monitor/number compressor starts and run hours
- Chiller input kW
- Demand kW

## 5.5 WATER COOLED CHILLERS

### 5.5.1 ACCEPTABLE MANUFACTURERS

The following equipment is deemed to comply with this standard:

a. Trane;

b. Carrier; and

c. Powerpax

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

### 5.5.2 GENERAL REQUIREMENTS

Chillers must be variable speed, fixed speed machines will not be accepted.
The chiller controls must be configurable for manual or automatic start up and shutdown. In automatic operation mode, the controls must be capable of automatically starting and stopping the chiller. Controls must be capable of resetting and resuming normal operation after power outage or flow failure. Repeated flow failure alarms within a set time period must lock the chiller out and manual reset must be performed.

Chillers must be rated for continuous operation of up to 46°C ambient without tripping. The selected capacity must be rated at the design outdoor condition. They must be equipped with soft starters and electronic expansion valves. Refrigerant isolation valves must be fitted for easy recovery of refrigerant. Isolation valves must be fitted to refrigerant dryer and oil filters. Electronic expansion Device must be used permitting operation at a lower condensing pressure and improved utilisation of the evaporator heat exchange surface.

Subject to noise control requirements specific to the project and based on the advice of the project acoustic consultant, additional acoustic enclosures may be required.

During construction chiller must be fully covered from dust and moisture. Chiller must be pre-factory tested with certification of test.

5.5.3 CORROSION PROTECTION

All surfaces of chiller to come pre-treated and painted, water boxes to be ceramic coated before commissioning of chiller with a five year guarantee on Ceramic coating performance. Tube sheets are to be stainless steel or ceramic coated. Contractor is to remove water boxes and provide university notice to allow inspection of the tube sheets and the water boxes. Chiller and pipe work to be isolated via rubber flexible coupling to the chiller.

5.5.4 WATER BOXES

Water boxes must have vents, drains, and be of marine grade A materials. Allow for tube cleaning space in plant rooms as per manufacturers’ recommendation. Service space must be shown on the drawings. Water boxes must be ceramic coated or be made of stainless steel.

A thermistor type temperature sensor with quick connects must be factory installed in each water box.

5.5.5 CONTROLS

Manufacturer must ensure that they comply with University control strategy for chilled water system, noncompliance with University control strategy will result in chiller being rejected. Chiller must send the condenser water pump speed signal to the BMCS, the chiller must not send the signal directly to the condenser water pump drive.

All passwords, software and hardware must be provided to the University for service of chillers.

Chiller control systems must be BACnet High Level Interface compatible. Refer to the University BMCS standard for the complete of required points.
Chiller unit must incorporate devices to limit the number of starts per hour to a maximum of four (4) per hour. The design of the system and the sizing of capacity to match building load characteristics is an important factor and designers must ensure that this has been considered in their design. The chiller controls must be configurable for manual or automatic start up and shutdown. In automatic operation mode, the controls must be capable of automatically starting and stopping the chiller. Controls must be capable of resetting and resuming normal operation after power outage.

Hard wired control inputs/outputs points to be available:
   a. Contact for remote alarm for each refrigerant circuit
   b. Automatic chilled water reset hard wired signal to chiller from external source and HLI through BMS
   c. Outputs for driving condenser pumps
   d. Outputs for driving chilled water pumps
   e. Cooling call
   f. External safety device loop (such as pressure and flow switches)

The following points are to be available from the local controller:
   a. Entering/Leaving chilled water temperature
   b. Ambient temperature
   c. Condenser fan operation
   d. Refrigerant pressures and temperatures
   e. Oil temperature and Pressure
   f. Automatic chilled liquid reset timer programmed locally at chiller controller
   g. Soft loading control by temperature or load ramping
   h. Power (demand) limiter
   i. Manual speed control (Variable speed Chiller)
   j. Chiller operating status message
   k. Cooling call mode ie: local or remote
   l. Power-on/off
   m. Pre-start diagnostic check
   n. Compressor motor amps
   o. Alert (pre-alarm)
   p. Alarm and description of fault
   q. I/O test function
   r. Safety shutdown messages
   s. Elapsed time (hours of operation)
   t. Monitor/number compressor starts and run hours
   u. Chiller input kW
   v. Demand kW

5.6 Heat Rejection Methods

The choice of heat rejection method for water cooled chilled water systems must be assessed for each specific project. Closed circuit coolers offer water savings but require a larger area, more acoustic treatment and thus, greater capital costs. The indirect nature of cooling also requires greater running costs. Therefore, their application must be carefully assessed and the advantages and disadvantages analysed in a balanced manner.

Conventional use of cooling towers requires the lowest capital and running costs, but have a higher requirement of maintenance and water consumption costs associated. Consultants and designers are expected to assess the unique nature of each project and the priorities therein to make appropriate recommendations.

For process cooling loads, closed loop systems must be utilised.
5.7 Cooling Towers

5.7.1 Acceptable Manufacturers

The following equipment is deemed to comply with this standard:

- BAC
- Aquacool
- Marleytemcel

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

5.7.2 General

When cooling towers are used in water cooled chilled water systems, water side free cooling must be considered.

Cooling tower and installation must comply with all relevant codes, standards, acts and regulations. Towers must be designed and installed strictly in accordance with AS3666 and AS1055 as a minimum requirement. Particular care must be taken in its location with respect to intakes of air conditioning and ventilation systems, kitchen exhaust systems and similar locations which may pose a risk and provide breeding environments for legionella.

Pipe work connection to cooling tower must be a flexible connection. Side stream filtration and Automated Dosing system must be provided.

The tower and its installation on site must be designed to facilitate easy fan removal and maintenance with the installation of a platform and ladder for accessing/ removing the cooling tower fan and drift eliminators.

5.7.3 Construction

Cooling towers to be of fibreglass reinforced polyester (UV resistant) or stainless steel construction. Sumps must be one piece and coated with a smooth gel coat finish to increase bacteria resistance of the sump.

All parts must be accessible for cleaning and service. All access panels must have seals to prevent water leakage.

All steel support components must be heavy gauge hot dip galvanised steel and all welded components after fabrication must be hot dip galvanised.

5.7.4 Fans

All cooling tower fans must:

- have VSD drives fitted
- be fully enclosed and weather proof to IP 55 rating with Class F insulation with windings that are tropic proofed.
- ensure maximum fan operation speed must not exceed 1000RPM
- have epoxy coated type fan motors
5.7.5 WATER DISTRIBUTION

Header pipes must be configured to ensure even distribution over the entire fill area.

UPVC or ABS Nozzles must be used.

5.7.6 CAPACITY

Cooling towers dedicated to chilled water systems must be a minimum of 1.5% oversized for the designed heat rejection capacity.

5.8 THERMAL METERS

Thermal meters must be installed on all chilled, heating and condenser water systems must provide total plant/system active capacity, meters must be connected to the BMCS and data from the meter picked up by the AUMS. Meters must comply when used for billing purposes (tenancies) they must comply with metering guidelines under the weights and measures legislation, as outlined under the current National Measurement Regulations.

Following are specific areas that require meters:

a. Chilled water tenancies
b. Chilled water system
c. Heating water system
d. Heating water tenancies
e. Condenser water tenancies
f. Process chilled water loops
g. Building take offs from central chilled/heating and condenser water systems

5.9 PUMPS

The following are general requirements for pumps:

a. Must be end suction pull out type. Closed coupled types are not acceptable.
b. Casings must be gun metal or cast iron
c. Impellers must be bronze
d. Shafts must be stainless steel
e. Maximum speed must be 1,440 rpm
f. All pumps must be mounted on an inertia base
g. Motors for external applications must be IP56, totally enclosed, selected for non overloading
h. Pumps above 0.75 kW must be selected with a minimum efficiency of 70%. Pumps below 0.75 kW must be of minimum 50% efficiency
i. For chilled water applications, provide stainless steel drip tray between pump and base, and extend beyond edges and flanges
j. Allow for 20% spare capacity in pump selection
k. Provide permanent marking of pump rotation direction
l. Provide permanent nameplates of make, model, rating and serial number
m. During construction pump and motor are to be fully covered from dust and moisture.

The following equipment is deemed to comply with this standard:

a. Grundfoss
b. Ajax
c. Masterflow

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

5.10 VARIABLE SPEED DRIVES (VSD)

5.10.1 MODEL

The following equipment is deemed to comply with this standard:
   a. Danfoss
   b. ABB

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

5.10.2 REQUIREMENTS

   a. VSDs must be BACnet compatible and connected to the BMCS
   b. VSD to be positioned and installed as per manufacturer’s instruction, including earthing and sheathing of VSD cabling.
   c. Servicing of the drive must not require access from the back of the VSD.
   d. The VSD must be solid state adjustable frequency drive type controlled by a microprocessor and suitable for use on cube power absorption loads such as fans and pumps
   e. The drive must be capable of adjusting the speed of any 415V, 50 cycle, 3 phase motor of suitable power rating over a full speed range and determine the optimum power supply to its connected motor to maintain the most efficient running characteristic of that motor. The drive must be capable of starting a motor that is freewheeling backwards.
   f. During construction VSDs are to be fully covered from dust and moisture.
   g. The drives must be able to accept a fire signal to run at a designated speed under fire condition where required.
   h. The variable speed drive must be interfaced to the University’s BMCS DDC system and allow full monitoring and control functions from the Front End Terminal.

VSDs must include the following features:
   a. Ventilating enclosure
   b. 4-20 mA DC or 0-10VDC signal
   c. Separately adjustable ramps for soft start and soft stop
   d. Manual speed control
   e. Manual reset button for all trip functions
   f. Adjustment facility for maximum and minimum speed setting
   g. Electronic overload motor protection - Faulty alarm relay -0-10VDC speed indicating signal.
5.10.3 VSD, EMC AND THD COMPLIANCE

Preference must be given to using VSDs using IGBT input rectifier systems if available, for the rated load, as these provide very low input harmonic distortion.

a. Electromagnetic Compatibility and Harmonics

i. Incorporate filters to limit radio frequency interference and electromagnetic emission to the levels prescribed by AS/NZS CISPR 11 Group 1 Class A. External RFI filters are not acceptable.

ii. The VSD must comply with E.M.C. (Electromagnetic Compatibility) (R.F.I. Control) document VDE0875 (EN55011).

iii. The manufacturer must issue a Certificate of Compliance upon request. It must conform to immunity standard IEC 801 parts 2 to 5. The VSD must carry the C.E. Mark of Compliance.

b. Provide DC link harmonic filtering with inductors and capacitors in the DC Bus to limit the Harmonic Distortion Current into the incoming supply to no greater than permitted by AS/NZS 61000.3.12:2013 - Electromagnetic compatibility (EMC) - Limits. “Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and ≤75 A per phase”, or lower if required to achieve aggregate compliance with this standard for all loads at the respective mechanical switchboard.

c. VSDs not incorporating DC inductors may include maximum 5% AC input inductors to achieve compliance.

d. Comply with Harmonic emission requirements of AS 61800.3-2005 - Adjustable speed electrical power drive systems - EMC requirements and specific test methods

The VSD must include a radio frequency suppression filter, within its enclosure, to ensure compliance with AS61800.3 as follows:

i. For powers ≤90kW the VSD - Category C1 products with 50m motor cable;

ii. For powers >90kW the VSD - Category C2 products with 50m motor cable;

5.10.4 VSD AND MOTOR PROTECTION FEATURES

The VSD motor must incorporate the following protection functions:

a. Over voltage, under voltage and mains phase loss

b. Output earth fault, short circuit and loss of motor phase

c. Switching on output (alternatively control interlock to VSD allowed)

d. Flying start of motor in forward or reverse direction

e. Electronic motor thermal protection and motor condensation protection

f. Over current / current limit with automatic ramp control

g. Inverter overload / over temperature / operation without motor

h. Automatic re-start must be available on over/under voltage and current limit trip
5.10.5 CONTROL PAD

The control panel must include:

a. Manual / off / auto, start, stop and reset control functions
b. Output current, voltage, frequency, kW, kWh, Hours run, heat-sink temperature reference and feedback signal indication:
c. Last event fault memory and program lock.

5.10.6 PROTECTION

The drive must have ingress protection against duct and splashing water in all directions to not less than IP-54.
A door mounted control panel must be incorporated with alpha numeric display and keypad for programming, status and fault diagnostics indication in plain English.

5.10.7 WIRING

VSDs connected to the BMCS must have status, enable, fault and start/stop signal hard wired all other parameters will be provided via the BACnet HLI.

5.10.8 SOFTWARE, PROGRAMMING, PASSWORDS AND OPERATION AND MAINTENANCE

Provided with installation of VSD:

a. Software and required unique devices for programming VSD
b. VSD program parameters once final commissioning is complete
c. HLI Points list
d. All product passwords for servicing and installation
e. Installation diagrams
f. Sizing information of drive
g. Wiring requirements
h. Application support information
i. Trouble shooting charts

5.10.9 HIGH LEVEL INTERFACE AND CONTROL

BACnet HLI must make available a minimum number of points, please refer to BMCS standard for minimum required points.

The control signal to the VSD must be provided via a low level interface control signal such as a 0-10v DC signal. The low level control signal must be adjustable via BMCS for testing and maintenance purposes.

5.10.10 VSD OUTPUT SHIELDED CABLEING

Provide shielded multicore cables specifically designed and identifiable for use with VSDs.
Restrict maximum length of output cabling to 45m.

5.10.11 VSD ENVIRONMENT PROTECTION

VSDs must be located within plant room spaces. If an external location is impossible to avoid, then irrelevant of any manufacturers IP rating, locate exterior VSDs under an awning / shade providing protection from direct sunlight and rain. VSDs must not be located in enclosed boards.

5.11 FANS

5.11.1 GENERAL

All 3 phase motors must be MEPS 2 compliant. During construction, chiller must be fully covered from dust and moisture.

5.11.2 VENTILATION FANS

The following equipment is deemed to comply with this standard:

- Fantech and Flakt-Woods.

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

Fans and motors must have 10% additional capacity for future refurbishment flexibility.

5.11.3 BELT DRIVEN FANS

Drive sizing:

- size for $\geq 125\%$ of motor power and capable of transmitting the full starting torque without slip

Belts:

- Wedge belts to AS 2784, consisting of matched sets of at least 2 belts.
- Mark belt size in a prominent location on the fan casing.

Belt tensioning:

- Provide adjustment of belt drive tension by either movement of motor on slide rails or by pivoting support. Do not use the weight of motors to provide belt tension.
- Restrain motors with locknuts on bolts, clamping motors in place.
- Provide rigid, removable belt guards on all fans where drive is accessible while motor is running.

Provide the following:

- Tachometer opening
- Perforated sides on double width, double inlet fans
- Weatherproof construction, ventilated and drained where exposed to weather.
- Material: Open mesh or perforated metallic coated sheet steel.

5.11.4 HIGH TEMPERATURE EXHAUST FANS

Provide heat slingers and guards on shafts between the inboard bearings and fan casings. Locate inboard bearings clear of fire rated insulation applied to fan casings.
5.11.5 KITCHEN EXHAUST FANS

In addition to the requirements above, provide the following:

a. Access for cleaning:
   i. Provide a large gasketed access panel.

b. Drain:
   i. Provide trapped drain from lowest point in casing.
   ii. Provide unions at connection and arrange drain to be easily cleaned, pipe drain to waste.

c. Finish:
   i. Internally zinc sprayed.

d. Fire rating:
   i. If installed in a fire rated duct system and not installed in a separate fire rated room or enclosure, fire rate fan to the same standard as duct.
   ii. Ensure that fire rating provisions permit easy access for inspection, cleaning and maintenance.

5.12 PLANT ROOMS

a. Plant rooms must not be used as a plenum unless they are serving one zone and the plant room is sealed
b. Plant rooms used as a plenum must not have any uncharged open floor wastes
c. All plant room floor wastes must be charged by condensate or a nearby tap to prevent odours
d. Chilled/Heating water schematics must be laminated/ framed and fitted to all major plants room wall in A1 size
e. AHU plant rooms must have an air schematic laminated/ framed and fitted to the plants room wall in A1 size
f. All trip hazards are to be suitably covered and highlighted to ensure they made safe and the trip hazard is removed
g. The bottom of duct work must be installed no lower than 2.1m from the floor in trafficable plant room spaces

5.13 RETURN/SPILL AIR

Return air must be fully ducted from the conditioned zone to the FCU/AHU.
It is the University preference that spill air be used to condition spaces external to conditioned zone rather than relieving to atmosphere.

5.14 AIR HANDLING UNITS

5.14.1 GENERAL

Air handling units can supply multiple levels if the areas have a similar function.
Note to designers that flexibility must be assessed with the University to ensure that spaces will not be re-purposed nor have loads increased in the future. In the case where spaces will be re-purposed, individual AHUs must service the space or if there is a specific afterhours operation of a particular space.
AHUs must service common space types (e.g.: University will not accept an AHU servicing office and lecture theatres).
VSDs must be employed on all air handling units.
For VAV systems, these must be used for air volume modulation, for CAV systems will not be accepted.
Fans must be selected as per the previous sections on equipment selection and fans.
During construction AHUs must be fully covered from dust and moisture.
The following equipment is deemed to comply with this standard:
   a. Fan Coil Industries
   b. York
   c. Air Design
   d. Carrier and Trane

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

5.14.2 CONSTRUCTION
AHU construction must be of double skinned sandwich panel construction, preferably modular type with easy and safe maintenance access.
Integrated supply and return air flanges must be provided to allow bolting of supply and return air duct work for ease of removal. University will not accept direct fixing of duct work to the AHU.
Fixed switchable lights must be provided in AHU chambers

5.14.3 HEAT RECOVERY
The installation of an air to air heat exchanger setup must be assessed on each system design where there is exhaust or relief air from a space. The designer must perform detailed calculations to show the annual energy savings from the installation of the heat recovery system in particular weighing up the energy recovered against added fan energy required for the heat exchanger. Where there is an annual energy saving from the installation of a heat exchanger, the exchanger must be installed. Heat exchangers must utilise bypass dampers when conditions for heat recovery is not favourable.
The accepted methods are:
   a. Rotary wheel
   b. Cross flow plate exchanger

5.14.4 SPRAY COILS
Supply airstream spray coils are not accepted.

5.14.5 COOLING COILS
A maximum face velocity of 2.5m/s across the cooling coil must be followed.
Low cooling load dehumidification must be considered when selecting cooling coils

5.14.6 DRIP TRAYS
Drip trays must be provided at each coil section and all connected to a main AHU drain.
Drip trays must be manufactured from stainless steel.

5.14.7 HEATING COILS

The maximum allowable face velocity for heating coils is 3.8 m/s.

Electric resistance heaters must not be used.

5.14.8 FILTERS

Each air handling unit must be provided with pre filters and fine filters.

5.14.9 MIXING BOX

Each air handling unit must come with its own mixing box for return and outside air connections. It must be of the same construction as the main body of the unit. Opposed blade dampers must be provided at connections for balancing.

5.14.10 FACE BYPASS DAMPERS

Where an AHU supply air volume is above 4000 L/s face bypass dampers must be utilised to reduce fan static while operating on economy cycle.

5.14.11 LOCATION

All air handling units must be located in plant rooms with appropriate access for maintenance. Maintenance access must be provided as per manufacturers’ recommendations.

5.14.12 HUMIDIFICATION / DEHUMIDIFICATION

Where specific dehumidification is required, the consultant/designer must ensure efficient operation of the system, this would include the use of standalone dehumidification units for single zones. Where multiple zones require dehumidification then a central plant solution is appropriate. The overcool reheat method must be used as a last case for dehumidification due to its inherent energy inefficiency.

Where large humidification loads exist, the use of ultrasonic dehumidification is appropriate.

5.15 CHILLED/HOT WATER FAN COIL UNITS

5.15.1 GENERAL

Fan coils must be mounted using vibration springs or the internal fan must be fitted with vibration elimination mounts.

Supply fans must be provided with and utilise a variable speed drive or three speed windings.

Local power isolator must be provided with FCUs.

Filters must be installed in FCU’s in a position to be removed by a service person without moving of furniture or standing on fixed furniture.

Filter access must be safe; where single filters are not practical split/multiple filters will be accepted.

Safe and efficient access for service to FCUs is a key issue for the University and must be ensured by the contractor.
The following equipment suppliers are deemed to comply with this standard:

a. Temperzone
b. Fan Coil Industries Pty Ltd
c. Muller
d. Sink (Air Solutions International)
e. Carrier and Trane

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

5.16   CHILLED/HOT WATER PIPEWORK

5.16.1 DESIGN

Future expansion allowances must be made when designing and sizing chilled/hot water pipe work reticulation systems with practical considerations of the steps in each pipe size. Pipework systems must be designed and configured such that they assist in balancing inherently and reduces the reliance of high throttling of valves due to high system pressure differences between various legs.

Insulation provided on pipe work must be compliant with Section J: Energy Efficiency of the National Construction Code (NCC) and must have zero Ozone Depletion Potential (ODP).

Victuakic Couplings are not considered as an appropriate means of vibration isolation and pipe joining.

5.16.2 PIPE SIZING

Pipework systems must be sized with considerations to flow rates, velocities and friction rates, so as to minimise noise, erosion and energy consumption.

Table 1 shows the guidelines for velocities and friction rates for pipe sizing.

<table>
<thead>
<tr>
<th>Diameter in mm</th>
<th>Velocity in m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>50</td>
<td>1.1</td>
</tr>
<tr>
<td>100</td>
<td>1.25</td>
</tr>
<tr>
<td>150</td>
<td>1.5</td>
</tr>
<tr>
<td>200</td>
<td>1.75</td>
</tr>
<tr>
<td>250</td>
<td>2</td>
</tr>
<tr>
<td>300</td>
<td>2.5</td>
</tr>
</tbody>
</table>

The friction rate of 200 Pa/m is considered a good benchmark for most sizes, for large sizes and in exceptional circumstances this may be exceeded, but to no more than 400 Pa/m. 2.5 maximum velocity.
5.16.3 PIPE MATERIAL

Pipework material must be as per Table 2.

Table 2 : Pipe work material

<table>
<thead>
<tr>
<th>Design Pressure (kPa)</th>
<th>Chilled and Condenser Water (10°C to 50°C Max.)</th>
<th>Heating Water (10°C to 90°C Max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diameter (mm)</td>
<td>Minimum Pipe Wall</td>
</tr>
<tr>
<td>700</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 200</td>
<td>Type B</td>
<td>2.34 mm</td>
</tr>
<tr>
<td>- 225</td>
<td>2.64 mm</td>
<td>200</td>
</tr>
<tr>
<td>- 250</td>
<td>2.64 mm</td>
<td>225</td>
</tr>
<tr>
<td>1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 100</td>
<td>Type B</td>
<td>0 - 90</td>
</tr>
<tr>
<td>- 125</td>
<td>Type A</td>
<td>100</td>
</tr>
<tr>
<td>0 - 150</td>
<td>Type A</td>
<td>125</td>
</tr>
<tr>
<td>- 200</td>
<td>2.95 mm</td>
<td>150</td>
</tr>
<tr>
<td>1400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 80</td>
<td>Type B</td>
<td>0 - 50</td>
</tr>
<tr>
<td>- 100</td>
<td>Type A</td>
<td>80</td>
</tr>
<tr>
<td>- 150</td>
<td>3.25 mm</td>
<td>100</td>
</tr>
<tr>
<td>- 200</td>
<td>3.25 mm</td>
<td>125</td>
</tr>
<tr>
<td>2100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 40</td>
<td>Type B</td>
<td>0 - 32</td>
</tr>
<tr>
<td>- 50</td>
<td>Type A</td>
<td>40</td>
</tr>
<tr>
<td>- 65</td>
<td>2.03 mm</td>
<td>50</td>
</tr>
<tr>
<td>- 90</td>
<td>2.64 mm</td>
<td>80</td>
</tr>
<tr>
<td>- 100</td>
<td>3.25 mm</td>
<td>90</td>
</tr>
</tbody>
</table>

In addition, steel pipework should be considered for large size and high pressure systems, although ensuring that there is adequate provision to avoid corrosion due to direct contact between dissimilar metals.

Stainless steel must be considered where warranted for special applications such as process water or similar.

5.16.4 COPPER PIPE JOINTS

a. Silver soldered joints for all pipe sizes.

b. Viega Propress compression fittings for copper pipe sizes equal to or less than 65mm diameter using specialised pressing tools in accordance with the manufacturer’s instructions, for above ground applications only.

c. 15% silver solder for chilled and hot water lines

d. Minimum 6mm lapped joints

e. Joints must be made from preformed copper tees. Site or factory fabricated copper tee joints are not permitted.
The use of alternative compression press fittings will not be accepted without prior approval from CIS.

5.16.5 CLADDING AND INSULATION

All external pipe work i.e. exposed to weather, etc. must be insulated and encased in stainless steel sheet metal cladding.

All pipe work must be identified in accordance with the appropriate standard for the Identification of Piping (See Section 5.30.5): flow direction arrows must be provided to all pipe work in accordance with these standards.

All exposed pipe work in plant rooms and risers must be fully painted and clearly labelled to indicate the purpose of the pipework, direction of flow and, if relevant, hazards.

Insulation must be provided to chilled water and heating water piping to comply with NCC (BCA) requirements.

Moulded polystyrene section must be used for cold piping with an appropriate vapour barrier.

Mineral wool or glass fibre must be used for hot piping only.

Table 3: Pipe work metal sheathing

<table>
<thead>
<tr>
<th>General</th>
<th>Service</th>
<th>Location</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chilled and heated Water</td>
<td>Plant Room</td>
<td>0.55mm (min) Zinc Coated Steel</td>
</tr>
<tr>
<td></td>
<td>Chilled and heated Water</td>
<td>Sterile Environment/outside</td>
<td>0.6mm (min) Stainless Steel 316</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Jointing</th>
<th>Run</th>
<th>Lap</th>
<th>Location of lap</th>
<th>Riveting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td>40mm minimum</td>
<td>Facing down</td>
<td>Stainless Steel pop rivets and be riveted with 100mm uniform spacing</td>
<td></td>
</tr>
<tr>
<td>Vertical</td>
<td>As above</td>
<td>Sheltered</td>
<td>As above</td>
<td></td>
</tr>
</tbody>
</table>

5.16.6 PRESSURE TESTING

Each system must be pressure tested to 2 times the design operating pressure. The test pressure must be held for 24 hours as a minimum. The consultant/designer must be responsible for advising the designed system pressure and check the contractor’s proposed testing pressure.

5.16.7 FLASHINGS AND PENETRATIONS

Must comply with CIS Roofing Standard.

5.17 CHILLED/HOT/CONDENSER WATER VALVES

The following equipment is deemed to comply with this standard.

a. Butterfly valves:
   i. Ebroor;
   ii. Turnflo

b. Butterfly valves – groove jointing:
   iii. Victaulic

c. Double regulating valves:
   i. Belimo;
   ii. Tour and anderson;
   iii. Oventrop

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d. Test probes:
   i. Binder engineering

e. Auto drains:
   i. Spirax 12 mm ca550
   ii. Champion / hiross pac120

f. Flow limiting devices:
   i. FlowCon

g. Automatic Air Vents:
   i. Spirax OSI or AE Series

h. Industrial hand tool fittings:
   i. CEJN Series 320

i. Breathing air outlets:
   i. CEJN Series 342

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

5.17.1 CONTROL VALVES

Control valves, inclusive of all components and actuators, must have working pressure ratings and close off ratings suitable for the system in which they are installed. Valve body, glands, seals and components must be capable of withstanding the design pressure and design and test pressure. Valve, actuator, disc and seat must be capable of closing against a differential pressure of 125% of the maximum shut off pressure which can be developed across the valve by the system pump/s. When closed, the valve must have zero leakage. Control valves must be suitably sized to ensure that noise is not generated through the valve. The following equipment is deemed to comply with this standard:
   a. Belimo

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

5.17.2 ISOLATING VALVES

For each type of system, isolating valves on flow and return lines must be installed at each floor and zone to allow isolation of systems without the need for draining the whole circuit. Isolation valves must not be used for balancing and must be left in the fully open position. Isolation valves must be provided on all major pieces that would require maintenance such as chillers, boilers, heat exchangers, bypass valves, air and dirt separators, cooling towers, pumps, FCUs, AHUs, Reheat coils and water cooled package units.

5.17.3 BALANCING VALVES

At least one balancing valve must be provided at each item of equipment. Valves used for balancing must be specifically designed for this purpose, with appropriate regulating characteristics, of sufficient linearity, markings and settings. Balancing valves must be located in the return lines from each item of equipment and sufficient space must be provided around valve for service. For each balancing valve, an isolation valve must be provided adjacent to it for isolation purpose.
5.17.4 VALVES IN THE CEILING SPACE

All chilled water and heating water and any other valves in the ceiling space and which are subject to sweating must be insulated.
Access panels must be provided at each valve located within ceiling spaces to allow service access.

5.17.5 VALVE UNIONS

All screwed valves and fittings must have unions to allow removal of the valve or the equipment it serves without dismantling an extensive amount of pipework.

5.17.6 CONNECTIONS TO EQUIPMENT

Isolating valves must be used at connections to all items of plant and equipment.
Connections must allow the removal of the pant without removing a large section of pipework or draining the system.
Victaulic couplings are acceptable method for connection to a chiller condenser and evaporator water boxes.

5.17.7 BINDER COCKS

Must be fitted to all chilled water and condenser water heaters, all chillers, the main flow and return line from a chiller plant, each main flow and return feeder or riser, to all flow and return lines to air handling units/ FCUs and adjacent to all DDC sensors.

5.17.8 VENTS

Manual or automatic air vents must be provided at the highest points of the system and all other points where air may collect.

5.17.9 DRAIN/ MANUAL FILL POINTS

Drain points must be provided at the top/bottom of the system and on each floor.
Manual fill points must be provided at the top of the system and on each floor of the system.

5.18 CONDENSATE DRAINS/SAFETY TRAYS

5.18.1 GENERAL

All drainage must comply with CIS Hydraulics Standard.

5.18.2 CONDENSATE PUMPS

Condensate pumps are not accepted. All condensate drains must be gravity drained. Condensate pumps are only permitted in the case of split system cassette units when they are integral parts of the unit.
The University expects the consultant/contractor to take a holistic view on locations not within their build zone to provide location for condensate drainage to run to.

Where a dispensation is approved for a condensate pump, suitable safeties must be included such as moisture sensor in safety tray, local visual alarm where BMCS connection is not possible and unit to shut down on pump failure or high level sensor.

BMCS must have an alarm for leak detection and condensate pump failure.

5.18.3 SIZING AND MATERIAL

Condensate drain pipework must be minimum 32mm diameter.
Drains must be run in Copper for AHUs, Boilers, Discharge temperature is higher than 40˚c & where treated water is discharged.
All there condensate drains are to be in Best Environmental Practice (BEP) certified UPVC.

UPVC Fittings must be an approved brand spigot and/or socket type for solvent welding.
Electrical conduit or flexible hose is not an accepted material for use on condensate lines.

5.18.4 CONDENSATE WASTE DRAIN INSULATION

All Internal condensate waste pipework must be fully insulated.

5.18.5 CONDENSATE TRAPS

Either barrel unions must be fitted to all traps or a clear trap with the access ports for maintenance of the trap must be used to allow the ability for easy maintenance access.

5.18.6 CONDENSATE DISCHARGE

All Condensate water must be discharged to waste line only.
All condensate drain lines must be plumbed and installed independently to the discharge point of the drain.

5.18.7 SAFETY TRAYS

a. Condensate and safety trays must be independent of FCU ceiling package units.
b. Floor mounted package units must have tray installed under them.
c. Tray must over hang unit by 50mm to allow sufficient coverage.
d. Tray must cover associated chilled water valves or valves that could allow condensation to form on them
e. External condensate pumps must be located in a small safety tray.

5.19 AIR CONDITIONING CONTROLS

Note this section is for standalone controls for small applications such as single package unit installation, where BMCS has not been specified.
5.19.1 GENERAL

The following equipment is deemed to comply with this standard:
   a. Seimens
   b. Innotech
   c. Regulator

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

Control systems must be setup to maximise energy efficient operation of plant.

The following control items must be utilised in a site specific combination for control of air conditioning systems on/off control of small systems or individual units:
   a. Passive Infra Red (PIR)
   b. Time delay push button
   c. Time clock function (Only applicable for open plan office spaces)
   d. After hours switch to be used in time clock controlled areas

Individual offices must be provided with individual control (operation on/off and temperature adjustability limited to 20-26°C)

User interfaces items such as occupancy switches, alarm buttons/switches etc. are to be positioned in locations suitable for use by persons with limited mobility.

5.19.2 ALARMS

The university operates a 24/7 operated security desk. Critical alarms must be hard wired to the nearest Cardax communications room with a relay provided with a set of normally open and normally closed contacts for security to connect to.

This includes areas such as animal houses, cool rooms, labs/research environments and major plant.

5.19.3 ALARM PRIORITIES

Alarm priorities must be identified for each individual project and consultation must occur between the users and CIS Engineering.

5.19.4 FIRE MODE OPERATION

For systems which are designed to trip out upon a fire trip, once the fire trip has been activated all relevant mechanical fans are to automatically shut down. After the fire panel has been reset to correct operation all plant must be designed to restart automatically.

Plant that is not required to shut down under Australian standards and codes must not be shut down.

5.20 MOTOR CONTROL CENTRES AND MECHANICAL SWITCH BOARDS

In addition to general compliance with the CIS Electrical Services Standard switchboards clauses, mechanical boards must also comply with the following addition requirements which are specific to motor control centres.

Metering must be provided on mechanical boards according to the CIS Electrical Services Standard.

This detail includes the specific loads that are required to be metered for example cooling tower fans and AHUs.

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The metering must be connected to the University’s Advanced Utilities Monitoring System (AUMS). The intent is that mechanical services switchboards must be of the same high quality as applies to the electrical distribution system. Traditional “Form 1” type MCCs with all internal wiring and components contained within a single open compartment without any internal escutcheons will not be accepted.

All mechanical control boards must be located indoors. All mechanical control boards must comply with the minimum IP ratings listed below.

Mechanical control boards are to have the following minimum IP Ratings:

a. Located Indoors: IP43 degree of protection in accordance with AS 60529
b. Located externally: IP55 degree of protection in accordance with AS 60529

Boards must be well ventilated and extraction fans be fitted to boards where overheating is an issue.

Separation of equipment must comply with AS/NZS 3439.1.

Essential services must be Form 4a separated from non-essential services and otherwise separation must be as scheduled.

Mechanical electrical systems must be of an equivalent high standard and type as that provided by the electrical contract works on any project. Ensure and must comply with relevant portions of CIS Electrical Services Standard.

5.20.1 BOARDS

Construction forms refer to AS NZS 3439.1-2002 Low-voltage switchgear

Input Supply Greater Than 400a:

a. MCCs rated more than 400A input supply must be constructed to Form 3B for the mains distribution with input, output and functional units segregated using metallic compartments behind separate covers.
b. Separately protected and metallically segregated distribution or controls sub-sections within such MCCs that are rated less than 250A may be constructed in accordance with the following 400A MCC type.
c. Type “ih” construction utilising CB or insulation of conductors must not be used.
d. Provide a multifunction power meter in the input supply complying with the CIS Electrical Standard.
e. All essential services sections must be segregated by metallic compartments.

Input Supply Less Than 400a:

a. MCCs rated less than 400Amps input supply must be constructed to Form 1 standard of materials and fabrication equal to the CIS Electrical Services Standard using custom built fully folded welded metal frames.
b. The main power distribution including incoming mains terminals, main switch, power distribution and circuit overcurrent protection must be contained within a separate metallic segregated compartment. The compartment must have a dead front door with only the main switch operator exposed on the front, all other circuit operators behind the door, and a hinged escutcheon plate with neat cut-outs for CB toggles. Live parts must not be visible with the front door open.
c. Provide a segregated compartment for BMS and AUMS terminals which must be located to permit external ELV cabling to enter the compartment directly from the external surface of the switchboard and be safely connected without de-energising the switchboard. External ELV cabling must not pass through the mains voltage sections. The BMS terminal compartment may be located within and behind the general controls door section, but must be fitted with an unlocked internal hinged cover.
d. Segregate internal ELV, BMS and mains voltage cabling within the switchboard.
e. Provide front panel control switches for all motors or loads with auto / off / manual switch positions, and run / fault indicator lamps.
f. Provide a “supply available” lamp illuminated white near the main switch.
g. All essential services sections must be segregated by metallic compartments.

5.20.2 SWITCHBOARD FAULT LEVEL AND PROTECTION GRADING

a. Obtain details of the power supply system fault level, protection trip settings and voltage drop at MCCs from the electrical contractor.
b. Provide MCC and equipment rated at standard fault current steps, and minimum 10kA for 0.2 seconds.
c. A fault or overload on any sub-circuit must not interrupt supply to any other load. Circuit breaker protection grading must be fully co-ordinated and with full protection discrimination from the supply to the final load.

5.20.3 FIRE TRIP INDICATOR AND FIRE FAN CONTROL

a. Provide a fire trip indicator lamp on any MCC with fire interface, which must be illuminated red and labelled “Fire Trip Activated”
b. Provide an electronically regulated, output overcurrent protected inverter type 24VDC power supply for the fire trip controls signal. The fire trip input will be fail safe normally closed voltage free contacts that open on fire trip.
c. Provide local “Fire Fan Control Panels” for smoke control systems in accordance with codes and standards, and NSW Fire Brigade requirements. Liaise with the fire services contractor and ensure a fully integrated and co-ordinated system is provided.

5.20.4 FIRE RATING ESSENTIAL SERVICES

Attention is drawn to the requirement for all essential services wiring and control equipment, including VSDs that do not have an external automatic hard wired bypass, to be segregated and protected against fire and water spray for two hours. Refer to and comply with the CIS electrical services standard fire-rated wiring section for wiring to all essential services loads.

5.20.5 BMS AND SIGNAL CONTROL CABLELING SEGREGATION

Comply with standard and code requirements for segregation of ELV wiring (BMS, communications and <100V) and mains voltage wiring. This applies also within switchboards. Provide separate cable trays or conduit for ELV cable groups of 5 or more cables. ELV and mains cable to single loads or small MCCs (<5 loads) may be run cable tied in neat bundles on the same cable tray, provided that minimum 150mm space is provided between, and they are on opposite sides of tray, and labelled.
General floor controls to fan coil units and thermostats etc must be separately enclosed from the mechanical sub-circuit wiring. Mechanical or BMS cabling must not be installed on University communications’ cabling trays or infrastructure, or on general power system cable supports.

**5.20.6 CABBING IDENTIFICATION**

All mechanical wiring systems must be clearly identified in areas outside of a dedicated mechanical plant room, label all mechanical wiring and cable supports at maximum 10m intervals, Provide “MECHANICAL SERVICES” or “BMS SYSTEM” self-adhesive stickers or cable tied plastic labels on trays and conduits. For catenary or clip supported sub-circuit bundles provide plastic tags with >8mm text cable tied to the cable bundle.

**5.20.7 BOARD ACCESSORIES**

a. Mechanical boards must be fitted with a manual/auto/off switch for all equipment allowing manual operation of the equipment.

b. Fire trip indicator light must be provided.

c. Lamp test push button must be provided.

**5.20.8 AGGREGATE HARMONIC DISTORTION PERFORMANCE AT THE MCC INPUT SUPPLY**

This clause specifies the aggregated Harmonic Distortion performance at the input to Motor Control Centres (MCC) or mechanical switchboards with single or multiple loads, to account for the additive effect of harmonic current distortion from otherwise individually “EMI compliant” VSD components. It requires that the designer and contractor must design and install an integrated system accounting for multiple loads, providing harmonic mitigation measures, and / or high quality VSDs to achieve the specified performance.

a. Obtain details of the supply fault current and sub main impedance from the electrical designer or contractor to permit equipment suppliers to carry out calculations and provide compliant equipment. Advise the equipment suppliers of the number and load of all VSDs connected to the respective MCC to permit them to account for aggregate harmonics.

b. The maximum current THD (Total Harmonic Distortion) in the sub main phase conductors to any mechanical MCC must be less than 30%, for all loads above 10% of the normal maximum running MCC load. This must be measured and recorded by a temporary multifunction meter provided by the mechanical contractor, and verified at the main switchboard multifunction meter for the respective MCC (all new projects) with assistance of the electrical contractor.

c. The maximum voltage THD at the input to the mechanical MCC must be < 5%, noting that it is the electrical designers / contractor responsibility to supply adequate sub mains in accordance with the electrical standard. The mechanical contractor must provide the fundamental load and THD currents to the electrical contractor for verification of the sub main sizing prior to installation. The THD voltage must be measured and recorded at the MCC input by a temporary multifunction meter provided by the mechanical contractor.

d. Mechanical plant sub-main neutral current must be less than 50% of the fundamental line current and must be measured and recorded by the mechanical contractor.

e. Mechanical plant sub-main earth current must be less than 2% of the fundamental line current. To be measured and recorded by the mechanical contractor.
f. Include option for adding an Active Harmonic filter at the MCC in approved circumstances, noting that the primary case must be compliance through equipment selection.

5.20.9 **PROVISION FOR ACTIVE HARMONIC FILTER AT THE MCC**

All MCCs rated greater than 20kVA aggregate load in any running mode must be fitted with the provision to connect a future Active Harmonic Filter. This provision must consist of a labelled “Future Active Harmonic Filter” dedicated circuit breaker space rated at 50% of the total connected load. The mechanical plant layout plan design must include a space 750mm wide by 1.5m high on the wall in the respective plant room within 1.5m of the MCC to accommodate this equipment in the future, Active Harmonic filters may only be installed with prior permission of the superintendent. Primary elimination of harmonics must be achieved by selection of quality VSDs with internal filtration or superior rectifier input technology.

5.21 **WATER COOLED PACKAGE UNITS**

5.21.1 **GENERAL**

The following equipment is deemed to comply with this standard:

a. Temperzone;

b. Carrier APAC;

c. Daikin; and

d. Mitsubishi Electric

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

Where project requires connection to BMCS BACnet gateway must be provided with unit, the interface arrangement must not use a PC as the gateway.

Unit casing must be of galvanised sheet metal or powder coat finish.

Required wall controller points (where not controlled via the BMCS) include:

a. Wall mounted controller with inbuilt temperature sensor

b. On/off switch

c. Programmable off delay timer

d. Master/slave

e. Fan speed selector

f. Temperature set point adjustment

g. Self diagnostic function

h. Liquid crystal display

i. Current space temperature

j. System temperatures

5.21.2 **VALVES**

Units must have the following valves fitted:

a. Balancing valve

b. Flow return shut off valves

c. Flow return binder type test fittings

d. Strainer

e. Flow switch

f. Automatic condenser water shut-off valve (valve to be closed when the unit is not calling for condenser water)
5.21.3 **ACOUSTIC CONSIDERATIONS**

Where units are installed in occupied spaces units must be located in a bulk head/cupboard with an acoustic treatment.

5.22 **Split Systems**

5.22.1 **GENERAL**

The following equipment is deemed to comply with this standard:

a. For small split systems:
   i. Daikin
   ii. Mitsubishi Electric

b. For larger ducted systems:
   i. Daikin
   ii. Mitsubishi Electric
   iii. Temperzone; and
   iv. Actron

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

Condenser unit casing must be weatherproof constructed from powder coated anti-corrosion treated galvanised steel.

For installations in existing buildings, the locations of outdoor condenser units are of great importance so as to not create any noise and/or aesthetic problems. Consultants and designers are expected to carry out thorough investigations and consult with CIS and users to agree on appropriate locations.

Compressor must be a variable speed type.

Condenser fins to be coated with epoxy or other durable finish suitable for a marine environment.

Required wall controller points include:

Wall mounted controller with inbuilt temperature sensor

a. On/off switch
b. Daily reoccurring programmable off/on delay timer
c. Fan speed selector
d. Temperature set point adjustment
e. Self diagnostic function
f. Liquid crystal display
g. Current space temperature
h. System temperatures
i. When interfaced with BMCS, the BMCS must be able to override the local controller

5.22.2 **INSTALLATION**

Split systems must be in installed as per the following:

a. Mounted on:
   i. Wall Bracket
   ii. Fixed proprietary mounting blocks
   iii. Fabricated galvanised stand

b. 150mm gap between underside of unit and roof/ground level

c. Feet are to be fixed with waffle pad between feet and mount
d. All pipe work and interconnecting cables must be run in colour bond sheet metal trunking with colour matched to existing building or to architects requirements

e. Pipework and cables must be suitably fixed to allow neat and rigid installation in ceiling/roof spaces, bulk heads, risers and Underfloor areas

f. Condensate lines must not be run in electrical conduit

g. Maximum total length of flexible conduit allowed is 600mm

h. Power isolator must be mounted to wall next to unit (not on heritage buildings) or unit panel that is not used for servicing

i. Units isolators to be labelled with a traffolyte label noting board it is fed from and circuit breaker number

j. Outdoor unit must be labelled with traffolyte label indicating what room or rooms it services

k. Units are to be setup with run on push button or from PIR to control the unit for energy savings

l. All Fire seals protecting openings in fire resisting components as per the CIS Essential Fire Safety Measures Standard

m. All penetrations are to be appropriately sealed

n. Ducted FCUs must have safety tray installed under the unit

o. Ducted FCUs must be appropriately hung utilising hanging rod with springs to ensure no vibration transfer

p. Duct work must comply with duct work section of this standard

5.23 VRF/VRF

5.23.1 GENERAL

The following equipment is deemed to comply with this standard:

a. Daikin
b. Toshiba
c. Mitsubishi Electric

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 of this standard.

For installations in existing buildings, the locations of outdoor condenser units are of great importance so as to not create any noise and/or aesthetic problems. Consultants and designers are expected to carry out thorough investigations and consult with the CIS and users to agree on appropriate locations.

BACNET HLI to be provided with VRV/VRF systems, the interface arrangement must not use a PC as the gateway.

Multistage inverter driven compressors are preferred.

Condenser fins to be coated with epoxy or other durable finish suitable for a marine environment

Condenser unit casing must be weatherproof constructed from powder coated anti-corrosion treated galvanised steel.

All external interconnecting pipe work and cables to be run within metal trunking,

Required wall controller points:

a. Wall mounted controller with inbuilt temperature sensor
b. On/off switch
c. Programmable off delay timer
d. Master/slave
e. Fan speed selector
f. Temperature set point adjustment
g. Self diagnostic function
h. Liquid crystal display
i. Current space temperature
i. System temperatures

When interfaced with BMCS, the BMCS must be able to override the local controller.

5.23.2 INSTALLATION

VRV systems must be installed as per the following:

a. Mounted on:
   i. Wall Bracket
   ii. Fixed proprietary mounting blocks
   iii. Fabricated galvanised stand
b. 150mm gap between underside of unit and roof/ground level
c. Feet are to be fixed with waffle pad between feet and mount
d. All pipe work and interconnecting cables must be run in colour bond sheet metal trunking with colour matched to existing building or to Architects requirements
e. Pipework and cables must be suitably fixed to allow neat and rigid installation in ceiling/roof spaces, bulk heads, risers and underfloor areas
f. Condensate lines must not be run in electrical conduit
g. Maximum total length of flexible conduit allowed is 600mm
h. Power isolator must be mounted to wall next to unit (not on heritage buildings) or on unit panel that is not used for servicing
i. Indoor unit must be traffolyte labelled identifying what FCU number it is and outdoor unit it is feed from
j. Units isolators to be labelled with a traffolyte label noting board it is fed from and circuit breaker number
k. Outdoor unit must be labelled with traffolyte label indicating what outdoor unit number it is
l. Branch Boxes must be suitably supported and installed in a position to allow access for servicing
m. Units installed in offices where there is no BMCS control are to be setup with run on push button or from PIR to control the unit for energy savings
n. All Fire seals protecting openings in fire resisting components as per the CIS Essential Fire Safety measures Standard
o. All penetrations are to be appropriately sealed
p. Ducted FCUs must have safety tray installed under the unit

5.24 REFRIGERANTS

5.24.1 REFRIGERANT TYPE

Refrigerants must be non ozone depleting, HCFC and CFC refrigerants must not be utilised. The following refrigerants are the acceptable refrigerants to be used within the university:

a. R134A
b. R410
c. R404A
d. R507; or
e. natural refrigerants.

5.24.2 REFRIGERANT RECOVERY

Refrigerant must be reclaimed and disposed of in accordance with Australian refrigeration handling guidelines. Certificate of recovery must be recorded and provided to USYD upon completion of works.
5.25 REFRIGERANT PIPE WORK

5.25.1 FLASHING AND PENETRATIONS

Must comply with CIS Roofing Design Standards

5.25.2 EXTERNAL TRUNKING

All external pipework to be mechanically protected, maximum of 300mm vertical/horizontal of pipe work to be run on final connection external to trunking. External trunking must be as a minimum:

a. Material:
   i. Zinc coated steel, 0.55mm minimum thickness.

b. Type:
   i. Rectangular with clip-on lid. (Screw fix for safety where on outside of building)

c. Finish:
   i. Galvabond painted to match external building colour as applicable.

5.25.3 PIPE JOINTS

Fully silver solder all joints in copper piping in accordance with all relevant Codes. All bends must be pre-form bends with no flattening or corrugation of the pipework.

5.25.4 PIPE SUPPORTS

All pipes must be adequately and substantially supported and restrained both horizontally and vertically using a proprietary support system. Pipes must be supported at a spacing of not more than 1800mm. Pipework adjacent to equipment mounted on vibration isolation mounts must be arranged to provide adequate flexibility to ensure vibration is not transmitted to the building structure. All supports must be constructed from zinc plated steel with contact between dissimilar metals prevented by non-conductive isolating materials.

5.25.5 THERMAL INSULATION

All pipe work to be insulated to BCA section J requirements. End joints must be neatly taped with 50mm wide PVC tape of colour similar to the insulation. Insulation must not be split or zippered type.

5.25.6 PRESSURE TESTING

Refrigerant pipe work must be pressure tested over a 24 hours period minimum for VRV system and must be signed off by CIS Engineering or CIS Engineering representative.

5.25.7 VACUUM

New systems must be pulled down to a minimum of 250 microns. Vacuum gauge must be installed at furthest point away from vac pump as possible in the system. Before approving the vacuum pump must be isolated from the system and vacuum held for a period of time.
CIS engineering must inspect and sign off vacuum for VRV systems or CIS Engineering representative.

5.26 DUCTWORK

5.26.1 GENERAL

All ductwork design and installation must be to current SMACNA standard and to the appropriate pressure class rating.

In the design of ductwork systems, ensure the following:

a. Issue Date: 002
b. The system configuration must assist in the balancing of the system so that it does not rely on over throttling of dampers
c. Ductwork velocities must follow good design practice. Table 4 provides the maximum velocities which must be followed.
   The above velocities must also be considered with the design friction loss factor
d. Balancing dampers must be provided on each floor and each major branch, spigot dampers must be provided at each flexible duct connection, avoid relying on dampers or balancing devices at diffuser or grille face as these may lead to local noise problems further clarify

The following are some key issues that must not be overlooked in installations:

a. Ensure all duct work and flexible connections are fully sealed.
b. All duct work must be sealed during construction, where found not be sealed sections are to be cleaned
c. Flexible connections must not be put under tension they must be installed with play left to allow for any movement in ductwork or other equipment.
d. Flexible duct work to be a maximum length of 3 meters from branch take off to terminal.
   Installation of solid duct between will not be accepted to achieve the maximum length of 3 meters.

All ductwork must be leakage tested to SMACNA standards. All ductwork must be cleaned prior to commissioning and switching on any fans and/or air handling units. Provide rough filters for unit protection at initial cleaning.

Table 4: Maximum velocities for duct work

<table>
<thead>
<tr>
<th>Ductwork</th>
<th>Maximum velocity (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main or riser ducts</td>
<td>7</td>
</tr>
<tr>
<td>Horizontal mains or main branches on floor</td>
<td>5</td>
</tr>
<tr>
<td>Final branch ducts</td>
<td>3.5</td>
</tr>
<tr>
<td>Flexible ducts</td>
<td>2.5</td>
</tr>
</tbody>
</table>

5.26.2 INSULATION

All supply and return ductwork must be thermally insulated to meet NCC/BCA requirements. All exhaust ductwork which may be subject to surface condensation must also be insulated. Special attention is drawn to high temperature exhaust ducts such as kitchen exhaust and/or exhaust from dishwashers/sterilisers if and when they travel through spaces with a lower environmental temperature.

The University prefers the use of internal insulation for its better quality in robustness.
5.27 AIR GRILLES AND DIFFUSERS

5.27.1 GENERAL

Outlets, grilles and registers must be selected to provide adequate air movement without creating draft. The throw of air diffusers must be selected such that there is no splash on walls above occupied level. Average air velocity in the room must be between 0.1 and 0.15 metres per second. Horizontal and vertical flow patterns and sound power levels must all be checked to ensure compliance with the intent of this standard.
All slot diffusers, linear grilles, air boots and light air troffers must have provision for air pattern adjustments such that air can be deflected in a vertical and horizontal direction.

5.27.2 EXHAUST GRILLES

Exhaust grilles must be egg-crate type with a 12 x 12mm core.
All exhaust grilles must be complete with integral opposed blade volume control dampers operable through the respective grille face.

5.27.3 PLENUM BOXES

Plenum boxes must be galvanised steel plenum constructed as for low pressure steel ductwork, insulated internally with minimum 25mm thick (or to NCA, which ever has the higher requirement) internal duct insulation. All joints must be sealed air tight.

5.27.4 DOOR GRILLES

Door grilles must be of the, flanged frame type with inverted chevron, sight proof blades with minimum 60% free area. Grilles must comprise fixed horizontal blades, concealed vertical bracing bars where necessary and must be of aluminium construction anodised to the colour to be nominated.

5.27.5 UNDERCUTTING OF DOORS

Undercutting of doors for return air path is not accepted.

5.28 FILTERS

Deep bed and/or panel filters may be used depending on the air volume and the level of filtration required per the application, consultant is to provide clear PPR requirements for each project on the filtration requirements.

5.29 VIBRATION/NOISE

5.29.1 EQUIPMENT

Statically and dynamically balance equipment and isolate from the building structure. Select vibration isolators with due regard to the weight and speed of the equipment to be isolated and with isolating efficiencies as specified by consultant/designer for the particular equipment or in any
case, not less than 95%. Select springs with a length when loaded approximately equal to their diameter. Provide inertia blocks as required.

5.29.2 PIPING

Piping must be designed to have sufficient flexibility where connected to vibrating machinery and must be effectively isolated from the building structure where necessary to prevent the transmission of vibration. With respect to the pipework installation to pump sets, for a minimum of 15 metres run there must be anti-vibration, spring mounts, on the supporting brackets. The installation must utilise bends and natural vibration insulation wherever possible to aid the positive vibration isolation steps taken.

5.29.3 DUCTWORK

Ductwork and fitting must be designed and constructed so as to prevent any excessive generation of air noise and vibration of fittings.

5.29.4 FLEXIBLE CONNECTIONS FOR PIPEWORK

Flexible connections must be installed parallel with and horizontal to the shaft of operating equipment wherever possible and of full bore.

5.29.5 FLEXIBLE CONNECTIONS FOR DUCTWORK

Flexible connections must be fitted to isolate fans and/or conditioner casings from ductwork. Materials and application of flexible connections must be in accordance with AS4254. Flexible connections must be airtight and arranged to permit the renewal of the fabric without disturbing the ductwork or plant. All fabric at the seam must be folded back to conceal raw edges. The flexible connections must have adequate slack to absorb relative movement and vibration of the connected items. Allow flexible connections for ductwork where there are building movement joints. Flexible connection within ceiling spaces must be wrapped with 1 (one) layer of ‘Wavebar’ or equal.

5.29.6 PUMP INERTIA BASES

All pumps must be mounted on inertia bases specifically sized for total vibration isolation. The pump inertia bases must be fitted with spring isolators specifically selected and manufactured to suit the final pump selection. Each pump set must be complete with flexible connections on the pipework and electrical supplies. These flexible connections must be selected such that they isolate the vibration at source and do not transfer it into the pipework or other connections.

5.29.7 BUILDING NOISE

The overall building sound levels in user occupied spaces must be in line with the lower values specified in the current version of AS/NZS 2107 as per UOS Sustainability Framework. Overall building sound incorporates all noise sources including mechanical and hydraulic systems.
5.30 Painting/Labeling and Colour Schemes

5.30.1 General

All pipe work must be clearly labelled.
Direction of flow and contents of pipework must be clearly marked on the pipework labelling.

All external duct work must be painted with a primer coat then a finish coat; colour must be selected to ensure ductwork blends in with surroundings.

5.30.2 Painting Application

Prepare surfaces for, and apply paint coatings to, the requirements of clause Corrosion Protection relevant to the application.
The finishing coats must be full gloss enamel, of the colour designated in the following schedule and must be as smooth and free of brush marks as possible.
Thermoset powder coatings must be of full gloss finish and of colour designated in the schedule. Where this requirement is not available from the equipment manufacturer, prepare the powder coat surface with a wash primer or etching solution washed down with clean water and dry thoroughly prior to application of primer and two coats of heavy duty full gloss alkyd finish, all to the requirements of the referenced standards/codes.

5.30.3 Plant Room Floors

Plant room floors must be painted in a grey finish in a product that is low VOC, slip and wear resistant, light chemical resistant and oil resistant.

5.30.4 Ductwork Subject to Wet or Damp Environment

Vertical ducts that are open to weather at the top, and cooling tower, industrial cooler and evaporative condenser discharge ducts, must be internally corrosion protected and painted.

5.30.5 Equipment Colour Schedule

Below is a list of University required painting colour schedules for mechanical plants.

B15 Mid Blue
a. Remote Compressors and Motors (excluding coupling guard)
b. Condenser Pumps and Motors (excluding coupling guards)
c. Chilled Water Pumps and Motors (excluding coupling guards)
d. Hot Water Pumps and Motors (excluding coupling guards)
e. Air Compressor, Motor and Receiver (excluding belt guard)
f. Shell and Tube Condenser
g. Liquid Receiver
h. Refrigeration Gauge Panel (exterior)
i. Pneumatic Gauge Panel (exterior)

Y54 Oatmeal
a. Exposed Ductwork (unless specified to match building/environment)
**Y35 Off White**
- a. Valves, Strainers, etc.
- b. Electrical Switchboard / Mechanical Control Board (interior)
- c. Refrigeration Gauge Panel (interior)
- d. Piping, Excluding Oil Piping, Valves, Strainers, etc.

**R13 Signal Red**
- a. Coupling Guards
- b. Belt Guards
- c. Hot Gas Mufflers

**Y14 Golden Yellow**
- a. Valve Handles

**N52 Mid Grey**
- a. Plinths, including floating bases

**X53 Golden Tan**
- a. Heating Piping and heating Storage Vessel

**Black**
- a. Brackets, Drains

**Brunswick green**
- a. Condenser water piping

**Blue**
- a. Chilled water

**Silver Grey**
- a. Steam pipe work

**B25 Aqua**
- a. Conditioner casing
- b. Evaporative Condenser (excluding belt guard)
- c. Fans (excluding belt guards)

**X15 Orange**
- a. Electrical Switchboard / Mechanical Control Board (exterior)
- b. Electrical Troughing and Conduits

### 5.30.6 EQUIPMENT LABELLING

All mechanical equipment must be traffolyte labelled indicating equipment designation e.g. CHWP 1 or AHU 2-5. Indoor and outdoor labelling must correspond to each other e.g. FCU2-2 and CU2-2.
All filter details including type, quantity and size must be attached in a traffolyte label to all AHUs, filter bays and ducted fan coil units.

All Belt driven fans must have a traffolyte label with belt sizes this includes AHUs and FCUs.

Equipment must be Asset labelled as per CIS Asset Identification and Labelling Standard.

5.31 SERVICE ACCESS/SAFETY REQUIREMENTS

5.31.1 GENERAL

The following are the University access and service requirements:

a. Position all equipment and arrange access provisions at equipment, to optimise future maintenance and repairs.

b. Equipment must not be located in ceiling spaces above labs, animal houses and critical environments. Plant will only be accepted in ceiling spaces within office buildings.

c. The University will not accept plant within tight spaces. Plant that is located in ceiling space must have free and easy access. This includes ability to service system without reaching around or over columns, beams, cable trays, pipe work, lights and duct work.

d. All motors are to be provided with isolators within 3 meters distance from motor.

e. A plus 20% additional dimension access allowance must be provided above the manufacturers access requirements for equipment.

f. Plant located above 3m height will have permanent stair/ladder access provisions with permanent workable platform.

g. Trip hazards to be identified and painted in yellow.

h. Electrical hazards must be identified and labelled appropriately.

i. Yellow walkways to be painted around all plant areas in plant rooms.

j. Chemical hazards to be labelled and safe clearance lines to be painted on the floor also appropriate paper work to be present on-site.

k. Confined spaces to be noted and appropriate signage applied.

l. Access to plant and equipment must comply with all WHS regulations.

m. Where access is within high ceilings that a standard platform ladder cannot reach project must provide access device to allow safe access.

5.32 REDUNDANT EQUIPMENT

All redundant mechanical services and associated services (power, water, drainage, etc) must be removed as part of the project. Building surfaces and finishes must be made good.

5.33 PRODUCT SUPPORT/EXPERIENCE REQUIREMENTS

All products must be supported locally and internationally by factory trained service networks. All spare parts must be available ex-stock factory for a period of 10 years from purchase date. Products must comply with Australian Standards and have a proven record of operation within the Australian facilities.

Equipment and associated accessories must be specified as products that have established manufacturing reliability and proven installation history in Australia.

Proven installation history includes products installed and operated for over 10 years and operational costs and detailed life cycle reports must be provided.
All spare parts must be readily available as spares with minimum ordering and delivery times.

6 COMMISSIONING

Comprehensive pre-commissioning, commissioning and quality monitoring must be specified by the consultant/designer as per the University of Sydney Sustainability Framework.

Project specific commissioning plan must be developed and provided to the University for review and comment.

Detailed testing and commissioning records must be provided for each system and each component as appropriate. All such records must be witnessed and verified by the project consultant/designer.

Project handover plan must be developed by the consultant/designer to allow the system to be handed over to The University.

Project handover plan must be developed by the consultant/designer to allow the system to be handed over to The University. A 12 month building tuning process will commence at Project handover with systems monitored monthly, reported and assessed quarterly, and include assessment of feedback from the occupants.

7 SAFETY IN DESIGN

The contractor must consider risk during the design. A design safety report must be submitted to the relevant CIS Project Manager for every design project. Contractors must confirm, so far as it is reasonable practicable (SFAIRP), that the structure is without risks to health and safety.

Design risks must be considered for the asset lifecycle covering construction, operational and maintenance, refurbishments and decommissioning.

The design safety report must include the following:

a. Description of design element;
b. Description of potential risks and hazards associated with the design element;
c. A low/medium/high risk assessment considering likelihood and consequence;
d. Proposed measures to eliminate risks where practicable;
e. Control measures to mitigate and manage design risks;
f. Nominating responsibilities for managing the design risks

This may be provided as a design risk register where appropriate and must include results of any calculations, testing and analysis etc.

8 DOCUMENTATION AND RECORDS

The following design documents must be provided:

a. Return brief defining the systems proposed and any deviations from this specification;
b. Heat load calculation spreadsheet
c. Calculations to be provided on the sizing of the duct work and pipe work. Future allowances are to be included in these calculations/sizing

d. Calculations and selections to be provided on the proposed equipment;

e. Budget calculations

f. Designers statutory compliance certificates

g. Requests for all variations to this standard submitted using the **CIS Request for Dispensation Form (CIS-PROJ-F001)**

h. Complete the Design and Construct checklist using the **CIS Design and Construct Mechanical Services Checklist** document (Refer to Attachment 1)

The following documents must be provided at practical completion

a. Maintenance manual

b. Commissioning records

c. Product manufacturer specific information

d. System schematics

e. Complete as-built drawings

f. Electrical and wiring diagrams

g. System functionality and operation description

h. System set point values

i. Controls schematic

j. Controls description

k. Controls wiring

l. All equipment selection calculations and schedules

m. Full design documents and calculations (soft copy only)

n. Building users’ guide

9 OPERATIONS

Access to all plant rooms within the University is controlled by a **UNIVERSITY OF SYDNEY PLANT ROOMS ACCESS PERMIT**.

This permit provides the University with vital information about the applicant. Permits are to be submitted to the University delegate.

The University delegate will review risk assessments and SWMS before access is granted.

Before the shutting down of plant a risk analysis must be performed highlighting areas served by plant and implications of shutting plant down. The risk analysis must be provided to University project manager for approval.
10 AUTHORISATION OF VARIATIONS

Project managers, consultants, contractors, commissioning agents and facilities maintenance personnel must ensure compliance with these requirements is achieved.

Variations to this standard must only be considered where:

a. the University Standard’s requirement cannot physically or technically be achieved.
b. the alternative solution delivers demonstrated and proven superior performance for the same capital and life cycle cost or better.

Consultants and contractors must identify and justify requirements of the standard that do not apply to the project or which need to be varied and these which must be approved by the issuer of this standard. Formal requests for all variations to this Standard must be submitted using the CIS Request Dispensation from Standard Form (CIS-PROJ-F001). The issuer of this standard or their delegated authority must review and consider requirements of stakeholders from clients, projects and facilities management before deciding whether to approve variations. Their formal sign-off is required for acceptance of any non-compliances and departures from this standard’s requirements.

11 QUALITY CONTROL

11.1 DESIGN STANDARD COMPLIANCE

Compliance with requirements of this standard must be checked throughout the design, construction and commissioning phases of projects by CIS’ services consultant. Any issues or deviations from this standard must be reviewed and approved in writing by the issuer of this standard.

Competent CIS consultants and representatives must check compliance with this standard during design reviews and formal site inspections. Any non-conformances with requirements of this standard must be documented and provided to the CIS Project Manager for issue to contractors and their consultants.

Project Managers must maintain a formal register of non-conformances and manage close out of outstanding non-conformances. Contractors and their consultants issued with non-conformances must take appropriate corrective actions. The CIS Project Manager must ensure:

a. proposed corrective actions are implemented
b. close out of non-conformances in relation to this standard is formally approved and signed off by the author of the standard or their delegate

11.2 DESIGN STANDARD CERTIFICATION

Contractors and their consultants must certify compliance to the design standard by completing and submitting the CIS Project Design Certification Form, CIS-PROJ-F001 to the CIS Project Manager at each of the following project phases:

a. Design and Documentation
b. Tender
c. Construction

Notwithstanding CIS’ internal quality control processes, contractors and their consultants must implement their own robust quality assurance and control procedures to ensure compliance with requirements of this standard.
12 REFERENCES

Design and documentation utilising these standards is to incorporate the requirements of the following current standards and requirements as a minimum:

- National Construction Code
- Building Code of Australia (including all relevant clauses of Section J)
- Environmental Planning and Assessment Regulation
- Work Health and Safety Act
- All CIS Standards
- AS 1668.1 Mechanical Ventilation and Air Conditioning code, Part 1
- AS 1668.2 Mechanical Ventilation and Air Conditioning code, Part 2
- AS/NZS 3666 Air handling and water systems of buildings – Microbial control
- AS 1571 Copper – Seamless tubes for air conditioning and refrigeration
- AS 1569 Copper and copper alloys – Seamless tubes for heat exchangers
- AS 4254 Ductwork for air handling systems in buildings.
- SAA HB40 The Australian refrigeration code of good practice - for fluorocarbon emissions.
- AS 60947.8 Low voltage switchgear and control gear - Control units for built-in thermal protection (PTC) for rotating electrical machines
- AS 1359 Rotating electrical machines – General requirements
- AS 1271 Safety valves, other valves, liquid level gauges, and other fittings for boilers and unfired pressure vessels
- AS 4180 Cooling tower drift loss
- AS/NZS 2982-2010 Laboratory Design and Construction
- AS/NZS 2243.1-2005 Safety in laboratories – Planning and operational aspects
- AS/NZS 2243.2-2006 Safety in laboratories – Chemical aspects
- AS/NZS 2243.6-2010 Safety in laboratories – Plant and equipment aspects
- AS/NZS 2243.8-2006 Safety in laboratories – Fume cupboards
- AS 4809 - Copper pipe and fittings-installation and commissioning
- AS/NZS 1677.2 - Refrigeration systems:
- AS 2107: 2000 Noise levels:
- AS/NZ 4776
- AS 1682 Fire dampers
- AS 1210 Pressure vessels
- AS 1324 Air filters for use in general ventilation and air conditioning
- AS 2129 Flanges for pipes, valves and fittings
- AS 4254-2002 Sheet metal ductwork: Ductwork for air handling system in buildings
- AS 2107 Acoustics - Recommended Design Sound Levels and
- AS/NZS 5601 Gas Installations

13 DOCUMENT AMENDMENT HISTORY

<table>
<thead>
<tr>
<th>Provision</th>
<th>Amendment</th>
<th>Commencing</th>
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</thead>
<tbody>
<tr>
<td>001</td>
<td>First Issue</td>
<td>16 August 2013</td>
</tr>
<tr>
<td>002</td>
<td>5.10 added EMC &amp; THD compliance.</td>
<td>16 August 2013</td>
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<td></td>
<td>5.12 plant room clause added.</td>
<td>18 September 2015</td>
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<td>5.14 Air handling units clause added.</td>
<td>18 September 2015</td>
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<tr>
<td>5.15</td>
<td>chilled\hot water fan coil section added.</td>
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<tr>
<td>5.17</td>
<td>chilled\hot condenser water valve clause added.</td>
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<tr>
<td>5.20</td>
<td>Motor control centres and mechanical switch boards clause added.</td>
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<tr>
<td>5.21</td>
<td>Water cooled Package units clause added.</td>
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<tr>
<td>7</td>
<td>Safety in design clause added.</td>
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<td></td>
<td>Design &amp; construct checklist now included in attachment 1;</td>
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<tr>
<td></td>
<td>New Forms added to the website;</td>
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</tr>
<tr>
<td></td>
<td>CIS Design &amp; Construct Services Checklist Form (CIS-ENG-F009)</td>
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</tbody>
</table>
14 ATTACHMENTS

ATTACHMENT 1  DESIGN AND CONSTRUCT CHECKLIST FOR CONSULTANTS (CIS-ENG-F009)
ATTACHMENT 1 DESIGN AND CONSTRUCT CHECKLIST FOR CONSULTANTS (CIS-ENG-F009)

This spreadsheet is available in Excel via the Forms section of the UoS Website.

**Design and Construct List**

The following is a list of mechanical documents which CIS require the building service consultant and contractors to provide as part of their package.

This is a guide for the consultant/contractor to ensure they meet minimum design components in all projects.

These documents will be reviewed by the relevant CIS Services Engineer or their delegate during the design phases.

This list does not alleviate the building services consultant’s responsibility to design to the online CIS Design standards.

<table>
<thead>
<tr>
<th>Item Required</th>
<th>Detail of the Design Item to be Completed</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
<th>Phase 5</th>
<th>Phase 6</th>
<th>Compliance Achieved</th>
<th>Building Services Consultant Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan Layouts Drawings Duct, Pipe work &amp; equipment location</td>
<td>Design drawings in Autocad (and Revit 3D model where applicable) format including plans, schematics and single line diagrams.</td>
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<td>Yes / No or N/A</td>
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<tr>
<td>Confirm Room Spatial Allowances with Mechanical Equipment</td>
<td>Confirm all equipment installed will fit within the room/ceiling space and maintain accessibility and egress as per Australian Standards</td>
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<td>Yes / No or N/A</td>
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<tr>
<td>Maximum Demand Calculations</td>
<td>Provide the calculation in editable spreadsheet format, and to satisfy the Supply Authority and to AS/NZS 3000 as a minimum for Mechanical services. Note: Equipment data sheets must be provided for all major load groups (i.e. AC Units, chillers, pumps, etc.).</td>
<td></td>
<td>x</td>
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<td>Yes / No or N/A</td>
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<tr>
<td>Heat Load Calculations</td>
<td>Provide the calculation using Camel, or approved equal software.</td>
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<td>Yes / No or N/A</td>
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<tr>
<td>Ductwork &amp; pipe work sizing</td>
<td>Calculations to be provided on the sizing of the duct work &amp; pipe work. Future allowances are to be included in these calculations/sizing.</td>
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<td>Yes / No or N/A</td>
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<tr>
<td>Equipment sizing</td>
<td>Calculations &amp; selections to be provided on the proposed equipment.</td>
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<td>Yes / No or N/A</td>
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</tr>
<tr>
<td>Mechanical Specification (Where applicable)</td>
<td>Complete an mechanical specification for the project. Include all schedules for mechanical switchboards, Storers, chillers, AHU’s, FCU’s, VRV, Fans, Package units, Split systems, etc.</td>
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<td>x</td>
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<td>Yes / No or N/A</td>
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<tr>
<td>BMCS Specifications (Where applicable)</td>
<td>Complete an BMCS specification for the project. Include all schedules for points and control/functional description.</td>
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<td>Yes / No or N/A</td>
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<tr>
<td>Supply of statutory design certifications and certification of compliance to the University standards and other relevant standards.</td>
<td>Complete the design certificate in line with the relevant standards and requirements.</td>
<td>x</td>
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<td>Yes / No or N/A</td>
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<tr>
<td>Safety in Design Documentation</td>
<td>Provide a Safety in Design document for review and approval by the Services Engineer.</td>
<td>x</td>
<td>x</td>
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<td>Yes / No or N/A</td>
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<tr>
<td>Asset List</td>
<td>Proposed final asset list to be submitted for approval</td>
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<td>Yes / No or N/A</td>
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<tr>
<td>Inspection, testing and maintenance</td>
<td>Confirm all inspection, testing and preventive maintenance to be performed during DLP together with proposed dates when the tasks will be performed</td>
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<td>Yes / No or N/A</td>
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