MECHANICAL

THE UNIVERSITY
OF QUEENSLAND
AUSTRALIA

DESIGN STANDARDS

DS-07

Document Register

Revision	Date	Description	Prepared By	Reviewed By
1.0	18.10.2021	Project Use		ML
1.1	01.08.2022	Update	H. Gouda	B. Veliscek
2.0	21.07.2023	Annual Review and Update	H. Gouda	B. Veliscek

Contents

Disclaimer
Refer to the Disclaimer within the UQ Design Standards.

Reference Documents
Refer to the UQ Design Standards for the list of documents and associated standards to be referenced for design work.
The designer is to coordinate between disciplines and standards.
UQ design standards are to be complied with in addition to the NCC and Australian standard requirements.

1 Air Conditioning Policy

1 Air Conditioning Policy

The installation of air conditioning to the University's buildings shall be in accordance with the following:

(a) New Buildings - all new buildings shall be air conditioned in accordance with UQ Design Standards & Mechanical Design Standard.

(b) Existing Buildings - Existing partially or non air-conditioned buildings will be air conditioned on a case by case basis dependent on the available budget.
The following criteria shall apply:
1. Chilled Water - Buildings having chilled water infrastructure shall be air conditioned by the chilled water system unless special conditions apply.
2. For all other buildings, the most appropriate form of air conditioning shall be selected on the basis of an individual evaluation, taking into account the following factors:

i. Life cycle cost based on Net Present Value (capital cost, maintenance, energy management etc) based on the Universities current and future rates for utilities.

ii. Good engineering practice, statutory codes, etc.

iii. Heritage implications, aesthetics and maintenance access.

iv. Required usage of the space and the need for future flexibility of services.

v. Required system resilience and redundancy.

vi. The required internal conditions suited to the space to be air conditioned, including the level of tolerances on temperatures, humidity, noise levels, etc.

vii. Future scheduled air conditioning requirements for the adjacent space.

viii. Mechanical Consultant Analysis - The mechanical consultant is required to provide an analysis of the proposed system in terms of the above evaluation criteria, and make a recommendation to the **UQ P&F Associate Director – Mechanical Infrastructure (ADMIE)**.

ix. In general, at the St Lucia, Long Pocket Gatton and Herston Campuses, RAC and unitary DX equipment may only be used with the written approval of the **ADMIE**.

(c) UQ P&F Associate Director Mechanical (**ADMIE**) shall have the final approval on the type of system to be used.

(d) Space heating must be all electric or heat pumps (no gas).

(e) All supplied equipment shall be new, factory assembled of high quality from a reputable manufacturer brand. Equipment technical data shall be submitted for approval by UQ **ADMIE** before order. If not approved, contractor shall supply the specified equipment at no additional cost to UQ.

(f) Installation shall be of high-quality workmanship as per standards, regulations, and best practice. Contractor shall submit a list of all proposed subcontractors for approval by UQ **ADMIE** before order. If not approved, contractor shall engage alternative approved subcontractors at no additional cost to UQ.

1.1 Minimum Design Criteria

Due to the wide range of facilities constructed by the University, each project undertaken will require specific adaptations of the following guidelines; however the following general principles shall apply to all projects:

(a) The system shall meet the specific internal conditions required by the Users.

(b) Note must be taken if the conditions required are of a critical nature or general.

(c) Close co-ordination with all other services is required to ensure accessibility.

(d) Plant rooms for all equipment. No ceiling mounted plant without the approval of the **ADMIE**.

(e) Ventilation systems to be provided to selected plantrooms (based on functional and equipment requirements), substations, MSB rooms and any spaces, processes or equipment which produce heat/steam/contaminants.

(f) Ensure adequate ceiling space for ductwork, including future flexibility for additional services and modifications to internal layout and space usage.

(g) Outside air intakes shall be located such that cross contamination with exhausts shall not take place.

(h) Where feasible access for servicing plants shall be outside teaching, laboratory and office areas.

(i) Comfort conditions shall be maintained in accordance with clause DG 1.3

(j) Future expansion provisions shall be incorporated as briefed. Additional capacity to be included in all new chilled water infrastructure including pumps, chillers, cooling towers, pipework and MSSB's as nominated within this guideline.

(k) Inclusion of sustainable design and installation solutions in conjunction with the Design Standards and Site Development Plans.

1.2 Designer's Responsibility

The mechanical consultant/designer shall be responsible for providing the following:

(a) Overall system concept.

(b) Suitability of specified component sizing or equipment performance to achieve the design intent with regard to cooling, heating, ventilation and humidity control capacity.

(c) Provision of an airflow schematic for the area of the works, including confirmation that adjacent existing spaces are not negatively impacted by the works. Schematics shall indicate all airflow paths and direction, airflow rates (including variance during operation), and all active airside system control and monitoring devices and equipment. Air schematic shall be produced at schematic design phase and updated during design development.

(d) Designers Engineering drawings shall contain the RPEQ number of the engineer certifying the work." In the shop drawing section.

(e) Provision of advice to the **ADMIE** or representative during all phases of the project.

(f) Provision of advice to the architect on the minimisation of heat loads and fabric requirements. Provide advice and coordinate with the architect with regards to the insulation R-value and location of the vapour barrier to minimise mould growth.

(g) Provision of advice and technical information to the acoustic consultant, or undertake simple acoustic calculations where no acoustic consultant is engaged.

(h) Provide a complete *Camel* or other acceptable heat load program calculation printout for the perusal by the **ADMIE** when requested. Program shall be provided in a native format as well as viewable PDF Printout.

(i) The mechanical consultant shall investigate and report back to the **ADMIE** the cost and technical implications of meeting the User requirements, particularly the energy and space implications. The

consultant shall identify and clarify the design conditions and specific user requirements in writing prior to completion of calculations. This information will be reviewed by the **ADMIE** to assess the suitability of the proposed system.

(j) The mechanical consultant is required to advise the **ADMIE** when architectural considerations have adverse consequences for the mechanical functionality, in particular in relation to initial capital costs, energy costs, accessibility issues and life cycle costs.

(k) To ensure that the documentation considers the implication of any work on the functioning of the university, to minimise the disruption to teaching, research or general UQ business. All disruptive work is to be completed out of hours unless special arrangements are approved.

(l) The mechanical consultant is required to coordinate with the structural engineer, architect and other services consultants regarding AS1170.4 seismic restraint classification and installation requirements. The final design and certification of the mechanical seismic restraint systems shall be by the contractor's professional Registered Engineer RPEQ.

(m) Ensure compliance with all relevant sections of Acts, Regulations, Codes and Australian Standards and UQ Design Standards. If specific clarification is required, address the issue to the **ADMIE**. Some Australian Standards are specifically called up in this document.

(n) Design certification by a professional Registered RPEQ.

1.3 Design Conditions

The base design conditions used for air conditioning calculations shall be determined for each project. The designer shall select the appropriate design conditions taking in to consideration the type of project, the internal conditions required, tolerances and nature of the system, location, etc. The selected conditions shall be approved by the **ADMIE** prior to the calculations being undertaken by the consultant. Use of critical design conditions shall be identified and/or approved by the **ADMIE.** The conditions shall be in line with the weather data used in the *Camel* program for the particular site. Where variances in design criteria exist, the most onerous condition shall be used, unless approved by the **ADMIE**.

(a) Typical External Design Conditions – Major Campus sites.
(All Conditions to be confirmed by consultant).

	St. Lucia	Gatton /Ipswich
Summer Non-Critical	32.0^{0}CDB/25.0^{0}CWB	34.9^{0}CDB/24.8^{0}CWB
Summer Critical	35.4^{0}CDB/26.5^{0}CWB	38.3^{0}CDB/26.3^{0}CWB
Winter Non-Critical	9.0^{0}CDB	3.9^{0}CDB
Winter Critical	0.0^{0}CDB	-1.0^{0}CDB

(b) Outside air shall be provided to all air conditioned spaces, either via the central air conditioning system or via a dedicated outside air system. OA quantities shall comply with AS 1668.2 and the National Construction Code of Australia (NCC) to suit the proposed usage. High outside air applications shall utilise demand control ventilation and assess additional options such as heat recovery (air and/or water/DX based), run around coils etc. to provide the best life cycle cost outcome.

(c) Economy cycles shall be included where required by the NCC. Incorporation of economy cycle on smaller systems shall assess the total system energy advantage against the system installation and maintenance requirements.

(d) 100% outside air systems shall be used in animal houses, laboratories, and other special facilities where recirculation of air is not acceptable. Laboratories shall be designed to the requirements of AS 2982.1. Laboratory boundaries shall be clearly defined during all project phases. Refer to Laboratory

Standards Documents for additional requirements.

1.4 Performance Standards

(a) Room Conditions: Standard office and teaching spaces require the following conditions. A/C plant shall be designed to maintain the following internal design conditions:
Internal Design Conditions (Nominal)

23^0C DB - +/- 1%

50% RH (Nominal) +/- 5/%

(b) Room Conditions: Non-teaching spaces shall be provided by the user group and confirmed with the **ADMIE**

(c) Toilet Ventilation: All toilets shall be mechanically ventilated. Natural ventilation shall not be used without specific **ADMIE** approval.

(d) Air Velocity: Air movement in the occupied zone of conditioned spaces shall be maintained between 0.1 m/s and 0.2 m/s. Closer to 0.1 m/s is preferred.

1.5 Hours of Operation and Availability

(a) Times of operation of A/C plant shall be provided in the design brief. Normal hours of operation are between 7.30am and 6.00pm Monday to Friday.

(b) Teaching spaces available to be booked by Syllabus shall be confirmed with the **ADMIE**. These spaces shall be provided with afterhours plant operation to suit bookings.

1.6 Population Densities

Actual population densities shall be provided in the design brief/architectural documents if they differ from those listed below:

Space	M^2/person
General Office	7.5
Library Reading Room	2.5
Laboratory - Undergraduate (1st year)	3.7
Laboratory - Undergraduate (other years)	4.7
Laboratory - Postgraduate	12.0
Seminar Rooms	1.8
Lecture Theatre	1.1
Computer Laboratory	2.0

1.7 Equipment Naming Convention

(a) Equipment shall be named and labelled as per UQ equipment and naming convention (see appended BMS Equipment Numbering) and shall be approved by the UQ P&F Engineering Manager (**ADMIE**).

1.8 Equipment Heat Loads

(a) Equipment Loads - Shall be provided in the design brief or generally as follows:

Equipment	Watts
PC computer	90 W
Laptop computer	65W (1 laptop per person)
27” Monitor	50W
Printer, Scanner, etc,	200 W
Photocopier	250 W
Lighting	10 W/ m^2

1.9 Humidity Control

(a) In general A/C installations which are selected within the nominated internal design conditions are not required to actively control humidity (dehumidification via cooling only). Active humidity Control shall be utilised to limit indoor RH to a maximum of 65% under extreme

ambient dew point conditions all year around.

(b) Humidity control if required for archived storage, museums, libraries, laboratories etc will be included in the design brief. Confirmation of briefed requirements and mechanical solution (including control tolerances) shall be confirmed by the consultant and approved by the **ADMIE**.

(c) All conditioned spaces shall have suitable thermal boundary performance for the nominated function. Internal conditions requiring specific building fabric construction and installation methodology (including pressure testing) shall be identified to the architect by the mechanical consultant. Note detailing requirements consistent with that identified in the Coolroom section of this standard are applicable to such spaces (i.e. high temperature incubation rooms, controlled environment/constant temperature rooms, clean rooms etc).

(d) Coils shall be selected to achieve both sensible and latent heat loads and shall be capable of maintaining design RH of 50% under highest ambient conditions

1.10 Mould Control Measures

(a) Special consideration shall be given during design to prevent mould creation including:

i. Remove vegetation near outside air (OA) intake.

ii. Provide outside air filtration.

iii. Consider using demand control ventilation (DCV) for high risk applications.

iv. Consider using UV lights for high risk applications.

v. Consider active humidity control for high risk applications.

vi. Duct cleaning and insulation repair for asset replacement and refurbishment projects.

1.11 Noise and Vibration Control

(a) General: The system shall be designed to minimise the transmission of noise and vibration from air conditioning and mechanical equipment. Sound attenuators and/or internally lined ductwork shall be installed where necessary to minimise the transmission of fan/air noise.

(b) Noise Levels: Unless otherwise specified in the design or the brief the noise levels from equipment shall not exceed the following:

Location	Level NR
Equipment Rooms	50
General Office Areas, Laboratories	45
Teaching Spaces, Library areas	40
Private Offices	35
Outside	5 db above ambient @ 10 metres

(c) Equipment Isolation: Care shall be taken to minimise transmission of vibration to the structure from mechanical equipment. Where reciprocating or rotating equipment is installed these shall be isolated from the structure by vibration isolators. Reciprocating or rotating equipment shall be mounted on inertia bases weighing not less than 1.5 times the weight of the equipment. Provide vibration calculations to **ADMIE** to justify the isolation proposed for all large equipment items such as chillers on request.

(d) Acoustic requirements: Comply with AS/NZS 2107 and TG17 Acoustic Design Standard and any site specific requirement. Special requirements will be called for in the Design Brief. Noise levels at the University property boundary shall comply with the Environmental Protection Authority (EPA) requirements.

1.12 Performance Solutions

(a) General - all systems shall generally be in accordance with requirements

of the BCA. Where performance solutions are required or provide value to the project and are subsequently proposed, these shall be supported by calculations, certified by a suitably qualified person/s, all calculations and conclusions checked by an independent and suitably qualified person, and approved by the Building Certifier and the QFRS. A copy of the approved Fire Engineering Design Brief shall be incorporated in the Mechanical As-Built documentation.

(b) Returnable Schedule: The mechanical consultant shall provide performance requirements for plant and equipment listed in a returnable schedule.

1.13 Piping, Valves and Fittings

(a) General: Chilled water and condenser water lines within buildings shall be of Type B Copper or 316 Schedule 5 or 10 stainless steel. Underground chilled water pipework shall be of the approved proprietary pre-insulated manufacture or approved equal.

(b) Change in Pipe Material: Transitions from one material to another should be made in an access pit or other accessible area. Dissimilar metals shall be isolated. All connection bolts shall be 316 stainless steel.

(c) Valves: Valves shall be of local manufacture and readily available, i.e nominated manufacture, or approved equal and shall be in easily accessible positions. Ball or Butterfly valves shall be used throughout except where throttling or balancing is required.
Valve trains associated with chilled water Air Handling Unit (AHU), FCUs, etc. shall incorporate a suitably sized 304 stainless steel drip tray. Trays shall be insulated with foam on the under side and drained separately to waste.

(d) PIC Valves: PIC chilled water/ heating hot water control valve of the equal percentage type shall be used. The PIC valve shall drive fully closed whenever the associated AHU is not operating. Valves shall be suitable for the medium and sized to shut off against the maximum pressure of the system. PIC valves shall have test point such that the flow can be measured or have an integral flow meter.

(e) Balancing Valves: Balancing valves shall be of the nominated manufacture or approved equal by the **ADMIE** All valves shall be labelled with size, service and function.

(f) Balancing valves shall not be used as isolating valves.

(g) Constant flow valves shall not be used in series or in systems with modulating control valves.

(h) Floor and Wall Penetrations: Where pipes pass through floors or walls, sleeves shall be specified and filled with appropriate sealant to suit application. The sleeves shall maintain the required fire rating.

(i) Risers: All risers shall be provided with dirt legs and drains at the bottom. Each level of pipework shall be able to be isolated and provided with drains at the low point of each branch and at the riser. Automatic air vents shall be provided at the highest points.
All dirt legs, drains and non-automatic air vents shall be plugged.

(j) All screwed valves shall have unions for easy removal.

(k) Monitoring Points: Binder points shall be fitted to all chilled water and condenser water headers and to supply flow and return lines at all air handling units. Suitably sized and adequate number of well pockets shall be installed to the supply and return chilled water lines.

(l) A magnetic flow meter complete with remote LCD display shall be installed in the chilled water line to each building. The flow meter shall be connected to the BMS via high level interface for remote monitoring.

(m) Pipe Identification: Refer 13.4 for colour. Flow direction arrows shall be provided to all pipework.

Identification labels are to be applied as a minimum at 5 metre intervals horizontally and at 3 metre intervals vertically.

(n) Underground Services: All underground services including pipe work, conduits etc. shall be laid on 100mm of sand and covered with 150mm of sand. Appropriate brass markers shall be provided at the start and finish and all changes in direction. A concrete plinth maybe required.

(o) Testing of Pipes: New pipework installations are to be hydrostatically tested to approval.

(p) Pipe Flushing: Clean all pipe work and fittings thoroughly on completion, and prior to connection to existing systems. Remove all loose scale, burrs, etc. The new pipe work shall be filled and repeatedly flushed with detergent and water until clean. Provide pumps and temporary pipe work interconnections to ensure circulation through the new pipe work during the cleaning process. During construction, ensure that temporary covers are installed to prevent any foreign matter from entering the pipework. Refer to CIBSE and BSRIA standards.

(q) All cut-in work to the existing chilled water system shall be coordinated with the **ADMIE** or their representative.

(r) Condensate drain shall utilise gravity. Drain pumps shall not be without written approval from UQ engineering manager and only for extreme conditions where gravity drain is not possible.

1.14 Insulation to Pipework

(a) Insulation shall be subject to NCC requirement

(b) All above ground chilled water pipework shall be insulated with sectional, preformed, closed cell polyurethane or polyolefin insulation, complete with external vapour seal and mechanical protection. Mineral wool or fibreglass insulation shall not be used. Pipework insulation shall be installed as per Manufacturer's instructions.

(c) Insulation shall be compartmentalised every 5 metres and adjacent to fittings and take-offs to prevent longitudinal moisture transfer.

(d) Hangers: At hangers provide *Phenolic* foam insulation blocks complete with additional sheathing where required except for pipes up to 50mm diameter where zinc annealed saddles may be used. The vapour barrier shall be continuous over all hanger blocks.

(e) Sheathing - pipework exposed to view, in plant rooms or where mechanical damage is likely shall be metal sheathed with 0.5mm zincanneal sheet, all edges swaged and overlapped 50mm and fixed by means of metal straps and shall be at 500 maximum centres. Self tapping screws shall not be used. Reinforced aluminium foil factory bonded to the insulation with synthetic banding can be used in approved concealed areas.

1.15 Ductwork and Registers

(a) Insulation shall be subject to NCC requirement

(b) In general ductwork shall conform to the latest version of AS 4254. Use low velocity systems. Ductwork shall be designed to limit air velocities to ensure low noise levels. *Plenum* ceiling supply air systems shall not be used without approval of the **ADMIE**. Return and outside air plenums shall be ducted. Plantrooms shall not be used as a return plenum without approval of the **ADMIE**.

(c) Ductwork exposed to view preferably shall be spiral wound circular or oval with pocket and tail type joints. Samples are to be provided for the approval of the **ADMIE**.

(d) Registers: Ceiling registers shall be of the square faced type of nominated manufacturer or other approved manufacturers with removable cores. Full face cushion head boxes shall be used on all ceiling supply air diffusers. Sideblow

registers shall be of the adjustable double deflection blade type. Front set of blades are to be horizontal. Maximum blade spacing shall be 20mm. The type shall be selected to suit the air distribution and requirements of the space. Diffuser shall be selected to suit air flow range requirements. P3 cushion head boxes are not allowed.

(e) Toilet exhaust grilles may be of fixed core, aluminium egg-crate.

(f) Ductwork penetrations through walls and floors shall be packed with insulation and shall be flanged on both sides of the penetration. No ductwork is to be concreted into wall openings. Fire ratings of penetrated walls is to be maintained. Systems shall be designed to avoid fire dampers wherever possible. Fire dampers shall not be used in fume cupboard exhausts and fire separation requirements shall be identified and coordinated during schematic design. Fire Engineering requirements shall be identified by the mechanical engineer.

(g) Ductwork penetrations through walls and floors shall maintain the acoustic rating of the complete system. Internal return/relief/make up air shall utilise acoustic transfer ducts. Cross talk attenuators shall be used for meeting rooms and Quiet spaces

(h) Access panels for cleaning the ducts and as per AS 3666 shall be provided. All ductwork shall be accessible for cleaning. Provide additional duct access provisions as nominated in the project brief and where required to maintain the systems functional components and duct sensors.

(i) Ductwork hangers shall be a minimum thickness of 1.2mm and fixed to a permanent structural element.

(j) Fire-Resistant Floor Ceiling and Roof-Ceiling Structures: Ducting shall not be installed in the space above a suspended ceiling which forms part of a fire-rated floor-ceiling or fire-rated roof-ceiling construction, unless the fire resistance rating includes the presence of ducts.

(k) Balancing dampers shall be provided for each duct branch and take off.

1.16 Plant and Equipment

(a) **Pumps**: In general notwithstanding the specified duty point, select pumps capable of delivering the required flows over the full range of operational conditions of the system without cavitation. Ensure that the pump casing can accommodate an impeller with a diameter one manufacturer's size greater than that selected to meet the specified duty point.

Characteristics - ensure the pumps are of proven manufacture, fitted in accordance with the manufacturer's instructions and include the following characteristics:

i. Single stage, vertical centre line discharge. Centrifugal type, end suction and back pullout. Spheroidal graphite cast iron casing with integrally cast mounting feet. Bronze impeller, dynamically balanced. 316 Stainless steel shaft.

ii. Motors selected for non-overloading characteristics.

iii. Efficiency shall comply with NCC requirements.

iv. Impeller shaft bearing housing and impeller able to be withdrawn as an assembly without disturbing pipe work connections or casing.

v. Discharge and suction flanged pipe connections provided on casing.

vi. Casing shall be tar epoxy painted.

vii. Impellers shall be fixed onto shaft by S.S. or bronze nut with fine metric thread.

viii. Impeller shall be selected for mid range for pump casing size.

ix. Shafts to run on deep groove ball bearings selected at a life of 100,000 hours. Rear bearings shall be double row. Provide a grease nipple for each bearing.

x. Mechanical seals.

xi. Name Plate - Engraved Name Plate permanently fixed to the casing providing the following:

- Make
- Model
- Serial No.
- Casing, Impeller and Shaft materials
- Impeller diameter
- Seal type
- Direction of rotation

xii. Mounting - inertia base incorporating hot dip galvanised fabricated steel frame and concrete mass.

xiii. Spring mounts and neoprene blocks and pads. Spring ratio to be >0.8 for mean coil diameter to compressed length at full load static deflection.

xiv. Safety Tray - stainless steel tray under entire unit and valve trains.

xv. Dynamic Balancing - the rotating assembly of the pump shall be dynamically balanced.

xvi. Coupling - Pump and motor shall be direct coupled via a flexible coupling, aligned to the manufacturer's specification and covered with a metal guard. They shall be of rubber sheathed pin directly coupled type. Alternative close coupled pumps shall only be provided with approval from the **ADMIE**.

xvii. Continuous Rating - the motor shall have a continuous rating to suit the largest available impeller to suit the corresponding flow and pressure duty point.

xviii. Plinths are required for all pumps and motors. Concrete Plinths shall be provided and coordinated with the architect.

xix. Condensate Drain - Run 32mm diameter PVC condensate drain from AHU, FCU, pumps and to waste. Safety trays shall be separately drained.

Fit back pull out pumps with a spacer coupling of adequate length to allow the removal of the impeller and bearing housing without disturbing piping connection or motor alignment.

(b) **Motors** - shall be totally enclosed fan cooled and normally be limited to 1450 rpm. Motors shall have an IP56 rating. Provide easily removable guards on all belt drives and pulleys.

(c) Duct Heaters/Heater Banks

i. The heaters shall be constructed with a stainless steel casing and fins.

ii. The heaters shall be Solid State Relay (SSR) controlled unless the heater bank is equal to or less than a total of 3kW or as approved by the **ADMIE**

iii. General - Install duct heaters in accordance with AS 1668.2, located for maintenance and unit replacement without removal of equipment/building elements. Provide finned type heaters installed so as to prevent stratification of air temperatures across the duct. A Penn A25AN1 or approved equal Heat Protection Thermostat (HPT) shall be provided through the duct sidewall adjacent to each duct heater, installed in a manner to permit removal of the element by maintenance staff. Button type HPTs are not acceptable.

iv. Heaters shall be balanced across electrical phases. The duct heater shall be interlocked with the supply fan motor, air pressure switch and HPT in both manual and automatic operation.

v. Three Phase Heaters - All duct heaters greater than 2.4 kW shall be three phase.

vi. Notice - Provide a notice adjacent to the heater reading the following in 15mm high lettering in white on a red background:

WARNING

THIS DUCT CONTAINS ELECTRIC DUCT HEATING ELEMENTS.

IN THE EVENT OF A FIRE

DISCONNECT THE POWER BY ISOLATING THE AIR CONDITIONING SYSTEM AT THE MECHANICAL SERVICES SWITCHBOARD.

(d) **Filters** - shall be of approved quality. The following shall be the minimum type of filters to be specified:

i. AHUs: Deep bed type

ii. Under Ceiling or Floor mounted FCUs.

- (greater than 10kWr) 100m V form panel filters.
- (less than 10kWr) panel filters with aluminium frames or manufacturers standards.

iii. Dry media filters shall be of the disposable type, F5 grade. In areas where high efficiency filtration is warranter electrostatic filters of HEPA grade filters should be considered

iv. Install a Magnehelic gauge to indicate the pressure drop across the filters. Mark the fully loaded pressure drop on the gauge face and traffolyte label adjacent. Provide a galvanised sheet steel cover over the gauge to provide protection from the weather and sunlight where externally installed.

v. Provide access to filters for maintenance. Ensure that there is no air bypass around filters

vi. Replace all filters at end of defects liability period regardless of condition.

vii. Install roughing media over the filters during initial commissioning where builders dust could be a problem.

(e)

(f) Cooling Towers:

i. Access Ladder and Platform - Provide access ladder and platform to service the fan motor and fan belts. The ladder and platform shall be a proprietary item to suit the specific tower design. The platform shall be manufactured from corrosion resistant materials and installed in accordance with AS 1657.

ii. Maintenance - Provide cooling towers that provide maintenance access in accordance with AS 3666. Install the tower in accordance with relevant codes and regulations.

iii. The cooling towers shall comply with the following:

iv. Horizontal air inlet and vertical discharge.

v. Inlet louvers shall effectively eliminate water splash-out from the basin and minimise sunlight entering the basin areas.

vi. PVC eliminator assembly installed in the vertical airflow preferably below the fan / motor assembly. The discharge eliminators shall control drift to the level specified in AS 3666. Eliminators shall be easily removed for cleaning.

vii. Cooling tower fan shall be direct drive VSD controlled. VSD shall be of the nominated manufacturer to approval. If belt driven, the bearing assembly housing shall be constructed from non-ferrous materials and the fan shaft shall be hollow steel complete with bituminous coating. The drive belts shall be of the 'power band' type and the pulleys shall be of non-ferrous material with the drive rated for 150% of motor power. Fan bearings shall be sealed and provided with an externally accessed grease line, bearing life shall be rated at 40,000 hours. The motor shall be installed above the fan and shall be finished in two coats of bituminous epoxy to a minimum thickness of 0.4mm. The motor shall be constructed to IP56 rating. Fans and shafts shall be removable from the cooling tower without having to remove the cooling tower panelling. The tower shall be

configured to suit the space available, to facilitate removal of the motor and fan without interference from surrounding structure.

viii. Materials used in the construction of the cooling tower (including basin, sides, pipe work, sprays and distribution system, eliminators, infill, fan and drive system) shall be not subject to corrosion. No component shall be constructed of sheet steel, regardless of surface finish. Any plastics or resins shall be ultra-violet stabilised and suitable for long term exposure to direct sunlight.

ix. All internal surfaces within the tower shall be smooth and corners radiused to allow easy cleaning.

x. All bolts and fixing materials shall be 304 stainless steel.

xi. Noise level from the tower shall comply with the design guidelines..

xii. Access panels of minimum size 600mm x 900mm shall be provided to allow access to clean the inside of the cooling tower. Not more than eight fasteners shall secure each access panel. Provide reinforcing in the vicinity of the hinges.

xiii. Water levels within the tower shall be regulated via float valves, one per tower. Float valves shall be soft closing, low pressure type.

xiv. Towers shall be suitable for the space. Clearances shall achieve adequate airflow and maintenance access.

xv. Towers shall be provided with a drain connection to sewerage, a quick fill valve, provision for metered water bleed, overflow, drain and equaliser connections.

xvi. Cooling towers shall be able to be completely drained dry for cleaning. Provide a drop sump in the tower basin to minimise water mass in the cooling tower and eliminate the possibility of air entrainment. The cooling tower basin shall be arranged to ensure water drains to the drop sump without ponding in the basin. Sump shall include including a 316 stainless steel strainer, vortex breaker to ensure that no air is entrained into the water flow at any time. Hole size in strainer shall ensure that no material that can damage the pump shall be passed.

xvii. The tower shall be provided with vermin proof screens to intakes and outlets.

xviii. The tower shall be constructed so that there is no drumming of panels, or loose infill, eliminators, screens or other vibration.

xix. Water supply to each tower shall be run in minimum 40mm diameter copper.

xx. Each cell of each cooling tower shall have an infinitely adjustable manual balancing valve installed at the tower intake and discharge and shall be set to ensure equal water flow to each cooling tower. Isolation valves shall be provided for each cooling tower cell.

xxi. The balancing valve shall be locked to control the maximum opening of the valve yet allow the valve to be closed.

xxii. Ensure that each tower can be isolated and cleaned while other towers remain fully operational. Motorised tower isolation valves to have positive feedback to indicate valve position and raise alarm to BMS on failure

xxiii. Provide cooling towers basin equalising lines where multiple towers are used. Ensure adequate water movement through the equalising line to eliminate stagnant sections Condenser water to be circulated over each tower at least once a day.

xxiv. Provide drains to totally drain water from the equalising pipes.

xxv. Cooling towers shall be capable of performing efficiently with part load capacity and lower flow rates at least 50% of full load design figures. Select towers nozzles to suit

(g) Air Cooled Condensers:

i. Shall be of equivalent standard to nominated manufacture and generally be of the vertical airflow type.

ii. The acoustic performance of the air-cooled condenser shall comply with the EPA requirements at the property boundary.

(h) **Belts and Pulleys** - All belt drive equipment shall have a minimum of two vee belts where required by the manufacturer or over 1kW motor capacity. All equipment pulleys shall be equivalent to *Taperlock* or equal.

(i) A/C Unit - Under Ceiling chilled water type – Nominated manufacture or approved equal.

i. The units shall not have any internal bare metal surfaces that can cause cold tracking to the outside of the unit, and result in condensation forming externally on the unit.

ii. The discharge grille shall be double deflection type with the front blades horizontal.

iii. Coils and condensate tray shall be accessible for cleaning in accordance with AS 3666. Access to the condensate tray must be clear to allow complete cleaning and shall not be obstructed by any of the internal casing elements including the fan, fan supports, or motor. Condensate tray shall be stainless steel construction. Condensate trays shall be insulated with a minimum 5mm expanded urethane foam insulation.

iv. The chilled water valves shall be located over the drip tray. Chilled water valves shall be insulated. Chilled water pipe work or fittings inside the unit not located over the tray shall be insulated with a minimum of 25mm insulation.

v. The chilled water pipework shall be separated from the electrical components.

vi. Underbody access panels are to be hinged to aid maintenance access.

(j) Unitary Fan Coil

i. Unitary Air-handling Systems serving a single room or small number of similar rooms are preferred over large floor plate air-handling systems.

ii. Cabinets of sheet steel, 1.6 mm minimum thickness, reinforced to prevent drumming, treated to prevent corrosion, powder coated or colorbond finish inside and out. Insulate to prevent condensation with 25mm fibreglass or expanded polythene insulation with perforated sisalation facing.

iii. The units shall not have any internal bare metal surfaces that can cause cold tracking to the outside of the unit, and result in condensation forming externally on the unit.

iv. Access panels shall be provided to allow access to all components including condensate trays, held in place with half turn fixings. Screws shall not be used to secure access panels. Access panels shall include foam gaskets to provide an airtight seal. Fans shall be forward curved centrifugal, direct drive with speed control for units up to 20 kW cooling capacity and multiple belt drives in larger units. Belt drives shall not slip under any conditions and shall incorporate adjustable diameter pulleys. Fan motors shall be selected to provide non-overloading under all operational conditions. Fans shall be resiliently mounted on spring mounts.

v. Incorporate an internal flexible connection between the fan discharge and air conditioning unit casing. External flexible connections shall not be acceptable.

vi. Coils and condensate tray shall be accessible for cleaning in accordance with AS 3666. Access to the condensate tray must be clear to allow complete cleaning and shall not be obstructed by any of the internal casing elements including the fan, fan supports, or motor. Condensate tray shall be stainless steel construction. Coils shall be of copper tube aluminium fin mechanically bonded to tubes. Fin spacing shall not exceed 472 f/m. Water carryover from evaporator coil shall not be permitted. Face velocity shall not exceed 2.5 m/s. Air handling units shall be mounted to minimise transmission of both noise and vibration on double thickness

waffle rubber pads on galvanised supports. Provide a drained 50mm deep galvanised steel safety tray below air handling units installed within buildings at high level. Provide supports below the air-handling unit to ensure it is sufficiently elevated to ensure correct condensate drainage allowing for the depth of the trap and the height of the tundish.

(k) Variable air volume units:

i. Provide proprietary Variable Air Volume (VAV) boxes of nominated manufacturer or approved equal manufacturer complying with the following:

ii. Pressure independent including a grid type averaging differential pressure velocity pressure sensor, suitable for the location in which the VAV box is installed.

iii. Electronic controls for connection to the Johnson Metasys BMS.

iv. 24 VAC motor – 0-10V DC control, capable of tight close off of the VAV box.

v. External labelling indicating % open setpoint.

vi. VAV boxes shall be factory preset for the maximum and minimum airflows. Each VAV box shall be capable of delivering up to 15% additional airflow over the maximum quantity specified in the schedules.

vii. Insulated to prevent condensation with the main body of the box being internally insulated.

viii. Design the installation so that any noise generated by the VAV box does not exceed the required levels in the space.

(l) **Equipment Location** - All equipment such as air-handling plant, fans, outside air fans, pumps, switchboards etc. shall be located to provide clear maintenance access. Maintenance clearances shall be in accordance with the manufacturer's recommendations unless approved by the **ADMIE**. Equipment shall be located generally in plant rooms unless otherwise approved by **ADMIE**.

(m) **Bunding** - Provide adequate bunding and tanking to all plant rooms with special emphasis on the bunding of all penetrations in plant room floors to prevent flooding to lower levels. Bunded volume shall be calculated, confirmed against the potential containment requirement, and presented to the **ADMIE** for confirmation.

(n) **Plinths** are required for all equipment on concrete slabs and roofs. Concrete Plinths shall be provided and coordinated with the architect subject to structural engineer's review.

(o) **In ceiling Installation**: equipment installed in ceilings is only to be used with approval of the **ADMIE**. If used, label ceiling grids to show location. Provide access panels as necessary.

(p) **Labels:** All items of equipment, both in plant rooms and in the field, shall be suitably identified with traffolyte labels of an approved size and type. Thermometer bulbs, pressure gauge tappings and remote sensing points shall be similarly labelled to indicate their function.

(q) **Calibration** - all instruments shall be calibrated to read in the SI system of units. Dial gauges shall be 100mm minimum diameter. The range of the instrument shall be suitable for the application, i.e. normal operating point equal to 80% of full scale deflection.

(r) **Chillers**:

Chillers shall comply with the following:

i. Chillers shall be high efficiency air cooled or water cooled screw or centrifugal type of nominated manufacture. Chiller type and selection must be approved by **ADMIE**.

ii. The chillers may be separately tendered and a life cycle cost analysis undertaken. The chiller maybe pre-ordered. The order shall be taken over by the installing Contractor prior to delivery.

iii. Centrifugal machines may be used if they provide the lowest life cycle costs.

iv. The **ADMIE** shall determine the conditions to be included in the selection of the chillers in terms of load percentages, costings etc. Chillers shall be selected such that optimum chiller efficiency matches the prevailing load profile of the Chilled Water precinct.

v. Chillers shall operate only on long term refrigerants, No CFCs or HCFCs are to be used. Refrigerants shall have 0 ozone depletion potential (ODP), and low global warming potential (GWP). For equipment less than 100kWr, GWP is to be less than 700, and over 100kWr, refrigerants with GWP less than 10 shall be used.

vi. Chiller type shall be suitable for application, high efficiency, capable of variable flow, include harmonic filters and can provide the required minimum low load capacity without the usage of hot gas bypass. chillers shall be as specified and must be approved by **ADMIE**.

(s) **Chiller Evaporators** - shall comply with the following:

i. Shell and tube type with seamless copper tubes incorporating internal fins, and steel endplates.

ii. Tubes to be expanded into end plates, and accessible from both ends of the chiller.

iii. Vessel shall be rated for 1050 kPa water side pressure. Test the vessel to 150% of this pressure.

iv. Shell insulated with 50 mm expanded polystyrene, vapour barrier and metal sheathing as per 13.1.14.

v. 19mm air vent and 32 mm drain connection.

(t) **Chiller Condensers** - shall comply with the following:

i. Shell and tube type with seamless copper tubes incorporating internal fins and stainless steel end plates. Ceramic coated endplates and water boxes are subject to **ADMIE** approval.

ii. Tubes to be expanded into end plates, and accessible from both ends of the chiller via removable marine water boxes without requiring the disconnection of adjacent pipe work

iii. Vessel shall be rated for 1050 kPa water side pressure. Test the vessel to 150% of this pressure, a sub-cooling circuit complete with water drain and safety relief valves.

iv. Condenser shall be capable of containing the entire refrigerant charge of the chiller during servicing.

v. Sockets for connection to impressed current cathodic protection system 19mm air vent and 32mm drain connection.

(u) **Micro-Processor Control**: Each Chiller shall have a microprocessor control system complying with the following:

i. Chilled water leaving temperature control to within +/- 0.10 C of set point,

ii. Auto start after power loss,

iii. Auto - Off - Manual control switch,

iv. Current limit setting to limit % of Full Load Amps (FLA),

v. Motor protection including, phase loss or unbalance, momentary power loss. These faults to be auto-resetting after a period of ten minutes (adjustable).

vi. Phase reversal protection shall be included with manual reset required,

vii. Shutdown in the event of over temperature in motor windings,

viii. Indication of the following:

ix. Evaporator refrigerant pressure.

x. Condenser refrigerant pressure.

xi. Oil pressure.

xii. Chilled water leaving set point.

xiii. Motor amps.

xiv. Motor winding temperature.

xv. Percent of loading,

xvi. Compressor kW.

xvii. Inlet guide vane position.

xviii. Entering and leaving chilled water temperatures.

xix. Entering and leaving condenser water temperatures.

xx. Evaporator and condenser refrigerant pressures.

xxi. Condenser valve leaving set point.

xxii. Number of run hours.

xxiii. Number of starts.

xxiv. Total purge time.

xxv. Purge pump out time.

xxvi. Fault indication displaying the fault that initially caused the chiller to shutdown.

xxvii. SI units shall be displayed.

(v) **Air Cooled Chillers** shall only be used on the approval of the **ADMIE**. Sound levels are to comply with all statutory requirements. Condenser fans shall be selected for a low air velocity. In general electronic TX valves shall be used. Full condenser coil hail protection shall be provided via stainless steel mesh. Full condenser coil and pipework

(w) Refrigerant Monitoring System:

i. Provide a refrigerant monitoring system in accordance with the manufacturer's specification for the gases used.

ii. Locate the monitor in a location which does not require access to the chiller plant room. The refrigerant monitoring system shall incorporate the following features:

iii. Specifically designed for the refrigerant used in the chillers nominated,

iv. Display range 0-1000 PPM.

v. Accuracy +/10 PPM.

vi. Two alarm levels each with display:

vii. Critical alarm level shall initiate flashing strobe light, and

viii. Audible alarm with mute button to shut off audible alarm for one hour.

ix. Output connection to BMS system.

x. Maintenance limited to recalibration once per year.

xi. Suitable for operation in ambient temperature between 40 C and 400C.

xii. Provide filters at the intakes and provide all other items and complete the installation in accordance with the manufacturer's recommendations.

xiii. Provide a laminated set of operational instructions for the monitor, screw fixed to the wall adjacent to the monitor.

xiv. The detector unit shall provide detection of all refrigerants in use in the plant room.

xv. Sampling tubes shall be copper.

(x) **Fans** shall comply with the following.

i. Fans and VSD's shall be located in plantrooms unless otherwise approved by **ADMIE**.

ii. Provide fans that are factory assembled units, complete with casing or scroll, cowl, impeller, variable speed drive, motor, power terminal box, guards, fabricated steel frame, vibration isolation, and accessories.

iii. Fans efficiency shall comply with NCC section J.

iv. Fan support system shall be corrosion protected and separated from any dissimilar metals.

v. Fans and associated electrical and controls shall be installed to match the system hazardous rating.

(y) **Boilers:**

Boilers shall not be used for space heating/reheating applications unless specialist application with strict approval from the **ADMIE**.

(z) **Heat pumps** shall comply with the following:

i. Contain local technical & commissioning support, maintenance contractors and spare parts.

ii. Generally, comply with the requirements for chillers

iii. Minimum COP of 3.5 for air cooled, and total system minimum COP of 7.0 for 4 pipe heat pump systems.

iv. Life cycle assessment shall be undertaken where heating and/or reheat is required to compare electric duct heaters and heating hot water via electric heat pump. The lowest cost of ownership systems shall be provided, noting that this may include a combination of both system types.

1.17 Water Treatment

(a) Automatic water treatment systems are required for condenser water systems for the control of corrosion, scale, fouling and, biological growth. A water treatment specialist is needed to calculate the required level of chemical dosing.

(b) Pre-treatment - the following preliminary work on the pipe work is required:

i. Chemically treat all water used for pressure testing the pipe work system. This treated water shall remain in the pipe work until it is cleaned.

ii. The system is to be thoroughly cleaned following testing with a non-foaming alkali detergent solution. Continuously circulate the cleaner for a minimum of 2 hours, and then flush twice by circulating fresh water for 2 hours each time.

(c) Manual Dosing - provide a manual dosing pot system for the introduction of chemicals to the chilled water lines for scale and corrosion control.

(d) Corrosion Dosage - the corrosion inhibitor dosage shall limit the corrosion to less than: 0.3 m/s per year (0.0762mm) for steel, and 0 1 mil per year (0.0254mm) for copper.

(e) Total Dissolved Solids - the level of total dissolved solids shall be as required by the chiller manufacture, and the level of biocide shall eliminate all biological growth in the condenser water system including the cooling tower.

i. System Requirements - provide all necessary items for a complete condenser water treatment system, including but not limited to the following:

ii. The requirements for control are corrosion inhibition, scale retardation, mobilisation of fouling deposits, elimination of biological growth, and total dissolved solids balance.

iii. An electronic conductivity controller, operating a solenoid valve to bleed water to drain, to control total dissolved solids. The controller shall be adjustable. Provide a sensing circuit with electrode assembly isolated on either side by ball valves.

iv. Provide dosing pumps for corrosion inhibitor/scale retardant and biocide.

v. All chemicals to be stored in a container within a container to approval.

vi. The pipe work feeding the chemicals to the system shall be made of chemical resistant material. The timing and control of the dosing pumps shall be via the BMS.

vii. The dosing pumps shall be interlocked with the condenser water pumps so that they can only operate when either of the condensing water pumps are operating.

viii. Provide alarm signals to the BMS for high conductivity and dosing pump faults.

(f) Clean - a complete clean of the entire condenser water circuit at the end of the defects liability period is required. Other cleans of the system may be required during the defects period to maintain the desired chemical levels, or the performance of the chillers.

(g) Water treatment to be provided by the Contractor for the contract and the 12 month defects liability period. Copies of the monthly reports shall be forwarded to **ADMIE**.

1.18 Future Expansion

(a) Air conditioning installations, in particular chilled water systems, shall have the ability to be extended in the future to adjacent areas. Details are to be outlined in the project brief.

Where a project brief is not provided, future expansion provisions of the proposed systems shall be identified by the mechanical consultant and approved by the **ADMIE**.

(b) Chilled Water Pipes - chilled water piping systems shall be designed in accordance with the following criteria:

i. Inlet connection - diversified load of total air conditioned building plus 20% spare capacity.

ii. Secondary pumps - contract load plus 20% or full building load, as advised by the **ADMIE**. Spare connections for future pumps compatible with building inlet connection.

iii. Risers - undiversified load of all levels above on basis of total air conditioning but not exceeding inlet connections.

iv. Riser takeoffs - undiversified capacity of floor if totally air conditioned plus 20% spare capacity. Takeoffs to be provided to all floors/functional areas intended to be connected to CHW system.

v. Runouts - sized so that pressure drop to furthest equipment will not exceed 20kPa with all units operating undiversified.

(c) Unless approved by **ADMIE**, all piping for new installation and extensions/refurbishments shall be designed in accordance with NCC requirements. Existing retained pipework systems shall be designed for a pressure drop not exceeding NCC 2019 requirements of single piping run, and not exceeding 2.5m/s velocity.

(d) Future capacity allowances shall include full infrastructure to allow for master planning, including but not limited to plant room space, duct and pipework sizing, spatial requirements including ceiling and riser space and electrical and control systems. Utilising the included future capacity shall not require the relocation or modification of installed systems.

1.19 Redundancy

(a) The chilled water system shall provide N+1 redundancy for all mechanical equipment (including chillers, pumps, cooling towers) but excluding pipework unless briefed otherwise.

(b) Air handling and ventilation systems shall generally not be provided with redundancy unless specifically briefed. The inherent selection of equipment shall assess an individual component failure scenario and incorporate economically viable features to increase the resilience of the system.

(c) Communications and critical equipment rooms shall be provided with N+1 redundancy of complete air conditioning systems.

(d) Heating systems shall not be provided with redundancy unless briefed or specifically required for compliant requirements.

(e) Buildings provided with generator supply shall have critical mechanical equipment connected to generator essential supply. Generator essential systems shall be specifically nominated in the project brief and approved by the **ADMIE**.

1.20 Connection to Existing Chilled Water System

(a) General Requirements:

i. Buildings to be connected to existing chilled water systems shall be designed to be compatible with the distribution system. The capacity of the existing system shall be reviewed in consultation with the **ADMIE** to ensure that any additional load can be provided by the existing system taking into account current and future works. Provide additional monitoring to existing systems where necessary to ensure that complete system functionality is maintained.

ii. The new systems must be compatible with the CHW precincts temperature parameters.

iii. The shut off to existing systems must be co-ordinated through P&F and shall generally be done out of hours.

iv. Connection to the chilled water distribution system will be permitted only on the approval of **ADMIE**. Existing system pre-reads shall be provided to the **ADMIE** prior to modification of existing systems.

v. The complete chilled water system schematic (to the extent of the building connection) shall be updated and included within the project documentation. Final extent of chilled water schematic to be approved by the **ADMIE**.

vi. All equipment to be connected to a chilled water system shall be controlled and monitored by the BMS.

1.21 Cool rooms and Refrigerated Chambers

Cool rooms and refrigerated chambers shall comply with NCC requirements GP1.3 and G1.2 and shall include:

(a) General construction to no less than Insulated panel Council of Australia Code of Practice and AS/NZS5149

(b) Proprietary, prefabricated, free standing PIR panel construction from the nominated manufacturers or approved equal including windows, doors and all hardware/fixings constructed from stainless steel.

(c) Floor, walls and ceiling to have matching thermal performance. Minimum PIR panel thickness 100mm. All corners coved and cleanable. Provided with impact protection as required by users. Polyurethane floor insulation is acceptable if concrete encased. Mineral wool insulation is not acceptable.

(d) Doors to be PIR panel, coldroom type with balloon seals. Minimum door thickness 75mm.

(e) Penetrations, panel joints, vapour barriers and means for prevention of thermal bridging shall be detailed prior to manufacturer and provided to **ADMIE** approval.

(f) Anti-condensation trace heating shall be provided to door thresholds, pressure relief vents (provided for all freezers), condensate drainage, floor sub base. Dual heater cables & breakers shall be provided in all instances, with overlapping circuits.

(g) Coolrooms/Freezers in new buildings shall be provided with a slab setdown and flush floor entry. Installations in existing buildings shall be provided with ramping to meet the users requirements. Floor finish to be concrete hardened and sealed unless alternative to suit specific user requirements.

(h) Proprietary refrigeration plant from the same manufacturer designed and rated to operate together to achieve no less than the users load requirements at 5°C above local critical ambient. Refrigerants with GWP less than 150 shall be used.

(i) Provide load calculation with cooling plant run time of 16hrs and pull down/product temperature and mass as required by users.

(j) Evaporators shall contain aluminium finned copper coil, stainless steel or aluminium construction, defrost heaters.

(k) Air cooled condensing units shall be provided and installed externally or provided with direct ducted discharge to maintain unit capacity. Coil treatment shall be provided by nominated manufacturer or approved equal. Condensing units located within ceiling voids is not acceptable.

(l) Refrigeration plant shall be provided with standalone microprocessor based controls and not rely on the BMS for continued operation. Local temperature display of each space shall be provided above the main entry door. Monitoring and alarming via BMS shall be provided via BACnet HLI.

(m) Additional user monitoring of internal conditions to be provided as detailed within the project brief.

(n) Power supply to equipment serving the same coolroom shall be from the same mechanical services switchboard.

(o) Lighting to be bulkhead type LED strip.

(p) Drainage to be located at entry door and wash down facilities to be provided unless directed otherwise by the **ADMIE**.

1.22 New System Operation

(a) Chilled Water System - the chilled water distribution system will have the following characteristics:

i. Supply water temperature 6.00C

ii. Return water temperature 13.0^{0}C

(b) Configurations - All precinct chilled water systems shall be arranged in a Primary/Secondary or booster pump configuration. All systems shall be designed to approval of the **ADMIE**, and consultants shall provide full calculations or computer simulations for a range of load conditions, to clearly demonstrate the functionality of the system.

(c) The commissioning of new installation shall be witnessed by the University representative prior to the issue of Practical Completion. Test reports are to be reviewed by the consultant and submitted to the University with the As-Built documents.. These will clearly show the following for each air handling unit:

i. Inlet and outlet water temperatures.

ii. Coil flow rate and pressure drop.

iii. Water flow readings for all parts of and the whole system.

iv. Check calibration of all DDC points

(d) Provide heat load calculations for the total building and all zones. Heat loads to be calculated with ACADS *Camel* computer programme.

1.23 Air Conditioning Electrical System

(a) Switchboards and motor control centres for systems 300kWr and over shall normally be of type tested construction with a minimum IP54 rating.

(b) Labels: Provide permanent, clearly legible traffolyte labels screw fixed to all internal and external controls.

(c) Fire alarm shutdown relays shall be provided in accordance with the requirements of AS 1668 and AS 1670 as applicable.

(d) A minimum of 25% spare capacity shall be provided in all switchboards, sub-boards and control panels to allow for future extension, including an additional 25% spare in cable ducts and cable trays etc. 25% spare in cable entries, exits and switchboard cable ducts shall be provided.

(e) Meters - hours run meters shall be provided on all items of equipment which are duplicated or run in parallel, including equipment such as duct heaters, humidifiers etc.

(f) Polyphase Kilowatt-Hour Meters shall be provided for each chiller precinct.

(g) All cables shall be run on cable tray and terminated in terminal strips. Cables shall be identified by numbered ferrules at each termination including field terminations. All cables entering switchboards, Data Gathering Panels (DGP) etc., which are part of a multicore cable and any other cable which is unused, shall be terminated on a terminal block and shall be labelled as to its origin and numbered. All neutral and control wiring shall also be number ferruled both in the switchboard and at field terminations.

(h) Spare Consumables to be provided inside each board: Three fuses of each type, size and rating.

(i) Circuit Reference Numbers: Electrical drawings shall be prepared with Circuit Reference Numbers to indicate the number of contacts and their location to Australian Standards on an approved drawing.

(j) Provide a 10A power outlet in each switchboard and a single 18W fluorescent lamps in each switchboard compartment greater than 1m2 in face area.

(k) Indicating lamps shall be multi LED type, and shall be clearly visible from 5 m in front of the board with normal lighting conditions.

(l) Earth and Neutral Bar - the earth and neutral bar shall be sized to accommodate separately all earth and neutral cables.

(m) *Thermoscan* all mechanical services switchboards with a connected A/C load in excess of 100 Amps per phase. Any defects found shall be rectified and a complete report including thermal photographs shall be supplied to the **ADMIE** prior to the Certificate of Practical Completion being granted.

1.24 Air Conditioning Controls

The type of control required will generally be described in the project design brief and approved by the **ADMIE** and shall include:

(a) BMS shall comply with UQ BMS User Interface & BMS Critical Alarms.

(b) The BMS shall comply with BMS Applications Standard and BMS Equipment Numbering (refer to appendices).

(c) Stand alone controllers are to be electronic and either of proportional or step control. The controllers are to have adjustable deadbands and adjustable parameters. Stand alone control systems shall not be used in buildings or situations where the BMS is connected.

(d) Centrally Controlled:

i. The University's buildings are monitored and controlled by a *Johnson Controls METASYS* network. This network consists of operator workstations and DDC systems and subsystems through the campus. Other control systems must be compatible with *Metasys* and may only be used with the approval of the **ADMIE**.

ii. Consultants shall include a full points list for DDC systems and full functional strategies for all controlled components in the specification. BMS Standard nominate the minimum control and monitoring points to be provided.

iii. The installation shall include for the supply and installation of the appropriate system components to allow for the monitoring and control of new plant by the BMS. These components shall be compatible with the existing network and consistent with UQ network upgrade requirements and UQ ITS Design Specification.

(e) Provide the supply, installation, testing, commissioning and maintenance of a fully functional Direct Digital Control (DDC) system to UQ requirements. Programming staff shall be available to attend meetings during construction...

(f) DDC Controllers - provide DDC controllers capable of full stand alone operation and not reliant on other network devices for local control functions. Arrange for one controller to control a maximum of two air handling units. Arrange the system so that all inputs and outputs relating to one item of controlled equipment or functional requirement are connected to one controller, with only global variables required to be transmitted across the *LAN*.

(g) Analogue inputs - each analogue input shall be configurable to read the following signal types:

i. 4-20 mA

ii. 0-10 VDC

iii. Accuracy: Minimum +/- 0.2%.

iv. Minimum 10 bit analogue to digital conversion.

(h) Digital Inputs - each digital input shall be fully optically isolated and respond to 24 V A/C status signal.

(i) Digital Outputs:

i. Each digital output shall be in the form of a relay with voltage free, change over contacts rated of 24 V A/C operation.

ii. Each Digital Output shall have LED indication of status.

iii. 25.2.4 Analogue Outputs

iv. 0-10 Volt PC or 4-20 mA.

v. Minimum 8 bit digital to analogue conversion.

vi. Pulse width modulated outputs: Provide electronic interface card to derive proportional output.

(j) Firmware - each DDC controllers program shall reside in non volatile flash ROM. It shall be possible to download the program from the DDC Controller in the same format in which it was created.

(k) Data logging - each Network level device will be capable of data logging software and hardware points.. The DDC Controller shall have sufficient on board memory to retain up to 100,000 time or event bases readings. When the log memory is full the oldest data shall be overwritten by the newest data. Important trend data is to be sent to the ADX trend repository as determined by the BMS User Interface design guide.

(l) Programming and Software - the DDC Controllers shall be programmed from a Microsoft (MS) Windows based software package. All programming shall be accomplished in an object-orientated format such that no special programming skills are required to work with the system. The software shall maintain on line help for all functions. Provide all necessary software to undertake programming of the system. Provide all debugging and troubleshooting software. Provide documentation associated with this software.
Software licensing shall allow the University to load and operate. the software from more than one PC. The use of a single "dongle" style device transferred between PCs is not acceptable.

(m) Provide all software necessary to create and edit graphics. Graphics shall incorporate the following features:

i. Active display capable of changing colours in response to changes in inputs and outputs.

ii. Ability to display alarm messages.

iii. Ability to display 70 variables on one graphic with all data being no more than ten seconds out of date.

iv. Ability to display software and hardware points on graphics.

v. Ability to override input and output values from graphics.

vi. Ability to navigate around system directly from a graphic to any other graphic.

vii. The graphics system shall maintain the integrity of the level of password, access granted to the operator, and shall not provide access to functions not permitted at the operator's access level.

(n) Field Hardware

(o) Sensors:

i. Provide wall or duct mounted temperature sensors to suit the application:

ii. Wall mounted sensors shall be tamperproof and housed in an enclosure acceptable to the University. Insulate sensors mounted on external walls or columns from the face. In all cases, the wall penetration for cable access shall be sealed to ensure that air from within the wall cavity does not affect the sensor reading.

iii. Provide magna-flow type water flow sensors with a maximum full-scale error of +/- 1 %. Flow meters shall have no moving parts. Flow meters shall indicate the direction of flow.

iv. Ensure that sensors provide stable, accurate and repeatable signals to the system.

(p) Provide valve and damper actuators for proportional or P & I control suitable for positioning the device from a 0-10 VDC control signal and 24 VAC power supply. . Ensure that actuators are capable of tight close-off of valves and dampers against full system shut-off head. Actuators shall indicate the position or percentage open of the controlled device. Notwithstanding this, actuators mounted externally shall be protected from direct sunlight and rain with a sealed sheet metal cover

screw fixed in position. Actuators shall be capable of manual override.

(q) Provide heater protection thermostats equal to *Penn* Model A25CN4. Provide air proving switches equal to *Penn* Model P32AF2.

(r) The DDC contractor shall supply all power supplies as required by ancillary elements to make a fully operational DDC system.

(s) Provide high level interface from each chiller to the DDC system via BACnet/IP to record all available parameters and monitoring points. All parameters recorded shall be in SI units.

(t) Installation - take particular attention to the earthing of equipment cases and shielded cables to eliminate noise interference and avoid electrical loops. Use light grade Belden for data communications. Segregate data and input/output cabling from 240V cabling. Arrange the system so that DIs and DOs switch a maximum of 24VAC power. Provide lightning protection where *LAN* cables enter a building. Provide consistent labelling with all wires and terminals numbered. Ensure labelling is consistent across the entire installation. All cabling shall conform with the manufacturers requirements and recommendations and the following:

i. All cabling to sensors, *LAN* cabling, and other cabling where necessary shall be shielded continuously to prevent interference to and from other systems. Cables shall not be joined.

ii. Cabling shall be supported from the slab over where run in ceiling spaces with dedicated fixings into the slab. Cabling run externally shall be run in conduit.

iii. Cabling shall be run to numbered terminal strips within switchboards.

iv. The DDC supplier shall inspect and test the installation and shall provide written certification confirming their approval of the installation prior to the system commissioning.

1.25 Control Strategy

(a) Sequence of operation

i. Ensure that no settings of control parameters introduce instability or fluctuations into the system.

ii. The system shall be totally automatic in operation. The system shall return to normal operation following restoration of loss of power to any part of the system or loss of power to the site.

(b) Hardwired Controls -. Arrange for all HPTs, fan auxiliary contacts and air-flow switches to be hard wired into heater safety circuits.

(c) Chiller Start/Stop Sequences - in the following sections, when a chiller is called to start the following occurs:

i. The chilled water pump will be enabled and status confirmed.

ii. The condenser pump started and status confirmed.

iii. The chiller enabled.
Also, when a chiller is called to stop the following occurs:

iv. The chiller disabled.

v. The condenser pump stops after 1 minute.

vi. The chilled water pump stops after 1 minute.

(d) Load Steps

i. The system shall run at the following load steps depending on the system load:

ii. Chillers shall alternate between lead and lag chillers automatically at 6:00 am on Tuesday every week, excepting that if the lead chiller is operating the changeover shall occur when both chillers are not running. If a chiller or its respective pump fails to start, that chiller shall be locked out from further operation and an alarm raised.

(e) Load-Up:

i. A cooling call shall occur if any chilled water valve is open at more than 75% for five minutes

ii. Loading shall be determined by monitoring the Chilled Water (CHW) supply and return water temperatures. In the event of high supply or return temperatures a timer shall start. If the temperature drops to an acceptable level, the timer shall be reset to zero and not restart until high temperature are reached. If the timer reaches the trip time, the system shall step up to the next load step.

(f) Unloading:

i. Chiller sets shall be unloaded in the event that the sum currents of the running chillers sufficiently reduce. In the event of low running amps, a timer shall start. If the amps increase, the timer shall be reset and not restart until low amps are again indicated. If the timer reaches the calculated trip time, the system shall step down to the next load step.

ii. FLA being full load amps for one chiller. The trip time shall decrease linearly as the current drops below to the maximum current nominated above.

(g) Chilled Water Bypass - The bypass valve shall be controlled by the return water temperature sensor to suit the chiller manufacturers requirements. It shall operate only when the chiller is operating.

(h) Chiller Faults:

i. If any fault occurs during load-up or while a chiller is running (i.e.chilled water pump fail (indicated by flow switch), chiller-fault, chiller "fail to start, condenser water pump fail (indicated by flow switch), the chiller system will automatically bring in another chiller to replace the defective machine.

ii. When a chiller is deemed to be in fault, it shall be disabled and its corresponding CHW and Condenser Water (CW) pumps stopped. An alarm shall be generated.

iii. The pump status shall be indicated by a differential pressure switch across the respective chiller vessel. If the chiller call up signal and its status mismatch (for both states of the call up signal), an alarm shall be generated. Provide a 3 second delay at all times to prevent nuisance tripping.

iv. Generate an alarm if the differential pressure switch indicates loss of flow at any time, however do not place the chiller in alarm unless flow is lost for 3 seconds. The 3 second delay shall be hard wired via a timer in the electrical switchboard, and the chiller safety connected to the output of the timer such that the chiller shall not shut itself down unless flow is lost for more than 3 seconds.

v. Chiller fault controls shall be confirmed with the manufacturer to ensure chiller safety protection is maintained.

(i) Cooling Towers: When any condenser pump is running, the cooling tower fan control algorithm is enabled. The CT fans are enabled so that the fan speed is modulated in order to keep CT leaving temperature at set point. CT leaving temperature set point is calculated by adding $3^{o}C$ to the ambient wet bulb temperature, but has a minimum value of $22^{0}C$ or other temperature as recommended by the chiller manufacturer. The fans shall be controlled by VSDs.
The outside air dry bulb temperature and the outside air relative humidity will be used to calculate an outside air enthalpy. This outside air enthalpy will then be used to calculate via a straight line approximation the wet bulb temperature.

(j) Primary Pump VSD Control arrange for the pump VSDs to maintain a constant differential pressure across the chiller vessels or control to primary flow between high and low set points.

(k) Secondary Pump VSD Control arrange for the pump VSDs to maintain a constant field differential pressure. The secondary pumps shall operate on a Duty/Standby arrangement and shall alternate

between lead and lag pumps automatically at 6:00 am on Tuesday every week., If a pump fails to start, that pump shall be locked out from further operation and an alarm raised. ((force changeover))

(l) Air Handling Units Starting and Stopping: Fans shall start and stop under control of the system master software time clock. Provide a backup software time clock to function in the event of loss of communications with the controller containing the master software time clock. Provide a delay so that following a signal to start from the master software, time clock, or following loss of power, not more than 20% of AHUs start in any 30 second period. A local software time clock shall be set up for each AHU to allow the AHU to run after hours if so programmed. An after hours switch shall also be provided for each AHU to cause the AHU to run for one hour adjustable following actuation, starting immediately. Fans shall run on for two minutes following shutdown of heaters.
The fan status shall be indicated by the air flow switch. If the fan call up signal and its status mismatch (for both states of the call up signal), an alarm shall be generated. Provide a 30 second delay on start-up and shutdown to prevent nuisance tripping.

(m) Air Handling Units (Single Zone, No VAVs): If the fan is called to run by the DDC system, the chilled water valve shall be enabled. In the event that the temperature rises 0.5^0C above the local set point, the chilled water valve shall commence opening. If the temperature rises to 1.5^oC above the local set point, the chiller water valve shall be 100% open.
If the fan is called to run and the fan status indicates that the fan is running, the heater shall be enabled. In the event that the temperature falls to 0.5^0C below the local set point, the heater shall commence operation. If the temperature falls to 1.0^0C below the local set point, the heater shall operate at full current. Solid state infinitely variable relay shall control the heater current in response to an analogue output from the DDC system.

(n) Multi-Zone Air Handling Units The Multi-zone units shall operate as the above except that each zone temperature shall control each set of zone face and bypass dampers and the zone heater. The chilled water valve shall operate on a high signal select basis of the signal generated by the difference between the respective temperature sensors and the set point.
The heaters shall commence operation if the temperature falls 0.5 ^{0}C below the local set point and be supplied at full current if the temperature falls to 0.1 0C below the local set point.

(o) Air Handling Units - air handling units with variable air volume (VAV) boxes for zonal control shall generally operate as described for single zone AHUs and the following.
Each zone shall generate a control signal based on the difference between the local set point and its respective controlling temperature sensor. If the temperature is 0.5^0C above the local set point, the signal shall be 0% and at 1.0^0C, the signal shall be 100%. The highest signal shall control the chilled water valve.
VAV's shall be pressure independent, with the supply air quantity as measured by a differential pressure across a grid controlled by the DDC system analogue output. The actual air quantity shall be confirmed by measurements from the supply air grilles supplied by the VAV box with the system being calibrated in this manner. The supply air quantity shall rise from 30% of maximum to 100% of maximum as the temperature rises from 0.5^0C to $1.5+^0$C above set point. Local duct heater shall run at 0% at 0.5^0C below set point modulating to 100% at $1.^0$C below set point.
AHU's supplying VAVs shall incorporate a pressure sensor in the supply air duct to provide an analogue signal. If the pressure rises above set point the fan speed shall be reduced under proportional

control.
In after-hours mode the VAVs shall remain fully closed unless the after hours button for that zone has been pressed.

(p) Training and Seminar Rooms: The air conditioning shall operate when scheduled through the DDC system as centrally controlled rooms Start the unit 30 minutes prior to room booking start. The unit or zone shall run in relaxed mode between scheduled periods and then switch off at the end of the day's schedule. The air conditioning can be started outside the scheduled times or upgraded from relaxed to occupied modes when the swipe card of the security system is operated. The door is opened via the security system from a signal provided by the security system ie scheduled for occupation or the security swipe card is operated.

(q) Relaxed / Occupied Modes: Generally air conditioned space will be described as functioning in different modes. These are either occupied or relaxed mode, where relaxed mode the system shall adjust the proportional band so that the chilled water valve will begin to open at 2.00C above set point and to start the heaters at 2.00C below set point.

(r) After Hours Switches: Provide an after hours switch for each of the air conditioning units. The switch will allow the A/C to run for an adjustable period via the DDC system. Initially set the run to two hours. The switch shall be a push button type *Kraus* and *Naimer* Blue line P. series Model No. P01 1-53 on an engraved white *Clipsal* plate. Provide a green neon run indicator powered via the fan contactor.
Provide an after hours switch for each zone of the main floor A/C units. This will bring on the VAV or the zone control for the individual unit while keeping the other zones in relaxed mode.

(s) Set Point Adjustment: Generally all set point adjustments are to be located within a system page that contains the object being controlled. The system pages are to be uniform and user friendly.

(t) DDC panels shall be located adjacent to the MSSB or included as a compartment in the MSSB. In public spaces the panel shall be lockable to the UQ P&F master lock barrel series for the building.

(u) DDC Devices: Generally DDC devices shall be powered from the local mechanical services switchboard for which a separate control circuit is required. NAE or SNE devices shall be provided with 240V A/C at their proposed location. This circuit shall be that used for the DDC devices.

(v) Surge arrestors are to be installed on all communication trunks to limit voltages and surge currents to within tolerances of the DDC equipment.

(w) All 24V A/C supplies to DDC equipment must be dedicated and shall supply no other equipment.

(x) All 240V A/C services to DDC equipment shall be protected with surge arresting equipment similar to CRITEC model PLF 10/2B.

(y) Specific Control Strategies

i. Offices, Computer Rooms and Laboratories - Time clock control, adjustable via the BMS, with an approved schedule eg. 7.00am to 6.00pm. After hours (2 hours run-time) air conditioning call up via BMS (push button user interface).

ii. Single Occupancy Offices with individual chilled water Fan Coil Units - The FEC Johnson Control package shall be used, with the following modes of operation:

Office Hours:

iii. At an approved scheduled start time, the FCU will be enabled by the BMS but will not start.
When the air conditioning push button is pressed the FCU will start and the temperature maintained until the scheduled stop time or until the air conditioning push button is pressed. The green indicator light is lit when the FCU is running.

After Hours:

iv. If the air conditioning push button is pressed outside of the scheduled hours then the FCU will operate for a period of 2 hours nominal or until the air conditioning push button is pressed. The green indicator light is lit when the FCU is running.

The air conditioning push button switch plate shall include a push button and a green neon indicator light. The switch plate shall be labelled or engraved.

AIR CONDITIONING ON / OFF

v. Lecture Theatres and Seminar Rooms - The BMS shall control lecture theatres, seminar rooms and other specifically designated rooms. These rooms are booked by central booking system that will automatically start the airtconditioning system 30 min before lecture start..

vi. Alternatively, the airconditioning shallbe switched by either:

1. Time schedules in the BMS or

2. An afterhours switch located outside the main door of the lecture theatre.

(z) Fire - all fire controls shall conform to the NCC and AS 1668.1.

1.26 Testing and Commissioning

(a) NEBB Certification - testing and balancing of air distribution systems, hydronic distribution system and the connected plant and equipment shall be performed to the requirements of National Environmental Balancing Bureau (NEBB) standard and associated publications. NEBB reporting forms shall be used. Calibration and maintenance of all instruments shall be in accordance with NEBB standard.

(b) Shop Drawings - contractors shall supply:

i. Copies of all shop drawings on electrical, mechanical and control drawings for examination and comments by the Property and Facilities (P&F) Engineers prior to testing and commissioning of the installation.

ii. Engineering drawings shall contain the RPEQ number of the engineer certifying the work.

iii. Workstation graphics.

1.27 Energy Management

Refer Sustainability Strategy 2020-2030

(a) Air Handling Plants - air-handling plant should be designed on a unitary basis as much as possible. Only areas which operate collectively should be served by the one unit. Areas such as lecture theatres and laboratories should have individual units. General office areas may be served by a single AHU.

(b) Heat Transfer Systems - all lecture theatres capable of seating 100 or more persons with full fresh air conditioning systems should be assessed for the use of enthalpy control or heat transfer system on the outside air.

(c) Life Cycle Cost Analysis - all outside air economiser systems shall be evaluated and considered on the basis of life cycle cost analysis.

(d) Variable Air Volumes - the use of simple variable air volume systems is encouraged.
All VAV boxes are to be mounted so that they are accessible for maintenance.

(e) System functionality to be incorporated as detailed in BMS Documentation, including BMS User Interface, BMS Applications Standard, BMS Critical Alarms and BMS Critical alarms.

(f) Modifications to existing systems shall be provided with an energy assessment identifying changes to overall energy performance of system, and also opportunities and recommendations for energy improvements. Existing system pre-reads shall be provided to the **ADMIE** prior to modification of existing systems.

(g) Communications and equipment rooms shall incorporate both chilled water and direct expansion units (after hours, standby, peak assist) where infrastructure is available.

(h) For all new buildings and major refurbishments, the feasibility of incorporating natural ventilation or mixed mode ventilation to all areas or partial areas must be investigated.

(i) Require automatic AC shut-off to areas that are openable - reed switches to windows and sliding doors.

(j) Consideration of widening internal temperature set point bands in line with the ASHRAE adaptive thermal comfort standard to facilitate the utilisation of mixed-mode strategies.

1.28 Maintenance

(a) Design Requirements: It is important that all facilities are designed based on life-cycle costs and maintainability. Designs need to provide for the following:

i. servicing and maintenance.

ii. removal and replacement of plant and equipment.

iii. access.

iv. durability.

(b) Drawings shall clearly indicate locations of ceiling and wall access panels and other necessary access space and clearances to adjacent walls and fixtures etc.

(c) Service reports by the contractor during the defects liability period shall be signed and forwarded to the P&F Project Manager.

Maintenance Manuals: Two (2) complete copies of the Mechanical Services Operating and Maintenance manuals shall be provided to UQ. The manuals shall include but not be limited to:
Hard plastic 4 ring A4 binder.

Electronic copy

Relevant details shall be on the face and the spine of the binder,
1. Contents
2. General Description is to include the name of the contractor, and the names of the principal sub-contractors. It should also include a description of the scope of the work, a simplified diagram of the installation, and a plain English description of the control strategy.
3. Schedule of Equipment is to list all of the equipment and include the following details;
Item, manufacturer, supplier, model, serial number, location and asset number.
4. Maintenance Requirements for each type of equipment. The information is to be based on the supplier/manufacturer service recommendations. Maintenance to be expressed in terms of the monthly requirements.
5. Manufacturer's Brochures either originals or copies of the brochures highlighted to draw attention to the details of the particular model installed.
6. Commissioning Data - The measurements made after the installation has been completed. This is to be expressed in the terms appropriate to the type of installation.
7. A "Plain English" description of the Control System and set points and settings. Include a full description of the operation of the system in fire mode.
8. All as-built drawings describing the project at the stage of Practical Completion shall be supplied as a hard copy and as a CD AutoCAD v14 drawing file in each O&M manual plus a A3 copy of the all drawings shall be placed in the MSSB. The CD in the manuals shall be enclosed in a resealable plastic pocket to suit the binder.

2 Piped Services

2 Piped Services

2.1 General

(a) This guideline outlines the minimum requirements for the following services:

i. Demineralised and/or distilled water and/or RO water,

ii. Steam,

iii. Town Gas / Natural gas,

iv. Inert gases e.g. nitrogen,

v. Oxygen,

vi. Compressed air,

vii. Vacuum.

(b) Hot and Cold Potable and Non-potable Water: Refer Section Hydraulic and Wet Fire Design Standard for cold and hot water.

(c) Isolation Valves - in general, each riser shall be isolated at the bottom (or top in case of droppers). Branch lines serving an outlet or groups of outlets shall be isolated at the riser and in each bench. In all cases, isolation valves shall be readily accessible. For compressed air and gas, ring main distribution pipes should be used wherever possible. All pipe work shall be tested to a minimum of twice working pressure where no other testing standard exists.

(d) Solenoid valves shall be installed on the above services in laboratories as required. The solenoid valves shall be mounted in plant rooms or proprietary cupboards. Do not install solenoid valves in ceiling spaces. The actuation of the solenoid shall be via the RED emergency button adjacent the laboratory exit/s. The solenoid system shall be 24 Volt and the solenoids energised OPEN. Note: The RED emergency button shall also shutdown laboratory bench power. This shall be co-ordinated with Electrical Services.

(e) All pipe work where exposed shall be mounted 25mm off surfaces.

2.2 Distilled Water/ Demineralised/ RO Water

(a) Commercial plant should be used wherever possible. Storage tanks shall be opaque, high density polypropylene and installed in a safety tray drained to waste.

(b) Reticulation shall be by means of SDR11 Polypropylene PP-H piping and fittings.

(c) Regenerative systems shall be incorporated in the demineralised water plant. Valves shall be of similar material to the pipework with no metal parts other than stainless steel.

(d) Water Polishers - where water polishers are required, they shall be MilliQ 4 Bowl units and shall be preceded by a water meter matching the materials of the installed system.

(e) Conductivity meters shall be of the digital type.

(f) A spare set of filters including ion exchange and carbon cartridges shall be supplied with each unit.

2.3 Steam

(a) Steam distribution mains should be lagged, laid to a fall and have adequate provision made for expansion and drainage.

(b) Traps should be provided as necessary.

(c) Connect branches to the tops of steam and condensate mains.

(d) Pipe work shall be steel.

(e) Valves shall be globe type.

(f) Provide all systems with effective condensate returns from the steam traps to an isolated condensate / make up water tank.

2.4 Town Gas / Natural Gas

(a) The whole of installation shall be in accordance with current issue of Australian Gas Association AG601.

(b) Pipe work shall be Type 'B' copper.

(c) All joints shall be silver soldered using 15% silver solder.

(d) Isolation valves shall be of an approved type.

(e) A gas meter shall be provided on the building main supply.

(f) All underground pipes shall be wrapped in Denso tape. Mains pressure reticulation shall be as determined by the relevant authority.

2.5 Inert Gases

(a) Storage: Inert gases such as nitrogen should be supplied from bottles located within a ventilated storage space which is easily accessible from the service road. Provide 100% redundancy on bottled storage.

(b) Cylinders shall be manifolded with non return valves in such a way that any cylinder can be removed and still allow the effective operation of the remainder of the bank.

(c) A pressure relief valve and pressure gauge should be fitted to the low pressure manifold.

(d) Pipe work shall be copper and shall be silver soldered. Isolation valves may be globe or needle type.

2.6 Oxygen

(a) Storage: Oxygen shall be supplied from bottles located within an easily accessible storage space. Cylinders shall be manifolded with non return valves in such a way that any cylinder can be removed and still allow the effective operation of the remainder of the bank.

(b) A pressure relief valve and pressure gauge should be fitted to the low pressure manifold.

(c) Pipe work shall be Type 'B' copper and shall be silver soldered.

(d) Isolation valves may be of the globe or needle type. Oxygen lines shall be adequately drained and kept at least 150mm clear of pipes carrying gas and ignition sources.

2.7 Compressed Air

(a) Compressed air shall be supplied from duplicate air compressors within the building.

(b) Compressors shall be oil-free, and of the nominated manufacturer or other approved equal. The compressor shall be effectively silenced. Unless otherwise called for. Compressed air shall be reticulated at 700kPa and regulated at each floor to user requirements.

(c) Pipe work shall be Type 'B' copper and shall be silver soldered and shall fall in direction of flow to automatic drains.

(d) Isolation valves shall be of the diaphragm type. Connect branches to the top of the main line.

(e) Air receiver/s shall be provided to limit the number of starts per hour of the compressors. The receiver shall be provided with all necessary gauges, safety valves, pressure stats and automatic drain for automatic operation.

(f) Air Regulators: The compressed air system shall be complete with 'mains-to-system' air regulators on all

risers complete with water traps to nominated manufacturer.

2.8 Vacuum

(a) Vacuum shall be supplied by means of duplicate vacuum pumps within the building. Vacuum pumps shall be of nominated manufacture, capable of passing fluids from the system without damage to the pump. Pump impellers shall be bronze.

(b) Vacuum pumps and motors shall be mounted on an effective vibration isolation base that isolates the structure. Water seals with safety interlocks shall be provided to each pump.

(c) Pipe work shall be Type 'B' copper, silver soldered. Plugged tees shall be used in place of bends to allow for cleaning of piping. All 90° bends and tees shall be fabricated from 45° bends.

(d) Isolation Valves shall be of the ball valve type. Pipe reducers shall be of the eccentric type.

(e) Vacuum tank/s shall be provided to limit the number of starts per hour of the vacuum pump(s). The tank shall be provided with all necessary gauges, safety valves, pressure valves for automatic operation.

(f) Ensure each major branch to each floor falls to an individual bottle trap filter installed prior to riser connection. Provide an isolation valve on the suction side.

(g) All control systems shall be checked and commissioned by the manufacturer or his authorised representative. Copies of the commissioning data shall be provided to the **ADMIE**.

2.9 Service Outlets

(a) All laboratory outlets shall be of nominated manufacturer laboratory fittings to suit user requirements.

2.10 Floor Penetration

(a) Wet Areas - floor penetrations in wet areas shall have copper or PVC puddle flanges built into the floor and are to be appropriately insulated and caulked. In other areas pipes shall be sleeved. The sleeve shall be copper, standing 30mm above the finished floor. Appropriate fire ratings shall be maintained by the use of fire collars and caulking where necessary.

(b) Concrete Upstand - where a group of pipes penetrate the floor, it may be preferable to create a concrete upstand around the group of penetrations with appropriate fire rating.

2.11 Other Important Issues

(a) Provide bottle traps under each connection point on vacuum systems.

(b) Ensure that steam generators, and large pressure vessels are registered with relevant authorities and UQ P&F maintenance notified of the details.

3 Fume Cupboards

3 Fume Cupboards

3.1 General

(a) New fume cupboard construction and installation shall comply with AS 2243.8

(b) Recirculating fume cabinets to AS2243.9 shall not be used without **ADMIE** approval.

(c) Variable flow fume cupboards shall be provided. The fan speed shall be controlled by sash position to achieve the required flow rate through the sash opening. Include motion sensors to lower sash position if no motion is detected for 8 mins adjustable

(d) Where briefed fume cupboard shall have fume scrubber fitted directly to the cupboard.

3.2 Fume Cupboard Construction

(a) General - fume cupboard shall be single sided type of proprietary manufacture and proven design, constructed of unplasticised rigid polyvinyl chloride (UPVC) or self extinguishing, high heat resistant, corrosion resistant, fibreglass complying with AS 1530.3.
The chamber of the fume cupboard shall have a smooth interior finish and generous radii corners for cleaning purposes.

(b) Baffles - shall be fitted at the rear of the cupboard and be designed to minimise variation in face velocity. The baffles shall be easily removable for cleaning. Air shall be exhausted at a minimum of three levels across the back of the fume cupboard (bottom, middle, top).

(c) Sill Height - height of front sill above work surface should be approximately 25mm.
Height of lowest air intake slot on rear baffle should be as close to work surface as possible while allowing cleaning of the work surface.

(d) Width of the fume cupboard shall be specified by the User: (1200, 1500, 1800 or 2000).

(e) The depth of the fume cupboard shall be 750mm or as specified by the User.

(f) The clear sash opening height shall be at least 600mm or as specified by the User.

(g) The cupboard's facia shall be aerodynamically shaped to ensure an even flow of air in the chamber without turbulence.

(h) A counter balanced sash window made from 6mm thick toughened glass shall slide vertically and balanced by stainless steel cables and lead counterweights.
The sash shall be fitted with closure cushions at the limits and a gap of 50mm when closed.

(i) Air Flow: The fume cupboard shall be supplied with an approved exhaust system incorporating a variable speed fan for controlling the velocity of air flow across the sash opening at 0.5m/s for all sash positions.
Contractors shall demonstrate a working prototype before approval can be given.

(j) Lighting within the fume cupboard shall be as per the requirements of AS 2243.8. The light shall be positioned behind clear PVC panels which shall be sealed airtight against the fume cupboard.
Access shall be provided for maintenance and cleaning of the light and translucent panel.

(k) Working Surface: The type of working surface shall be determined by the type of chemicals used in the fume cupboard and Users preferences.
Preferable materials are: Trespa, Stainless steel, polypropylene, glass fibre, ceramic tiles which shall be bonded by approved acid resistant epoxy.

3.3 Bench

(a) Construction: The bench shall be made from epoxy coated steel frame, complete with double skin PVC or other approved plastic doors. The bench shall house the scrubber recycling tank, pump etc., mounted on UPVC drip trays with drain to waste.

(b) The Contractor shall ensure the stability and strength of the bench to carry the weight of the fume cupboard.

(c) The bench shall support the FC work surface at the adjacent working bench height.

3.4 Services

(a) Users shall be consulted on the services and the number of outlets required for fume cupboards.

(b) Services outlets shall be mounted on the inside walls of the fume cupboards. Services outlets and control valves shall be labelled and colour-coded in accordance with AS 1345.

(c) Water Spray - fume cupboards designed for use with Perchloric Acid shall be provided in accordance with AS2243.8.

(d) Electrical - the electrical services shall be provided in accordance with Section 2 Clause 2.2 of AS 2243.8.
Electrical power points shall not be positioned within the fume cupboard chamber. All power outlets shall be mounted on the side styles at least 300mm above bench height.

3.5 Scrubber

(a) General: The scrubber shall be of the wet cell cross-flow type designed to produce optimum scrubbing efficiency, and shall be made of UPVC or fibreglass.
The scrubber shall be designed to fit directly onto or into the fume cupboard in order to minimise length of ducting requiring continuous cleaning.
Nozzles shall be of corrosion-resistant material, and shall be removable for cleaning.
The scrubber shall be provided with easily removable (clip on or slide in) panel for cleaning and viewing panels shall be provided to allow inspection of sprays.

(b) Servicing and Cleaning: The scrubber shall be set up so that 95% of the water is recirculated and 5% is bled off to the nearest trade waste and or sewer line.

(c) The pump shall be supplied with a plug top enabling it to be plugged into electrical socket located under the fume cupboard bench in an accessible location.

(d) All plumbing including air break tanks shall be constructed in accordance to AS 3500.1.
The written test results for registered air gaps and registered break tanks shall be supplied by the Contractor.
Typical format for reporting test results as per AS 2845.3.

Note :For design of Scrubber Water Tank & Wastes refer the sketch at the end of this section.

3.6 Exhaust Fan and Assembly

(a) The fan shall be forward or backward curved centrifugal type to suit the application and shall be constructed of chemical and corrosion resistant material and being of approved design and manufacture.

All metal parts (including stainless steel shaft) which may be exposed to corrosive fumes are to be completely covered with PVC.
The flexible connection between the fan and ductwork shall be constructed of weather and UV resistant material.

(b) The isolating switch installed adjacent to fan motor shall be lockable in the on and off positions.

(c) The exhaust fan shall be mounted to approval of the **ADMIE**. The Contractor shall ensure the stability and strength of the supporting frame. All penetrations through the roof shall be weather proofed.

(d) The minimum discharge height shall be 3m above both the roof at the point of penetration and any adjacent access walkways etc.

(e) Chemical and corrosion resistant bird proof mesh shall be installed on the top of discharge stack.

(f) Backflow prevention system shall be incorporated into the fan discharge system.

3.7 Ductwork

(a) Ductwork shall be constructed from grey, pressed unplasticised rigid polyvinyl chloride.

(b) If perchloric acid is to be used in the fume cupboard, a special spray system shall be installed. Sprays shall be accessible for inspection and cleaning.

3.8 Occupational Health and Safety Requirements

Designers are to consider the University's Occupational Health and Safety requirements, and consult with the Universities appointed representative in all aspects of the design.

3.9 Fume Cupboard Controls and Alarms

The fume cupboard shall have a touch sensitive pad type safety control panel mounted on front facia, and shall contain the pressure switches and indicator lights.

(a) The operation of the emergency isolator shall not interrupt power supply to the exhaust fan system.

(b) The graphics for the indicator lights shall be clear and illuminated when activated.

3.10 Warning and Identification Labels

(a) The following warning labels shall be fixed to the cupboard:

(b) The maximum quantity of flammable liquid introduced into the fume cupboard at any one time shall be 2.5 litres.

(c) In event of a liquid spill or fire, activate the emergency isolator

(d) Identification Label:

(e) Identification number of the fume cupboard.

(f) Model number and Serial Number of fume cupboard and name of manufacturer.

(g) Dangerous Chemical Label. A permanent label indicating that perchloric acid may be introduced into the fume cupboard shall be affixed in a prominent position on the fume cupboard and its associated parts. Perchloric acid use will be advised by Users.

3.11 Fire Protection

A fire extinguisher of 5B rating (for light hazard) shall be available approximately at a distance of 4 m from the fume cupboard. Each case shall be assessed by UQ FSO.

3.12 Testing and Commissioning

After installation the fume cupboard shall undergo commissioning tests in accordance with sections 4 and 5 of AS 2243.8 and reporting provided to UQ.

Velocity test shall be performed as described in Appendix E of the Standard and reports provided to UQ.

3.13 Operation and Maintenance Manual and Instruction

After Commissioning the Contractor shall supply UQ with two copies of the Operation and Maintenance Manual together with As-Built drawings.

3.14 Maintenance

During the twelve months defects liability period, the Contractor shall be solely responsible for carrying out maintenance on a monthly basis. This responsibility shall extend to cover manufacturers, suppliers or agents that the Contractor may retain to maintain a particular system or item of equipment.

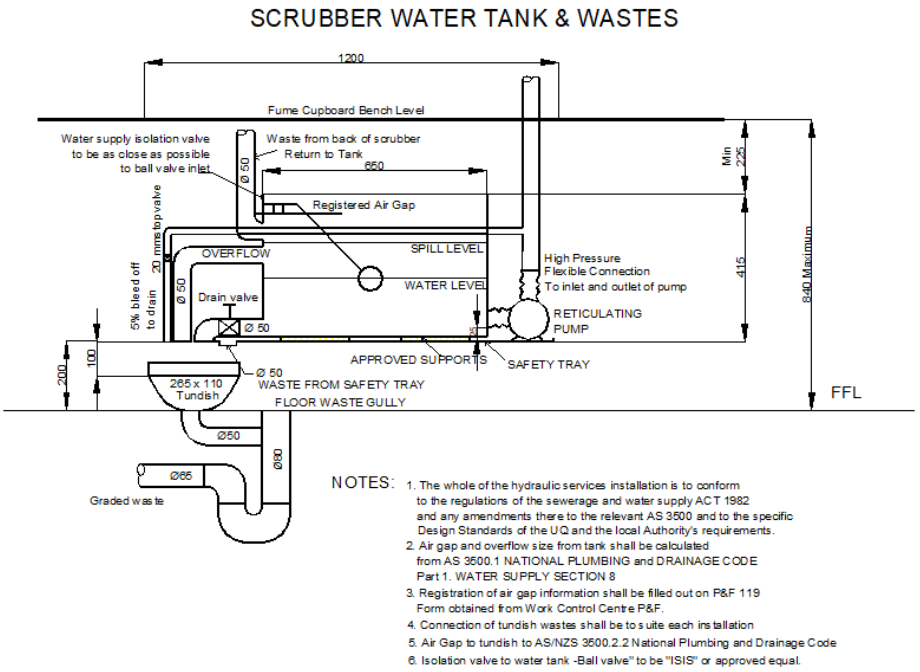

Figure 1: *Scrubber Water Tank & Wastes*

4 Colour

4 Colour

(a) All pipes shall be identified in accordance with AS 1345 for the Identification of Piping, conduits and Ducts; and AS 1318 - Industrial Safety Colour code and AS 2700 colour Standards for General Purposes.

(b) Architectural requirements may dictate that ducts and pipes for example are painted different colours. Pipe markings of contents flow and direction will still be required however it may vary from the requirements in this guideline. Where these instances occur they are to be to the approval of the **ADMIE**.

(c) The colour shall be applied over the full length of the pipeline and adhesive labels used. The location of identification marking shall be at intervals of not more than 5 metres horizontally and 3 metre vertically and adjacent to branches, junctions, valves, both sides of walls and control points. Such markings shall be placed so that they are easily seen from all approaches.

(d) The direction of the flow shall be indicated by an arrow adjacent each colour band and contents name.

(e) Air Compressors/Vacuum Pumps

Motors	Orange	X15
Compressor	Aqua	B25
After Cooler	Sapphire	B14
Air Receiver	Sapphire	B14
Guards	Grey Blue	B43
Belt Guards	Golden Yellow	Y14 with black stripes
Base	Black	

(f) Pipework, Valves and Fittings (Excluding Outlets)

Mechanical Service Pipes			Valves	Valves Tops
Chilled Water	Emerald	G13		Black
Condenser Water	Jade	G21		Black

Gases					
Gas L.P.	Beige	X43	Signal Red	R13	Black
Compressed Air	Aqua	B25	Signal Red	R13	Black
Vacuum	Aqua	B25	Signal Red	R13	Black
Oxygen	Beige	X43	Signal Red	R13	Black
Acetylene	Beige	X43	Signal Red	R13	Black
Other Gases	Beige	X43	Signal Red	R13	Black

(g) Pipework Support Systems:

i. 'Unistrut' Mounting Brackets, M/S. Angle Supports and Hanger Rods to be painted Black where exposed.

(h) Refrigeration Systems:

Centrifugal Chillers		
Compressor/ Motor	Manufacturers colours or Orange	X15
Condenser Vessel	Manufacturers colours or Pumpkin	X12
Chiller Vessel	Manufacturers colours or Canary	Y11
Oil Pump	Manufacturers colours or Sapphire	B14
Frame	Manufacturers colours or Black	
Condensing		
Units (DX system)	Manufacturers colours or Lettuce	G33

(i) Air-Handling Plants

Fan Coil Units and Conditioners		
Body:	Manufacturers colours or Deep Cream	Y25
External Motors	Manufacturers colours or Orange	X15
Belt Guards	Manufacturers colours or Golden Yellow	Y14
Toilet, Fume Exhaust, Miscellaneous Systems		
Fans	Manufacturers colours or Pumpkin	X12
Motors	Manufacturers colours or Orange	X15
Belt Guards	Manufacturers colours or Golden Yellow	Y14
Base	Manufacturers colours or Black	
Ductwork	Pumpkin	X12
Supply Air Systems		
Fans	Manufacturers colours or Straw	Y24
Motors	Manufacturers colours or Orange	X15
Belt Guard	Manufacturers colours or Golden Yellow	Y14
Base	Manufacturers colours or Black	
Ductwork	Canary Yellow	Y11

4.1 Abbreviations

AC	Air Conditioning
A/C	Alternating Current
A/V	Audio Visual
AHU	Air Handling Unit
AI	Analogue Input
AO	Analogue output
AS	Australian Standard
AS/NZS	Australian/New Zealand Standard
BCA	Building Code of Australia
BMS	Building Management System
CHW	Chilled Water
CT	Cooling Tower
CW	Condenser Water
DB	Dry Bulb
DC	Direct Current
DDC	Direct Digital Control
DI	Digital Input
DO	Digital Output
DX	Direct Expansion
ADMIE	Associate Director Mechanical Infrastructure Engineering
FLA	Full Load Amp
FCU	Fan Coil Unit
FSO	Fire Safety Officer
GPO	General Purpose Outlet
HPT	Heat Protection Thermostat
LAN	Local Area Network
LED	Light Emitting Diode
MS	Microsoft
MSSB	Mechanical Services Switch Board
NAE	Network Automation engine
NEBB	National Environmental of Balancing Bureau
OA	Outside Air
ORP	Oxidising Reduction Potential
P&F	Property and Facilities Division
PVC	Polyvinyl Chloride
QFRS	Queensland Fire & Rescue Service
RAC	Room Air Conditioner
ROM	Read Only Memory
SNE	System Network Engine
SSR	Solid State Relay
VAV	Variable Air Volume
VSD	Variable Speed Drive
WB	Wet Bulb

5 Materials/Equipment/Product Schedule

Building element	Material/Product/Code	Comment	Manufacturer	Contact
Underground Chilled Water Pipework			Insapipe or approved equal	
Control Valves			JCI, Belimo or approved equal	
Balancing and Isolating Valves			Tour and Anderson	
Ceiling Registers			Holyoake or Dragon	
Pipework Insulation Fixing/Joining			Fosters 30-45	
Pipework Insulation Coating			Emastac or Fosters 30-90	
Air Cooled Condensers			Fancoil Industries or Temperzoner	
Condenser Coil Treatment			Blygold	
Belts and Pulleys			Taperlock or approved equal	
AC Under Ceiling Chilled Water Type			Simko or approved equal	
Variance Air Volume Units			Holyoake, Air Grilles or approved equal	
Variable Speed Drives			Danfoss or ABB	
Chillers (water cooled screw type)			Trane, Carrier, York or Daikin	
Air Regulators			Spirax Sarco, Norgren or SMC	
Compressors			Ingersoll Rand, Broomwade or other approved equal	
Vacuum Pumps			Busch	
Laboratory Outlets including RO			Broen	
Pipework Insulation			Thermobreak	
Valve Insulation			Armourflex	

Fans	Fantech, Ziehl Abegg, EBM papst
VRV DX Systems	Daikin,Mistubishi Electric
Refrigeration Equipment	Kirby Refrigeration
AHUs	Air design , GJ Walker

6 Contacts Schedule

Reason for Contact	Organisation/Group	Name	Contact Number
Mechanical	P&F– Infrastructure and sustainability – Engineering Services	Hazem Gouda	0408197885

Appendix A – Design Standards: BMS Applications Standard

Please find Appendix A- BMS Applications Standard here

https://coo.uq.edu.au/files/31520/07A%20Appendix%20A%20-%20BMS%20applications%20standard_R1_1.pdf

Appendix B – Design Standards: BMS Equipment Numbering

Please find Appendix B- BMS Equipment Numbering here:

https://coo.uq.edu.au/files/31525/07B%20Appendix%20B%20-%20BMS%20equipment%20numbering_R1_1.pdf

Appendix C – Design Standards: BMS User Interface

Please find Appendix C- BMS User Interface here:

https://coo.uq.edu.au/files/31617/07C%20Appendix%20C%20-%20BMS%20user%20interface_R1_1.pdf

Appendix D – Design Standards: BMS Critical Alarms

Please find Appendix D- BMS Critical Alarms here:

https://coo.uq.edu.au/files/31622/07D%20Appendix%20D%20-%20BMS%20critical%20alarms_R1_1.pdf

Appendix E – Design Standards: BMS Categories and Priorities

Please find Appendix E: BMS Categories and Priorities here:

https://coo.uq.edu.au/files/31627/07E%20Appendix%20E%20-%20BMS%20Categories%20and%20priorities_R1_1.xlsx