SECTION 9: MECHANICAL SERVICES

CONTENTS

9.1 GENERAL

This section of the Design Standards details the design principles and mandated minimum requirements to be addressed in the design and specification of mechanical services.

The designers are required to produce their own specification which incorporates the requirements set out in this and other sections of the University's Design Standards. The design documentation must 'standalone' and not include references to this Design Standard.

This section of the Design Standards is to be read in conjunction with the other sections of the University's Design Standards, and in particular:

- Section 2 – Sustainable Design
- Section 7 – Electrical Services
- Section 10 – BAS & Controls.
- Section 16 - Laboratory Freezers and Refrigerators

In addition, the designers must comply with other design standard documents published on the Design Standards web page including:

- Computer Room Air Conditioning: The University of Melbourne Computer and Network Accommodation Strategy (CANAS) standard.

Should the designer identify any discrepancy between this section and other sections of the Design Standards or relevant statutory codes and standards, the more onerous requirement shall be adopted.

The design team is encouraged to innovate and may propose alternative design standards, however any departures from the Design Standards must be requested and approved via a Modification Request Form.

9.1.1 Design Principles

The mechanical services installation is required to optimise the total cost of ownership with respect to capital, energy, maintenance and renewal costs.

With a large property portfolio, the University also requires a consistent approach to system design, equipment types and sizing, particularly for maintainable assets or assets which have a user interface.

The mechanical systems are to be designed to ensure that they can be safely maintained and operated and ultimately renewed. The designer is required to include a plant access, maintenance and replacement strategy as part of the design development report.

The mechanical systems are to be designed to meet the approved project design criteria as set out in the project design brief. The design documentation shall ensure that the mechanical systems provide for easy future system modifications.

The mechanical systems for new buildings and large refurbishment projects are to be designed such that they are resilient to the impacts of a changing climate and natural disasters. A Climate Change Resilience Plan (refer to Section 3 - Sustainable Design) shall be provided with the system Pre-Design Report submitted to the University Project Manager for review.

For projects that include a Green Star Sustainability Rating outcome refer to Section 3: Sustainable Design of the Design Standards for details of the minimum requirements for Green Star points.

9.1.2 Heritage Requirements

Various buildings on the campuses are heritage protected. Mechanical services design and installation methods for these buildings require approval by the Heritage Consultant and the University's Project Manager.

The status of the building heritage is to be determined by the designer prior to commencing the design. A list of heritage listed buildings is available from the Heritage of Council Victoria and

local Municipal Council's website.

The design for heritage protected buildings shall minimise interference with the original building fabric as far as practicable and is to specify the recording of original architectural details and locations in order to ensure accurate reinstatement.

All wiring and pipework shall be concealed within existing wall cavities. Where wall chases are unavoidable, approval by the Heritage Consultant must be obtained prior to works proceeding.

Routing and installation of mechanical services shall be designed to minimize the visual impact on the building. Running ductwork and piping in concealed areas or locating equipment in non-visible areas is preferred.

9.1.3 Standards and Regulatory Requirements

All work shall be designed to meet the most recent requirements of national and local authorities and shall be in accordance with the following in so far as they apply to the work:

- National Construction Code (NCC) and Building Permit conditions
- Local Electricity, Water and Gas Authority requirements
- Australian Wiring Rules AS/NZS 3000
- Worksafe Victoria
- Occupational Health Safety & Welfare Act and Regulations
- Environment Protection Authority
- Australian Communications Authority (ACA)
- Gas Board Regulations
- Gas Installation Code
- Energy Safe Victoria Regulations and Legislation
- Disability Discrimination Act (DDA)
- All Health Authority Requirements
- Codes of Practice for the Control of Legionella
- Victorian Fire Brigade requirements
- All Local Council regulations
- State Government codes of practice for cooling towers

The works must also comply with the latest edition of all applicable Australian Standards. Note that the following list is not exhaustive, and the design team is required to inform themselves of all Standards which are relevant to the project.

Code	Description
AS/NZS 1132	Methods of tests for air filters for use in air conditioning and general ventilation
AS/NZS 1324.2	Air Filtration
AS/NZS 1345	Identification of the contents of piping, conduits and ducts
AS/NZS 1432	Copper tubes for plumbing, gas fitting and drainage applications
AS/NZS 1530	Methods of fire tests on building materials, components and structures
AS/NZS 1571	Copper seamless tubes for air conditioning and refrigeration
AS/NZS 1668	The Use of Ventilation and Air Conditioning in Buildings
AS/NZS 1677	Refrigeration systems
AS/NZS 1851	Maintenance of Fire Protection Equipment

Code	Description
AS/NZS 1894	The storage and handling of non-cryogenic and refrigerated liquids
AS/NZS 2243	Safety in Laboratories
AS/NZS 2625	Mechanical Vibration
AS/NZS 2670	Vibration
AS/NZS 2982	Laboratory design and construction
AS/NZS 3008	Electrical installations Selection of cables
AS/NZS 3500	Plumbing and drainage
AS/NZS 3666	Air handling and water systems of buildings set
AS/NZS 3833	The storage and handling of mixed classes of good, in packages and intermediate bulk containers
AS/NZS 4254	Ductwork for air handling systems in buildings
AS/NZS 4289	Oxygen and acetylene gas reticulation systems
AS/NZS 4332	The storage and handling of gases in cylinders
AS/NZS 4603	Flashback arrestors – Safety devices for use with fuel gases and oxygen or compressed air
AS/NZS 5601	Gas Installations
AS/NZS 60079	Electrical Apparatus for Explosive Gas Atmospheres

9.1.4 Design Change Authorization

All requests for changes to the requirements of the Design Standards must be made on the Modifications Request Form.

No design work is to proceed on the basis of the proposed modification until the modification request has been approved in writing.

A signed copy of all request forms together with a schedule of approved requests is to be provided as party of the project handover documentation.

9.2 DESIGN BRIEF

If required to confirm the University of Melbourne requirements, the designer shall prepare a return Mechanical Services Design Brief that confirms the following key aspects of the proposed project:

- Scope of Works
- Works by Others and Associated Works
- Design Criteria
- System Description

9.3 GENERAL DESIGN CRITERIA

9.3.1 Ambient Conditions

The heating and cooling systems shall be designed to meet the University's internal design criteria, based on the ambient conditions specified in the "The Australian Institute of Refrigeration, Air-Conditioning and Heating (AIRAH) – Design Handbook" for location- based weather data for typical design summer and winter temperatures.

Plant & equipment providing comfort air conditioning shall be specified to continue to operate at an ambient air temperature of not less than 45°C. Note that for the Dookie campus this temperature limit shall be increased to 50°C, acknowledging that the systems will operate in a de-

rated state.

The operating ambient temperature shall be increased to 50°C when the plant serves operationally critical areas such as computer rooms, server rooms etc. De-rated performance is not permissible in these areas.

9.3.2 Internal Design Criteria

Unless there are specific temperature and/or relative humidity requirements, comfort air conditioning shall be designed to maintain a temperature of between 20°C and 25°C.

In situations where there is potential to provide operational or sustainability benefits by modifying these design conditions, the designer shall consult with the Manager Engineering & Infrastructure. Approval to any proposed change to the design standards must be obtained via the Modification Request Form process.

9.3.3 Occupancy

The architect, in collaboration with the University project manager, is responsible for determining the number of occupants for each zone in the building. This information is to be provided to the mechanical services engineer for use in the design of the mechanical systems.

9.3.4 Ventilation Rates

Outside air ventilation rates to internal spaces shall achieve, as a minimum, the requirements defined in AS/NZS 1668.2.

Where Indoor Air Quality (IAQ) is a key consideration (i.e. meeting rooms, labs etc.), ventilation rates higher than the requirements set out in AS/NZS 1668.2 should be considered and balanced with energy related considerations.

Consideration shall be given to the use of CO_2 monitoring as a means of modulating ventilation rates to a given zone where occupancies vary significantly.

Naturally ventilated spaces intended for frequent occupation shall achieve at least the minimum ventilation rates as defined in AS/NZS 1668.4. This should be demonstrated by calculation at the design stage and, where required, verified with onsite measurement prior to practical completion.

9.3.5 Filtration

Filtration for comfort air conditioning systems shall be a minimum F6. The air velocity of the filters shall not exceed 1.8m/s.

9.3.6 Noise and Vibration

Noise from mechanical services shall be free of tonal and spectral content, and not exceed the levels stated in the following table, when measured at a distance of 1.2m above floor level and 1.5m horizontally from any diffuser or plant enclosure (including services voids).

Space/Function	**Noise Level (NR)**
Lecture Theatres	30
Professional Suites, Associated Deans, Training, Conference and Seminar Rooms	38
Senior academic staff, academic offices, managerial offices, meeting rooms, syndicate and common rooms	38
Foyers, Corridors, Toilets and Store Rooms	45
Laboratories	40

Continuous noise level criteria are expressed in terms of Noise Rating (NR) Curves and measured in the octave bands 63Hz to 4kHz. Sound levels are measured in terms of Leq over a period of 60 seconds.

Refer to Design Standards Section 12: Acoustics, Vibration and EMI for more information.

The requirement for vibration isolation shall be assessed for all mechanical plant, equipment and distribution systems. Where required, anti-vibration mountings shall be provided.

The contractor is required to provide details of the location and type of anti-vibration protection to the University's Project Manager for approval prior to installation.

9.3.7 System Efficiencies

Plant shall be selected to achieve, as a minimum, the more stringent of NCC Part J requirements, relevant Australian MEPS and the criteria nominated below.

All plant selections shall be presented to the Manager Engineering and Infrastructure for written approval prior to procurement. Where new technology offers potential for greater levels of efficiency these should be presented for consideration using the Modification Request Form. The additional efficiency benefits, including both initial and ongoing costs must be clearly presented.

Item	**Efficiency**
Pumps	>70%
Fans	>75%
Motors	Motors shall comply with the high efficiency requirements of AS1359.5:2000
Electric heat pumps	minimum COP of 7
Water Cooled Chiller	Minimum chiller IPLV/NPLV (measured to ARI55O/590:1995) of: IPLV 5.5 — water-cooled chiller <500kW; IPLV 7 — water-cooled chiller >500kW; Note that part load and full load COPs are to be assessed to ensure ABGR requirements are achieved.
Air Cooled Chiller	IPLV 3.75 – Air Cooled Chillers
VRF/Split Systems	DX Air cooled packaged systems (including condenser): COP of 3.0. DX Water cooled package systems (excluding condenser): COP of 3.5

An Energy Impact Statement shall be completed for each new major University building project. This statement is intended to focus the attention of designers in all disciplines on solutions that ensure efficient energy use throughout the building's life. The statement shall be submitted to the Manager Engineering and Infrastructure at the design stage of the project.

9.3.8 Refrigerants

No equipment that requires the use of chlorofluorocarbon gases shall be specified.

The specification of all equipment utilising refrigerants shall be subject to the approval by the Manager Engineering & Infrastructure.

New buildings and renovations around the University of Melbourne must follow a Global Warming Potential (GWP) limit of less than 675 to reduce our carbon footprint and support sustainable development. This requires using eco-friendly materials, energy-efficient systems, and sustainable practices.

9.4 GENERAL REQUIREMENTS

9.4.1 Safety in Design

The Designer shall comply with the Occupational Health and Safety Regulations and ensure that their design addresses the prevention of hazards or risks arising to health and safety out of the design through the construction and ongoing operation and maintenance of the mechanical services including their ultimate replacement.

Specific care shall be taken to ensure that the surrounding space and access routes are adequate

for the safe maintenance and replacement of equipment.

The designer shall provide a documented Safety in Design report (refer to Section 2 – Health and Safety) that identifies risks and risk assessment methods used in the design process to eliminate or minimise the risks so far as reasonably practical related to the installation, operation and maintenance of the mechanical services.

Documentation is to be created to detail the safety features and hazards associated with the product system or infrastructure. This information is to be provided as part of the documentation provided at project handover.

9.4.2 Plantroom Design

Access

Plant rooms should be designed with adequate access points to allow for the removal and replacement of any equipment. These access points should be located in areas that are easily accessible and not obstructed by other equipment or structures. Level access should be provided between plantroom and plant replacement route. Where level access cannot be achieved alternative measures such as access ramps and fixed lifting beams are to be provided to facilitate plant replacement.

The designer is required to include a plant access, maintenance and replacement strategy in the O&M manuals addressing each major plant item/system.

Where new plant is to be installed in existing buildings, the designer/contractor shall obtain a Structural Engineer's assessment of the resultant structural load against the buildings existing structural loading allowances.

Flooring

The Consultant/Contractor is to ensure that there is adequate waterproofing applied to the plantroom floor.

Dust and Dirt Control

Plantrooms shall be provided with ventilation to maintain air quality and minimise the build-up of dust and other such small-scale dirt and debris.

During construction, modification and/or maintenance, all works in plant areas shall be carried out such that dirt and debris production is minimised. Following completion of works, plantrooms shall be cleared of debris and receive a thorough clean. This shall be the responsibility of the Mechanical Contractor.

Noise Control

Plant rooms can generate a significant amount of noise from the mechanical equipment, acoustic insulation and dampening materials should be used to control noise levels in and around the plant room where possible.

Security

Plant rooms should be secured to prevent unauthorized access. All Plant rooms shall be restricted to access by BiLock plantroom master key series only.

9.4.3 Service Ducts

Entrance doors to ducts shall be fitted with a night latch to suit a BiLock plantroom master key and shall be sufficiently sized to facilitate easy entry and have a 2-hour fire rating.

Large service ducts shall be fitted with sufficient lighting to facilitate inspection and repair work. Switches for these lights shall be located just inside duct entry doors.

Installation of grid flooring or vertical ladders in vertical ducts to facilitate inspection and repairs shall be provided.

240V power outlets shall be located close to duct entry doors so that they may be used for portable electric tools or inspection lamps in the duct etc.

One draw-wire shall be installed in small horizontal service ducts.

9.4.4 Redundant Installation

Any services installation, including wiring, which is made redundant by the works shall be disconnected and removed from the site.

9.4.5 Painting and Identification

Asset Identification

All plant and equipment shall be labelled and tagged in accordance with the University's Asset Services identification system as provided by the University Project Manager.

Painting and Colour Scheme

The painting of all plant and equipment which is not factory finished shall be carried out in accordance with the following standards:

- AS/NZS 2311 - The painting of buildings;
- AS/NZS 2312 - Guide to the protection of iron and steel against exterior atmospheric corrosion.

An appropriate painting system (including surface preparation, primers and finishes) for each application shall be nominated from a recognised referencing system such as GPC or APAS and submit to the University's Project Manager for approval.

The following paint colours shall be adopted for Mechanical Services:

Equipment	**Paint Colour**
Boilers	Oatmeal Y54
Pumps	Oatmeal Y54
Chillers	Oatmeal Y54
Heat Exchangers	Oatmeal Y54
Motors	Oatmeal Y54
Air Handling Units	White Y35
Fan Coil Units	White Y35
Ductwork (visible)	White Y35
Fans	White Y35
Packaged Air Conditioning Units	White Y35
Plenums, attenuators	White Y35
Flues and Exhausts	Aluminium

Services Distribution Labelling and Identification

Services distribution i.e. pipework and ductwork shall be identified in accordance with AS 1345 – Identification of the contents of pipes, conduits and ducts.

Markings, labels and signs shall be located where they can be readily seen. This includes the use of self-adhesive markers indicating the service type and flow direction.

In general, label lettering should be a minimum of 30mm in height. Final lettering heights shall be suitable for the application given the local lighting conditions, the required viewing distance and status of the label or instruction.

Labels shall consist of two colour laminated plastic e.g. Traffolyte or similar approved system.

Warning and operational labels must be located to ensure visibility before any person is placed at risk. Labels should be applied to all internal MSSB equipment including filling the label

compartments of all door mounted hardware.

Equipment Labelling

All items of equipment shall be suitably identified with Traffolyte labels, fixed with screws or pop rivets. Thermometers, pressure gauge tappings, remote sensing points and valves shall be similarly labelled to indicate their function.

A valve schedule shall be provided in the plant room indicating valve number and function.

Any hidden equipment shall be identified with a label placed on the ceiling or wall within 1 metre from the equipment. The label shall include identification of isolating valves, electrical circuit number, switchboard location, and the area (room number/s).

All plant shall be coded, compatible with the University's Asset Services identification system as provided by the University Project Manager.

9.4.6 Bearings and Drives

Lubrication of Ball and Roller Bearings

Where bearings require lubrication, they shall be fitted with grease nipples which are readily accessible. A lubrication schedule shall be included in the maintenance manual as per the manufacturer's recommendations.

Lubrication Points

Grease nipples shall not be painted but shall be fitted with removable yellow-coloured caps with tethers attached to the equipment housing to prevent caps being lost during maintenance operations. Grease nipples, oil filling level and drain plugs shall be accessible on all items of equipment. Where access is difficult a central lubricating system shall be installed.

Machine Guards

Machine guards shall be applied to all rotating and oscillating equipment (e.g. pumps, fans, shafts, levers, arms, pushrods etc.).

All guards shall be of expanded metal, mesh or similar to enable easy inspection of the moving parts and belts. They shall be designed for ease of removal and re-attachment.

Guards should be designed to allow for easy access for maintenance and repair. This may include the use of quick-release fasteners, hinges and or latches.

Guards are to be provided with sufficient space to allow for maximum belt stretch, and be strong enough to support the weight of a man.

Guards shall be designed to be lifted safely by one person by the incorporation of mechanical lifting devices or breaking the guards down into several lighter parts. All guards shall comply with current Australian Standards.

All belt drive equipment shall have a minimum of two vee belts. All equipment pulleys shall be equivalent to Taperlock cast iron pulleys. Aluminium pulleys shall not be used.

Motor mountings, slides or other equipment shall provide for simple and accurate belt tensioning and alignment and shall be rigid enough to resist flexing and vibration.

Maintenance manuals shall record belt and groove sizes.

Belt sizes and types shall be clearly indicated on machine housings to facilitate ease of maintenance by the use of permanently attached labels with engraved letters and numerals.

9.4.7 Gas Detection

All areas that house specialist gases are to be provided with depletion monitoring with alarm functionality and connection to the BAS.

9.4.8 Building Services Penetrations

All external services penetrations are to be sealed.

The design team shall clearly document all smoke and fire compartmentation on the services documentation. Where a penetration passes through a smoke or fire-resistant wall the penetration is to be provided with an approved barrier system. See also Section 8: Fire Protection and Detection Services.

Physical Containment laboratories shall have clearly documented containment and quarantine lines depending on the project.

Depending on the location of the penetration, thermal and/or acoustic barriers may also be required.

Penetrations should be designed to maintain structural integrity of the building. This may require the engagement of a structural engineer to design the requirements.

9.5 MECHANICAL SYSTEMS

9.5.1 Air Conditioning Systems

General Requirements

The University's Air Conditioning systems shall be designed to comply as a minimum with part J5 of the NCC.

Energy efficiency and acceptable comfort conditions shall be the prime consideration in the design of the air conditioning system.

Systems shall be effective in delivering the required conditions to each thermal zone and/or application. The designer shall assess the overall concept of system design based on all given standard and specific user information.

Systems shall be designed in accordance with Standard 55 of ASHRAE Thermal Environmental Conditions for Human Occupancy. For details refer to Section 3: Sustainable Design of the Design Standards.

There shall be inherent design features that permit ease of modification and flexibility to suit future room or partition layout changes.

Refrigeration plant type selection shall be based upon a life cycle analysis of the most effective and economic system available.

Closed cycle condensing systems such as evaporative condensers are preferred for heat rejection in lieu of open cooling tower systems.

Where appropriate, air-cooled equipment shall be installed instead of cooling towers. In general, systems greater than 1,000 kW shall be water cooled chiller systems.

Consideration is to be given to utilising existing precinct/main plant infrastructure such as chilled water and heating water where practicable.

Externally mounted window air conditioning units are unacceptable and must not be used.

The design and location of equipment is subject to approval from the Manager Engineering & Infrastructure.

Critical areas such as computer rooms, server rooms, communications, AV rooms and any rooms with equipment that produces a heat load. shall be provided with dedicated air conditioning systems and must not be part of the main building plant. Such systems shall also be connected to the BAS.

Application of Green Star credits

The Green Star credits referred to in this section apply, at a minimum, to new buildings and major building refurbishments.

9.5.2 Electric Motors

The University requires the use of 3-phase motors, complying with relevant international and Australian standards and MEPs High Efficiency Classifications.

The minimum IP rating for all motors shall be IP56.

9.5.3 Chillers

Air Cooled Chillers

Air-cooled chillers are to be sourced from manufacturers who provide comprehensive performance data determined against a recognized performance standard i.e. ARI 550- 590 and who are able to provide local maintenance support.

New air-cooled chillers shall achieve, as a minimum, the efficiencies detailed in Section 9.3.7.

Water Cooled Chillers

Water-cooled chillers are to be sourced from manufacturers providing comprehensive performance data determined against a recognized performance standard i.e. 'ARI 550- 590 and who are able to provide local maintenance support.

New water-cooled chillers shall achieve, as a minimum, the efficiencies detailed in Section 9.3.7.

A refrigerant gas leak detection alarm is to be interlocked with the operation of the Chiller. An alarm notification shall also be sent to the Building Automation System (BAS).

9.5.4 Cooling Towers

The designer shall be thoroughly familiar with the Victorian Government's 'Guidelines for the Control of Legionnaires Disease' and adhere strictly to those guidelines in their design.

Cooling tower discharge shall be separated by adequate distance from any fresh air intake to prevent entrainment of cooling tower flume.

Cooling tower intakes shall be separated by adequate distance from all exhaust systems that could contaminate the condenser water system.

The University will only consider cooling towers that comply with AS/NZS 3666. Cooling towers shall have drift eliminators installed to prevent water loss as per the applicable Victorian Government regulations.

Tower fans are to be controlled through a Variable Speed Drive (VSD).

Stainless steel basins and components shall be used when exposed to moisture. Adequate space shall be allocated for effective and unhindered maintenance.

Cooling towers shall be set out in accordance with the manufacturer's recommendations to ensure maintainability and adequate air flow through the tower and separation between air inlets.

Acoustic performance requirements are required to be considered in the selection, location and acoustic treatment of cooling tower installations.

Cooling tower make up water supply lines are to be fitted with water meters with connection to the BAS.

All cooling tower sizing exercises shall include a water quality assessment such that bleed rate and blow down requirements can be accurately determined.

Attention is drawn to the appropriate regulations for the disposal of tower waste water. The designer is to incorporate the capture, treatment and potential reuse of bleed and blow down water as a means of reducing overall water consumption.

In accordance with Green Star Credit 18A.1, the Potable Water may be used where appropriate to reduce the buildings predicted water usage. Correct filtration methods shall be used in line with the manufacturers recommendation where potable water is used.

9.5.5 Chilled Water Distribution

The chilled water system shall be designed to provide energy efficient chilled water distribution and high levels of flow control.

Individual high spots in the system shall be minimised.

Air and dirt separators are to be installed when upgrading CHW central plant or when a new central system is installed.

To provide for system maintenance, isolating valves shall be installed to each circuit in accessible locations and clearly shown on the schematic design.

Temperature and pressure gauges capable of connection to the BAS for remote monitoring shall be installed on both the supply and return lines of all systems. Temperatures gauges to be installed in plantroom areas.

9.5.6 Packaged Air Conditioning Units

The use of package air conditioning systems is only acceptable where no centrally distributed water services are available, i.e. chilled water for cooling and/or hot water for space heating.

Packaged air conditioning units refers to the following equipment types:

- Rooftop packaged units;
- Single split DX units;
- Multiple indoor unit Variable Refrigerant Flow (VRF) systems;
- DX/VRF Systems with air cooled condensers;
- DX/VRF Systems with water cooled condensers.

For all proposed works involving packaged air conditioning units the designer/contractor is required to provide documentary evidence to the Manager Engineering and Infrastructure that the availability of centrally distributed services has been investigated. New packaged systems should achieve, as a minimum, the efficiencies detailed in Section 9.3.7.

9.5.7 Heating Systems

General Requirements

Heating systems shall be provided to all occupied areas and to specific applications (e.g. constant temperature rooms, animal houses etc.) as nominated by the University.

Energy efficiency is of prime consideration. Systems shall be effective in delivering the required conditions to each thermal zone and/or application.

The University's heating systems are to be designed to comply with part J5 of the NCC.

Boilers/Water Heaters

The University requires heating hot water via electric heat pumps with the removal of gas boilers to be in line with carbon neutrality. Air cooled heat pumps are to be external to buildings on ground or roof level. Water cooled heat pumps may be located within plant rooms. All heat pumps to be linked to the building automation system (BAS) via high level interface.

The University typically has 80 deg C coils in the AHU's and FCU's and requires that heat pumps can provide the capacity for buildings at a 3.5 deg C ambient condition.

All heat pumps are to be compliant with the following regulations, protocol and standards:

AS 3823 Performance of electrical appliances - air conditioners and heat pumps.

National Construction Code (NCC) 2019 Section J and 2022 Section J or Deemed to Satisfy requirements

> AS/NZS 5149-2018 Refrigerating systems and heat pumps

> AS/NZS 4776.1.1-2008 Liquid-chilling packages using the vapour compression cycle - Method of rating and testing for performance – Rating

> AS/NZS 4776.1.2-2008 Liquid-chilling packages using the vapour compression cycle - Method of rating and testing for performance - Testing

> AS/NZS 4776.2-2008 Liquid-chilling packages using the vapour compression cycle - Minimum energy performance standard (MEPS) and compliance requirements.

> AS/NZS 3000 Electrical Installations

> AS 2129-2000 Flanges for pipes, valves and fittings

Four types of heat pumps to be utilised including carbon dioxide (CO2) – high temperature, air to water, water to water and ground source.

Heat pumps are to be sourced from manufacturers that providing comprehensive performance data determined against a recognized performance standard i.e. ARI 550-590 and are able to provide local maintenance.

New heat pumps shall achieve, as a minimum, the efficiency detailed in Section 9.3.7.

Where feasible the use of four pipe heat pumps to provide heating and cooling in heat recovery is also acceptable.

Low Temperature Heating Water Distribution

The number of individual high spots in a system shall be minimised.

Air and dirt separators shall be installed when upgrading HHW central plant or when a new central system is installed.

To provide for system maintenance, isolating valves shall be installed in each circuit in accessible locations and clearly shown on the schematic design.

Temperature and pressure gauges connected to the BAS are to be installed on both the supply and return lines of all systems.

Space Heating Equipment

Where dedicated space heating is provided such as radiators, trench heaters and convectors they should conform to the following standards:

- AS 1571 – Copper-seamless tubes;
- BS EN 442-1, -2 and –3: Specification for radiators and convectors.

Such systems are to be installed to the manufacturers specification by a suitably qualified installer and subsequently pressure tested.

Panel radiators/connectors shall be equipped with automatic temperature control valve and balancing valve. Valves to be provided with isolation capability.

Direct electric heating devices including radiant panel heaters are not to be used.

9.5.8 Ventilation and Exhaust Systems

General Requirements

Fresh air shall be supplied to the building in accordance with AS/NZS 1668.2, refer also to ventilation rates noted in Section 9.3.4.

Internal exhaust ducts shall be connected to the fan suction side of the system. Exhaust outlets shall be arranged to avoid contamination of air intakes, opening windows, doors, wall vents or other building openings. Exhausts shall be positioned above roof level and comply with the relevant Regulations and Australian Standards. Notwithstanding such Regulations, the positioning shall be such as to ensure safe operation. Inlet louvres shall be located away from any possible sources of contamination. Inlets shall be located at least 6 meters away from exhaust locations.

Outside air shall not be drawn through plant rooms to inlet plenums. If necessary, outside air may be ducted to inlet plenums direct from outside, providing the ducting does not affect plant room use.

Fire and smoke damper locations shall be identified with a permanently attached engraved label placed where it is easily visible from within the occupied area of the room. New fire dampers shall be either fully actuated or be of the fusible link type. For the latter, dampers should be provided with a contactor such that the BAS shall monitor damper position. Access panels shall be provided either side of smoke and fire dampers to facilitate periodic inspection, cleaning and maintenance.

All building areas served by an extract ventilation system shall be maintained at negative pressure. Similarly, all building areas served by supply ventilation system shall be maintained at positive pressure.

Thermostat controlled exhaust systems shall be provided to all new main switchrooms.

Air Handling Units

Air handling units should be capable of delivering air at the design supply temperatures throughout the year with fan motor input powers compliant with Section J5 of the NCC.

Air conditioning systems should be provided with an economy cycle feature as a means of reducing energy consumption.

All air conditioning systems over 35kWr shall be provided with economy cycle operation in compliance with Section J5.2 of the NCC.

Where enthalpy control is provided there shall also be a mechanism that locks out and protects the system from inappropriate economy cycle operation upon failure of a humidity sensor.

Air handling unit installations should comply with all relevant standards including the following:

- AS/NZS 1668:1 - Fire and smoke control in multi-compartment buildings.
- AS4254 - Ductwork for air handling systems in buildings.
- ANSI/ARI 430 - Central station air handling units.

Air handling units should achieve, as a minimum, the efficiencies detailed in Section 9.3.7.

Air handling units shall be located and arranged relative to other services such that all components are readily accessible for maintenance. The design shall provide adequate space to allow the largest components to be removed unimpeded.

Unit selections shall incorporate internal lights where they are accessible. Installations to be coordinated with all other services and building structure.

Fan Coil Units

New fan coil unit installations shall, as a minimum, achieve motor input powers compliant with Section J of the NCC.

Fan coil unit installations should comply with all relevant standards including the following:

- AS/NZS 1668:1 - Fire and smoke control in multi-compartment buildings;
- AS4254 - Ductwork for air handling systems in buildings;
- ANSI/ASHRAE 79 - Methods of testing for rating room fan-coil air conditioners;
- ARI 440 - Room fan-coil and unit ventilators.

Fan coil unit installations must be fully accessible in all ceiling types. Allow to provide ceiling access panels in suitable locations such that all control panel, isolators and filters are accessible.

Installations to be coordinated with all other Services and the building structure.

Air Filters

Where new air handling systems are provided, filters are to be provided in accordance with the following standards:

- AS 1324.1 - Air filters for use in general ventilation and air conditioning - application, performance and construction
- AS 1324.2 - Air filters for use in general ventilation and air conditioning - methods of test
- AS/NZS 1530.3 - Simultaneous determination of ignitability, flame propagation, heat release and smoke release
- AS/NZS 1668.1 - Fire and smoke control in multi-compartment buildings
- AS 1668.2 - Mechanical ventilation for acceptable indoor air quality
- AS 1807.9 - Particle counting in clean rooms by microscopic sizing and counting
- AS 1807.7 - Determination of integrity of HEPA filter installations not terminally mounted

- AS 3666 - Air handling and water systems for buildings - microbial control
- AS 4260 - High efficiency particulate air (HEPA) filters - classification, construction and performance.

All new air filters must be serviced periodically during the defects liability period by the installing contractor.

Diffusers

Diffusers shall be selected to provide adequate air distribution and occupant comfort conditions for all supply conditions throughout the year.

For air conditioning applications, selected terminal devices shall achieve an Air Diffusion Performance Index (ADPI) of 80 or better when tested against 'ANSI/ASHRAE 113: Method of testing for room air diffusion'.

Ductwork

Ductwork shall comply with all relevant standards, including but not limited to the following:

- AS 4254.1 & 2 - Ductwork for air-handling systems in buildings
- AS 1668.1 - Fire and smoke control in multi-compartment buildings;
- AS 1668.2 - Mechanical ventilation for acceptable indoor air quality
- AS 1682.1 - Fire dampers, specification
- AS 1682.2 - Fire dampers, installation
- AS 3666 - Air-handling and water systems of buildings - microbial control

Flexible duct shall be the non-perforated type and shall comply with AS 4254.2 and the NCC. Flexible duct shall only be used on the final connection from the rigid duct to air terminal device.

Flexible ductwork is not permitted on hazardous exhaust systems or clean room systems.

All ductwork is to be insulated in accordance with part J5 of the NCC.

A sufficient number of bends and internal insulation is to be provided on ductwork passing over/through sound attenuated walls and through baffles.

Fans

Fans shall achieve, as a minimum, the efficiencies detailed in Section 9.3.7. Fan motor input powers shall be compliant with Section J5 of the NCC.

Fan installations shall comply with all relevant standards including the following:

- AS 1668.1 Fire & Smoke Control.
- AS 4429 Smoke Spill Tests.
- BS848 Part 1 Air Flow Tests.
- BS848 Part 2 Noise Tests.

Pumps

Pump selections shall be based on calculated system duty points. The calculations to inform the final pump selection shall be based on the ARIAH Design Guides and use the relevant hydraulic design drawings and the selected equipment.

Design head is not to exceed 90% of the pump capacity. Pumps shall comply with ISO or DIN standards.

Pumps 5.5kW and over shall be long coupled end suction type. Pumps below 5.5kW may be inline or short coupled.

Pumps are to be provided with the following features:

- Balanced/unbalanced mechanical seals suitable for the system operating pressures and temperature.
- Guarding of moving parts as per the relevant Australian Standards.

- Flexible couplings, supply and discharge on the horizontal legs.
- Drained drip trays.
- Gauges (suction/discharge) Pump installations shall include:
- Isolation valves.
- Suction strainers.
- Check valves.
- Variable speed devices.

Domestic hot water circulating pumps shall be made of bronze or stainless steel (Grundfos or approved equivalent).

9.5.9 Pipework

Pipework design, installation and testing shall comply with all applicable Australian Standards including the following:

- AS 4041 - Pressure piping to statutory requirements;
- AS 2129 - Flanges for pipes, valves and fittings;
- AS 2528 - Bolts, stud-bolts and nuts for flanges and other high and low temperature applications;
- AS5601 - Gas installations;
- AS/NZS 3500.1.1 - Performance requirements;
- AS/NZS 3500.1.2 - Acceptable solutions;
- AS 3500.4.1 - Hot water supply systems;
- AS/NZS 3500.4.2 - Hot water systems;
- AS 1722.1 - Pipe threads of Whitworth form - sealing pipe threads. Piping systems should be provided in accordance with the following table.

System	**Type**	**Material**
Cold Water	Open	Copper
Condenser Water	Open	Copper, Stainless Steel 316L
Compressed Air	Open	Less than 20 mm dia - Copper, Other - Galvanised Steel or polyethylene
Chilled Water	Closed	Less than 100 mm dia - Copper, Other – Copper or carbon steel
Drains	Open	Copper or UPVC
Floor Heating	Closed	Polyethylene
Heating Hot Water	Closed	Less than 100 mm dia – Copper Other - Copper or carbon steel
Natural Gas	N/A	Copper or steel to AS 5601
Vents	Open	Copper

All external pipe work i.e. exposed to weather, etc. (including refrigerant lines) shall be insulated and encased in galvanised metal cladding or an equal or approved alternative.

All pipe work shall be identified in accordance with Section 9.4.2. Flow direction arrows shall be provided to all pipe work in accordance with the above section.

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

All pipe work shall have test points, air bleeds and drains to ensure reliable operation and ease of maintenance.

Strainers shall be installed on the supply side of pumps.

Provide temperature and pressure gauges with a link to the BAS for remote monitoring on the flow and return lines.

Air bleeds and air / dirt separators are to be fitted to all heating and chilled water systems. Electrolysis protection for inground services shall be provided.

Under no circumstances is ABS piping to be used.

Refrigeration pipework

Refrigeration pipe work exceeding 10 metres in length and on branch tee's shall have service isolation valves provided in the suction and discharge lines.

Long refrigerated pipe runs shall be in accordance with manufacturer's recommendations.

Pipework supports, anchors and movement joints

Pipework support to be provided in accordance with the following standards:

- AS 4100 – Steel structures;
- AS 4041 – Pressure Piping;
- AS/NZS 3500.1 – National Plumbing and Drainage Code.

Movement, vibration and thrusts are to be calculated and appropriate fittings provided to counteract such effects.

Valves

The University requires isolating & balancing valves in heating and cooling water pipelines.

All similar valves shall be of one manufacture. Valves shall be approved by the Manager Engineering and Infrastructure.

Globe valves shall be used for the control of steam.

The University requires the use of STA-T Balancing Valves, where applicable, in water circuit with isolating valves up-stream of STA-T valves.

Isolating valves must be installed at each floor to allow isolation of systems without the need for draining the whole circuit.

In general valves shall be as follows;

- Ball valves to be used up to 50mm
- Victaulic manufacture butterfly valves to be used for valves 65mm and above.

HHW and CHW headers shall be provided with STA-T valves on the return side, with ball valves and Victaulic manufacture valves on the supply side.

Insulation

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

Insulation shall comply with all relevant standards including the following:

- AS 1530.3 - For all internal and external surfaces of ductwork;
- AS 1668:1 – Fire and smoke control in multi-compartment buildings;
- AS 2352 - Glossary of terms for thermal insulation of buildings;
- AS 4254 – Ductwork for air-handling systems in buildings;
- AS 4508 - Thermal resistance of insulation for ductwork used in building air conditioning.

Insulation shall be provided to mechanical services to limit heat loss or heat gains, prevent condensation and ensure fluids are delivered at required conditions at point of use. Applications included but are not limited to the following:

- Supply air systems ductwork;
- Return air systems ductwork;
- Spill air system prior to heat exchanger;
- Re-circulation ductwork;
- Air handling plants;
- Heat exchangers;
- Water heaters and flue systems;
- Storage tanks;
- Heating fluid headers, pipelines, valves, strainers and other fittings;
- Hot water supply headers, pipework, valves, strainers and other fittings.

9.5.10 Variable Speed Drives (VSD)

Variable Speed Drives shall be of Danfoss or ABB manufacture.

VSD's shall be installed no further than 1500mm from the equipment served. Drives must not be installed at high level and shall be operable from floor level. They should be installed in a clean, dry and well-ventilated area if indoors. Adequate space should be provided around the VSD for proper cooling and maintenance access, wiring and grounding should be in accordance with the local and national electrical codes.

All VSDs shall be provided with isolators immediately upstream of the drive.

Labelling shall be provided on the VSD indicating the equipment it is serving and the switchboard that is supplying it.

In addition, the labelling shall include the relevant safety and fire mode labelling in accordance with Australian Standards. Such labelling is to be provided on the front of the drive.

Labelling shall be Traffolyte. Dymo/Brother type labelling shall not be used.

VSDs should be operated within their designed parameters, and the manufacturer's instructions must be followed. The VSD should be programmed to operate at the most efficient speed for the given load conditions, and the speed should be adjusted as needed to optimise the energy efficiency.

9.5.11 Fume Extract and Fume Cupboards

Fume cupboard installations

Fume cupboard installation shall comply AS/NZS 2982 Laboratory Design and Construction standard and be appropriate for the use specified in the client brief.

Fumehoods are to be fitted with an appropriate mesh at the discharge outlet.

The fumehood duct fire protection method is to be either fire collars or fire dampers. The preferred design will require evaluation by the Fire Services Engineer and Building Surveyor.

Installation guidelines for fume cupboards include, but not limited to, AS2243 part 8.

Due to the close proximity of buildings on the University's main campus at Parkville, plume studies may be required for any fume cupboard installation.

Fume cupboards must be provided with LED lighting and automatic lowering sashes for energy efficiency.

Testing

All tests shall include face velocity, smoke, operation of controls and emergency button, condition of fans, belts, and bearings.

All tests shall be carried out by an independent NATA (National Association Testing Authority) accredited organisation approved by the University's Project Manager, and tested to AS2243.9. A copy of the calibration certificate for the instrument is to be included in the report.

Fan specifications are to be included in the test report giving details of fan, motor, total fan static pressure, total fan duty (l/s) measured in exhaust duct, make model and type of fan and operation details. The fan can be a belt driven or direct drive centrifugal fan and shall be capable of a 20% increase over the air quantity specified.

Extraction outlets shall maintain a safe distance from any operable intake in accordance with AS/NZS 1668.2.

Belt driven fans are to have a minimum of two belts on the drive train.

Instruments used for testing

The instrument to be used for testing fume cupboards shall be of the hot wire type. At the time of use, the instrument shall have a current NATA-issued certificate.

Hot wire anemometer readings shall be corrected against the calibration certificate.

Commissioning

All commissioning results shall be submitted in a written format as agreed with the Manager Engineering and Infrastructure.

9.6 BUILDING AUTOMATION SYSTEM

9.6.1 General

The Building Automation System shall comply with the requirements set out in

- Building Automation Systems (BAS): Section 10 – BAS & Controls.

9.6.2 Functional Control Description

The designer shall prepare a functional monitoring and control description that includes details of the global control functions provided including operational priorities, including the following as applicable:

- Fire mode
- Power failure and power fail restart
- Optimal start / stop
- Night purge
- Normal occupancy hours
- After hours operation

Details of the individual equipment control strategies and sequences complete with the following details:

- Plain English overview of the control strategy or sequence
- Sequence of automatic operation for all operating modes such normal, after hours, fire mode, etc.
- Sequence charts where applicable
- Details of all other interdependent control strategies, both parent and child
- Fault sequences including return to normal operation
- Duty or sequence roll over where applicable
- All associated physical and virtual BMCS points
- All operating setpoints and control parameter values
- All trend point logging and defined intervals
- All point alarming including alarm designation, actions and priorities

9.7 MECHANICAL SERVICES – ELECTRICAL

9.7.1 Standards

The installation shall comply with requirements of the Local Supply Authority Services Rules and the latest edition of all applicable regulations and Statutory Authority requirements.

Work not covered by the requirements of Statutory Authorities shall comply with the latest edition of the appropriate publication from the Standards Association of Australia and in particular the following standards;

- AS/NZS 3000 – Electrical installations Wiring Rules
- AS/NZS 3008 - Electrical installations – selection of cables – Cables for alternating voltages up to and including 0.6/1 kV
- AS/NZS 3111 - Approval and test specification- Miniature overcurrent circuit- breakers
- AS/NZS 3947.3 - Low voltage switchgear and control gear - Switches, disconnectors, switch-disconnectors and fuse-combination units
- AS/NZS 4417 – Regulatory compliance mark for electrical and electronic equipment.
- AS/NZS 3760 – In-service inspection and testing of electrical equipment

Refer to Section 7: Electrical Services for cable selection and installation requirements.

9.7.2 Documentation

Fully detailed drawings and schematics showing the proposed electrical installation shall be provided for review by the Manager Engineering and Infrastructure.

Functional schematic diagrams shall be prepared in a form which illustrate the electrical relationship between items of equipment, the sequence of operation and the control and protective functions.

9.7.3 Location and Fixing of Cables

Wiring within the ceiling space shall be run in an orderly manner parallel to the structure and on either cable trays, catenary wires or other method approved by the University's Project Manager.

Wiring within plant room areas shall be surface mounted on cable tray or in conduit and concealed within the building fabric in areas external to the plant room. Surface mounted conduit on building facades shall be avoided.

Except at tunnel-type terminals, all conductors shall be terminated with an industry standard clamp or crimp-type cable lug.

9.7.4 Balancing and Phase Rotation

Balancing and phase rotation shall be in accordance with AS/NZS 3000. The contractor must balance each section of the installation evenly over all phases and ensure that phase rotation is correct throughout.

9.7.5 Cable Selection

The minimum size of conductors shall be 2.5mm^2 for power on a 16 Amps circuit, 4mm^2 for power circuits on a 20 Amp circuit and 1.5mm^2 for control wiring using multi-strand copper conductors. See Design Standards Section 10: BAS and Controls for further specification of controls wiring.

Copper conductor fire rated cabling shall be used to supply all Life Safety Services equipment and control services. Aluminium cables shall not be used.

The project Consultant shall undertake all calculations necessary to ensure cables are installed in accordance with regulatory standards and requirements, based on final equipment selections, loads and length of cabling.

Equipment deemed as Life Safety Services equipment to run under fire conditions shall be wired with fire-rated cable and equipment as per AS/NZS 3000, AS/NZS 3013, AS/NZS 3008, AS/NZS

1668 etc.

Isolators used for Life Safety Services equipment e.g. smoke exhaust fans shall be locked in the ON position and be labelled

"WARNING: THIS ISOLATING SWITCH MUST BE LOCKED IN THE 'ON' POSITION AS THE FAN IS REQUIRED TO OPERATE DURING A FIRE."

9.7.6 Busduct

Copper conductor busduct systems may be used in certain installations where appropriate. In general, busduct may be used to supply high current, non-fire rated loads. Early approval of the use of busduct is to be obtained from the Manager Engineering and Infrastructure.

9.7.7 Mechanical Services Switchboard (MSSB)

Refer to Section 7: Electrical Services for details of MSSB and switch gear design and selection requirements.

During construction, on-site drilling or cutting may be required within the MSSB and/or controls cabinet. Where this occurs, filings, swarf, etc. shall not be allowed to lodge in electrical components. Cabinets shall be well cleaned out using vacuum cleaners, etc. at the completion of work.

9.7.8 Isolation and Overload Protection

Contactors and thermal overloads shall be manufactured by Sprecher and Schuh, Telemechanique, or Moeller.

Isolating switches shall be provided adjacent to all items of equipment. Isolator shall be rated at:

- AC-21 for normal switching duty.
- AC-23 for motor starter duty.

Short circuit protection may be provided by circuit breaker protection device. Circuit breakers shall be Terasaki, Merlin Gerin or Moeller.

The capacities and types shall be chosen according to the manufacturers' recommendations, with due regard to the temperature of their location, frequency of operation, etc.

9.7.9 Controls and Indicators

Where extra low voltage controls are employed, the preferred voltage is 24V.

Where appropriate, each control circuit shall be provided with a labelled selector switch offering the choice of AUTO-OFF MAN, AUTO-MAN or selector switch as required. See Section 7: Electrical Services for the labelling of switches for remote control wiring. Where appropriate, equipment controlled by the MSSB shall include indicating lamps. Lamps shall be LED type and be 22mm diameter.

Colours:

- GREEN indicates 'ON';
- RED indicates 'FAULT';
- RED indicates 'FIRE alarm'.

The panel design shall provide a test push button to check that all lights operate. The incoming electrical supply to the MSSB shall be fitted with current transformers and a Multi-function Energy Meter (MFM) shall be provided.

As a minimum the MFM shall have a LED or LCD display and provide the following functions:

- Current in all three phases (Amps);
- voltage each phase to neutral (volts);
- voltage between phases (volts);
- total load (kW).

The MFM shall be provided with a high-level interface to the University BAS.

9.8 TESTING AND COMMISSIONING

9.8.1 General Requirements

A list of all systems proposed to be tested and commissioned shall be provided to the Manager Engineering and Infrastructure for review and approval a minimum of 2 weeks prior to the testing and commissioning date.

On completion of the project works, the installation is to be commissioned in all modes of operation including fire mode testing.

The Contractor is to carry out comprehensive pre-commissioning, commissioning and quality monitoring in strict accordance with CIBSE Commissioning Codes or the HVAC&R Technical Requirements for the Commissioning Process published by ASHRAE (2007) to satisfy the relevant Green Star Commissioning Credit 2.2. Refer to Section 3: Sustainable Design for details of the minimum requirements for Green Star points.

Qualified technicians shall undertake testing and commissioning with appropriately calibrated equipment to carry out such tests as may be necessary to satisfy the Independent Commissioning Agent (ICA) that the installation meets the requirements of this Design Standard. All test instruments/equipment are to be calibrated at an approved

N.A.T.A. certified laboratory prior to carrying out the tests. ICA's will be appointed by the University for all new build projects, this is also in line with Green Star Credit 2.4. Refer to Section 3: Sustainable Design for details of the minimum requirements for Green Star points.

All pre-commissioning information, commissioning data, test records etc. shall be provided to the Manager Engineering and Infrastructure in a report format prior to practical completion.

In accordance with Green Star Credit 2.1, a services and maintainability review shall be undertaken during the design phase of the project. The review shall include input from the University and shall address the following;

- Commissionability
- Controllability
- Maintainability
- Operability, including fitness for purpose
- Safety

Refer to Section 3: Sustainable Design for details of the minimum requirements for Green Star points

Application of Green Star credits

The Green Star credits referred to in this section apply, at a minimum, to new buildings and major building refurbishments.

9.8.2 Test Points for Measurements

The project specification shall require the provision of properly designed test points for the measurement of all pressures, flows, temperature, etc. necessary for commissioning and performance testing. Such test points shall become part of the final installation so that they are available to the University for performance checks and fault finding during the operating life of the equipment.

9.8.3 Guarantee Tests of Major Items or Equipment

The performance of the boilers, chillers, cooling towers and other major plant items shall be demonstrated to operate at both peak and part loads and where required tested offsite prior to delivery. Testing procedures including methodology, testing standards, test rig details and testing outcomes shall be provided to the Manager Engineering and Infrastructure in for approval. Documentation is to include the following:

- Description of tests undertaken;
- Locations of test runs (i.e. on site, at manufacturer's premises or other location);
- Details of test rigs including method for simulating load;
- Where equipment fails to achieve specified design loads, remedial action and successful re-testing is to be undertaken prior to practical completion.

The Consultant's specification for the project shall clearly state what testing information is required for each item of equipment undergoing performance testing.

The designer/contractor shall be fully responsible for costs and programme implications of underperforming equipment.

9.8.4 Testing and Commissioning

The design consultant shall develop testing instructions and performance data sheets. The level of detail required, along with sample sets of such test and data sheets shall be reviewed by the Manager Engineering and Infrastructure. The design consultant shall draw up testing instruction and data sheets appropriate to the particular job and include them as part of the Mechanical Services specification.

The specification must require the contractor to prepare the equipment in all respects for the tests and advise the consultant of the date and time for their performance. The Engineering and Infrastructure Services team shall also be advised so that a suitably qualified University officer can be present to witness the tests.

All equipment shall be commissioned and fully operational prior to practical completion. All commissioning shall be undertaken by NEBB qualified personnel and in accordance with NEBB procedures.

Copies of the completed performance test sheets shall be included in the Operating and Maintenance manuals (O&M).

All systems are to be tested to the satisfaction of the design consultant and the University and in strict accordance with the CIBSE Commissioning Codes or ASHRAE Commissioning Guideline 1-1996 to satisfy the relevant Green Star Commissioning Credits. Refer to Section 3: Sustainable Design for details of the minimum requirements for Green Star points.

In addition to the design consultant's requirements for systems testing and commissioning, the following systems shall also be tested and commissioned;

- Plant and equipment
- Controls
- Air Systems
- Variable Air Volume (VAV) systems
- Water systems
- Water treatment systems
- Condensate systems
- Refrigeration systems
- Natural gas systems
- Compressed air systems
- Mechanical electrical systems

All adjustments necessary for the safe, reliable and satisfactory operation of the plant prior to Practical Completion. The Certificate of Practical Completion is not to be issued until after the plant has been inspected and approved and the requirements of this section of the specification are fulfilled.

Building system tuning

In accordance with Green Star Credit 2.3, tuning and adjustments of all building systems is to be provided on a quarterly basis for a period of 12 months from date of Practical Completion.

The objectives of the building tuning process are as follows:

- Verify that systems are performing to their design potential during all full and part load conditions;
- Reviews of environmental performance against the environment targets;
- Collection of user feedback to match the system performance with the occupant's needs;
- Adjustment of all the systems to account for all deficiencies discovered;

A building tuning report shall be provided to Engineering and Infrastructure Services which reports the outcomes of the quarterly turning process.

Refer to Section 3: Sustainable Design for details of the minimum requirements for Green Star points.

9.8.5 Operational Maintenance and As-built Information and Manuals

The design consultant must ensure that the project documentation includes a requirement that all installations are provided with a 12-month maintenance period from the date of Practical Completion. Routine and regulatory maintenance shall be scheduled per the manufacturers' and regulatory requirements. Monthly maintenance reports shall be provided to Engineering and Infrastructure Services for the University's records and information.

Refer to the University's CAD Standards for details of the formatting and submission requirements for as-built drawings, manuals and warranties. The CAD Standards can be found in the Associated Documents Section of the Design Standards web page.

O&M manuals are to comprise, but not limited to, the following;

- Maintenance manuals and instructions
- Maintenance reports
- General description of plant and systems
- As-installed/built drawings
- Plant operating instructions
- Schedule of technical data
- List of equipment suppliers
- Equipment literature
- Routine and preventative maintenance instructions
- Copy of the completed training records
- Product warranty certificates
- Copies of all test and approval certificates
- Detailed operating methodology for equipment and systems such that the reader can clearly understand the scope and performance of facilities provided;
- Consultants design specification relevant to the works;
- Function, normal operating characteristics and limiting conditions of equipment;
- HVAC equipment lists and manufacturers information
- Systems commissioning data, test sheets and instrument calibration certificates.
- Contact details for Consultant, Contractor, Sub Contractors, Commissioning Agents and other responsible parties.
- Details of consumables and spares (filters, fan belts etc).
- Plant access, maintenance and replacement strategy.
- Local Authorities certificates.
- Schedule of penetrations through fire walls.
- Registrations (as applicable) in the name of the University of Melbourne.

Draft manuals, inclusive of all the above noted items are to be provided four weeks prior to practical completion. Final manuals are required a maximum of four weeks after practical completion.

Systems Specialists Visits

Prior to practical completion, the Manager Engineering and Infrastructure shall be provided with details of any ongoing servicing requirements requiring the attendance of a manufacturer trained specialist. eg. proprietary systems.

Breakdown Emergencies

There are a number of occasions when malfunctioning of service equipment causes inconvenience to users or damage to new buildings during the Defects Liability Period (DLP). University service departments employ suitable tradespersons, who are often able to take remedial action much quicker than the Contractor or the Contractor's Sub- contractor, thereby minimising damage and inconvenience. In addition, the University operates a roster system to deal with out-of-hours emergencies. In many breakdown emergencies, use of University staff would be mutually advantageous to the Contractor and the University.

The contract documentation is to state that occasionally the University, without obligation and without prejudice, may make service staff available for emergency work under the following rules:

- The Contractor or Sub-contractor shall be notified that an emergency fault exists and agreement as to who will handle the job shall be reached;
- If the Contractor or Sub-contractor cannot be contacted, the University may, at its discretion take remedial action;
- If more than two hours work is involved, the University may claim reimbursement at normal overtime rates. For work of a lesser magnitude no charge will be made for the service;
- University staff shall exercise care in the performance of these jobs but shall not guarantee success or assume responsibility for subsequent faults or consequential damage resulting from failure.
- The Contractor's responsibilities under the contract will not be diminished by any breakdown emergency action undertaken by the University or its agents.