MACQUARIE University

MECHANICAL WORKS CHECKLIST

A summary of key technical requirements

Version 1.2
February 2016

Source document: MQU Mechanical Services Design Standard V1.2

****

Table of Contents

Sect. Ref	Technical Requirement	Complies	Comment

5.2 STANDARDS

	Meets applicable Standards	☐	……

5.3 DESIGN and DOCUMENTATION

5.3.1	Meets priority design considerations	☐	……
5.3.2	Proactive consultation	☐	……
5.3.3	Fully qualified consultants	☐	……
5.3.4	Computer based modelling performed	☐	……
5.3.5	Design conditions met	☐	……
5.3.6	Equipment selection and sizing	☐	……
	Design basis nominated in documentation	☐	……
5.3.7	Minimum Energy Efficiency and Heat Recovery requirements		
	a. Meets specified Efficiency requirements	☐	……
	d.e. VSDs for pumps and fan motors	☐	……
5.3.8	System Types		
	a. Uses MQU CHW reticulation infrastructure	☐	……
	b. Mixed mode AC/Ventilation considered	☐	……
	c. VAV systems with variable speed AHU	☐	……
	d. Not acceptable-Low temp. VAV systems	☐	……
	e. Not acceptable-Passive chilled beam systems	☐	……
	f. Active chilled beam system	☐	……
	g. Not acceptable-ceiling cassette units	☐	……
	h. Underfloor systems, subject to capacity	☐	……
	i. Split systems for very small additions	☐	……
	j. Not acceptable-RAC window units	☐	……
5.3.9	Future allowance-spare capacity	☐	……
5.3.10	Other Design Requirements		
	a. Variable speed chillers must be used	☐	……
	b. Fume cupboard requirements	☐	……
	c. Water control loop sizing (buffer tank)	☐	……
	d. Plant room ventilation	☐	……
	e. BMCS controls	☐	……
	f. Outside air supplied into mixing plenum	☐	……
	g. Redundancy incorporated for critical environ.	☐	……
	h. Hard drawn refrigeration pipework	☐	……
	i. Condensate pipework copper and insulated	☐	……
	j. Duct and Pipe insulation shall meet BCA	☐	……
	k. Not acceptable-RAC window units	☐	……
	l. Complies with CIBSE commissioning	☐	……

Sect. Ref	Technical Requirement	Complies	Comment

5.4 TECHNICAL COMPONENTS

	Specifications to adhere to requirements and no conflicting requirements or information	☐	……

5.5 AIR COOLED CHILLERS

5.5.1	Meets Air or Water cooled selection	☐	……
5.5.2	Preferred supplier installed	☐	……
5.5.3	Meets general requirements	☐	……
5.5.4	Preferred Refrigerant used	☐	……
5.5.5	Scroll or screw compressor	☐	……
5.5.6	Liquid Coolers	☐	……
	Insulation sheathing meets requirement	☐	……
5.5.7	Condenser coils meets specification	☐	……
5.5.8	Condenser fans, variable speed	☐	……
5.5.9	Coil has Blygold corrosion protection	☐	……
	Chiller and pipework isolated	☐	……
5.5.10	Controls panel LCD/LED touch screen	☐	……
	BACnet HLI interface	☐	……

5.6 WATER COOLED CHILLERS

5.6.1	Preferred supplier installed	☐	……
5.6.2	Meets general requirements	☐	……
5.6.3	Danfoss Compressor	☐	……
5.6.4	Liquid coolers meet specification	☐	……
5.6.5	Condensers meet requirements	☐	……
5.6.6	Water boxes meet requirements	☐	……
5.6.7	Corrosion protection, 5 year guarantee	☐	……
	Chiller and pipework isolated	☐	……
5.6.8	Controls panel LCD/LED touch screen	☐	……
	BACnet HLI interface	☐	……

Sect. Ref	Technical Requirement	Complies	Comment

5.7 COOLING TOWERS

5.7.1	Preferred supplier installed	☐	.....
5.7.2	Meets general requirements	☐	.....
5.7.3	Meets Construction requirements	☐	.....
5.7.4	Fans meet requirements	☐	.....
5.7.5	Water distribution meet requirements	☐	.....
5.7.6	Dead legs – all parts can be drained and flushed	☐	.....
5.7.7	Capacity oversized >15%	☐	.....
5.7.8	Access - maintenance	☐	.....

5.8 PUMPS

5.8.1	Preferred supplier installed	☐	.....
5.8.2	Meets general requirements	☐	.....
	Drip trays	☐	.....
	Drainage	☐	.....
	Sealant	☐	.....
	Marking	☐	.....

5.9 VARIABLE SPEED DRIVES (VSD's)

5.9.1	Preferred supplier installed	☐	.....
5.9.2	Meets general requirements	☐	.....
5.9.3	Motor protection features	☐	.....
5.9.4	Control pad	☐	.....
5.9.5	Performance >96% at 100% load	☐	.....
5.9.6	Location – internally mounted	☐	.....
5.9.7	IP 54 Protection	☐	.....
5.9.8	Cooling	☐	.....
5.9.9	O&M documentation	☐	.....
5.9.10	BACnet HLI interface	☐	.....

Sect. Ref	Technical Requirement	Complies	Comment

5.10 FANS

5.10.1 Meets General requirements ☐ .....

- Preferred manufacturer installed ☐ .....
- Meets efficiency and design air flow ☐ .....
- Acceptable noise level ☐ .....

5.10.2 Meets Installation requirements ☐ .....

- Installation-Maintenance ☐ .....
- Installation-Flexible duct connections ☐ .....
- Installation-Drain ☐ .....
- Installation-Ant-vibration isolation ☐ .....

5.10.3 Belt driven fan – rigid guard ☐ .....

5.10.4 Kitchen exhaust fans

- Self cleaning ☐ .....
- Close to discharge ☐ .....
- Access, drain, finish, fire rating ☐ .....

5.10.5 Roof mounted fans ☐ .....

- Type ☐ .....
- Housing ☐ .....
- Backdraft dampers ☐ .....
- Motors IP65 ☐ .....

5.11 AIR HANDLING (AHU) and FAN COIL UNITS (FCU)

5.11.1 Meets Preferred Suppliers requirements ☐ .....

5.11.2 Interpretation AHU, FCU - meets requirements ☐ .....

5.11.3 VSD's for >1000l/s, FCU 3-speeds ☐ .....

5.11.4 Construction and access panels ☐ .....

5.11.5 Room FCU requirements ☐ .....

5.11.6 Return Air must be ducted ☐ .....

5.11.7 Coils – meet requirements ☐ .....

5.11.8 Drip trays – S/S and drain ☐ .....

5.11.9 Access Doors and Panels ☐ .....

5.11.10 Service lights ☐ .....

5.11.11 Filters ☐ .....

5.11.12 Mixing plenums ☐ .....

5.11.13 Face Bypass dampers ☐ .....

5.11.14 Location – maintenance access ☐ .....

Sect. Ref	Technical Requirement	Complies	Comment

5.12 HEAT RECOVERY

5.12.1 Preferred supplier installed ☐ .....

5.12.2 Meets general requirements ☐ .....

5.13 VARIABLE AIR VOLUME UNIT (VAV)

Selection ☐ .....

Pressure independent boxes ☐ .....

Fan assisted boxes ☐ .....

- general, casings, dampers, insulation, access panels ☐ .....
- controls ☐ .....

5.14 CHW / HHW / CONDENSOR WATER PIPEWORK

5.14.1 Design ☐ .....

Future expansion allowance ☐ .....

Pipework assists in balancing inherently ☐ .....

Compliant Insulation ☐ .....

5.14.2 Pipe Sizing ☐ .....

According to guidelines ☐ .....

Shall facilitate balancing with minimum pressure loss ☐ .....

5.14.3 Pipe Material ☐ .....

As per table AS1432 Type B, hard drawn ☐ .....

5.14.4 Cladding and Insulation ☐ .....

Zinc coated steel or Colorbond ☐ .....

Painted, identified and labelled ☐ .....

Supports as per AS3500, refer table ☐ .....

Pipe hanger rod diameter, as per table ☐ .....

5.14.5 Pressure Testing ☐ .....

2x design for >24 hours ☐ .....

5.14.6 Flushing of Pipework ☐ .....

Prior to connection of any terminal equipment ☐ .....

Records provided ☐ .....

Hold point for inspection specified ☐ .....

5.14.7 Use of Air and Dirt Separators ☐ .....

Location, isolation valves, drain ☐ .....

Bypass line, with isolation valve closed ☐ .....

Sect. Ref	Technical Requirement	Complies	Comment

5.15 VALVES

5.15.1	General	☐	……
	Equal in size to nominal pipe size	☐	……
	Connections: screwed or flanged	☐	……
	Installation as per Requirements	☐	……
	Tag all valves and flow measuring devices	☐	……
	Balancing valves – hand wheel setting and flow rate stamped on the disk	☐	……
	Automatic/dynamic system balancing valves as per Requirements	☐	……
	Pressure Independent Automatic Control valves ensure minimum required pressure differential	☐	……
5.15.2	Water Valve Types	☐	……
5.15.3	Sensing Points	☐	……
	Test plugs in each pipe connection to every device and other locations where required	☐	……
	Installation as specified	☐	……
5.15.4	Valves in the Ceiling Space	☐	……
	Must be insulated	☐	……
	Access panels provided	☐	……
5.15.5	Valve Unions	☐	……
	Unions to allow removal without dismantling pipework	☐	……
5.15.6	Connections to Equipment	☐	……
	Isolating valves must be used at connections to all items of plant and equipment	☐	……
	Connections allow removal of plant without removing large section of pipework or draining the system	☐	……
5.15.7	Binder Cocks	☐	……
	Isolating valves must be used at connections to all items of plant and equipment	☐	……
5.15.8	Vents, Air and Dirt Separators	☐	……
	Vents must be at highest points of the system and all other points where air may collect.	☐	……

Sect. Ref	Technical Requirement	Complies	Comment

5.16 CONDENSATE DRAINS /SAFETY TRAYS

5.16.1	General	☐	……
	Complies with Authority requirements	☐	……
5.16.2	Condensate Pumps	☐	……
	Gravity drainage, not lift pumps	☐	……
	If lift pump used, integral to the FCU	☐	……
5.16.3	Sizing and Material	☐	……
	Min.25mm diameter	☐	……
	Hard drawn copper	☐	……
5.16.4	Waster drain insulation	☐	……
	Insulated full length, Min.12mm thick	☐	……
5.16.5	Trap	☐	……
	Barrel unions or clear trap eg Easy Trap	☐	……
5.16.6	Discharge	☐	……
	Discharge to waste line only	☐	……
	Tundish fitted to drain point	☐	……
5.16.7	Safety Trays	☐	……
	Independent of FCU, stainless steel	☐	……
	Under all FCUs, AHUs, and package units	☐	……

5.17 SPLIT SYSTEMS

5.17.1	Preferred Suppliers - used	☐	……
5.17.2	General	☐	……
	Weatherproof powder coated anti-corrosion	☐	……
	Location – no noise and/or aesthetic issues	☐	……
	Inverter driven	☐	……
	Fins coated with epoxy or durable finish	☐	……
	Metal trunking/sheathing; no exposed insulation	☐	……
	Insulation of refrigerant pipework-Armaflex	☐	……
	BACnet HLI for BMCS interfacing	☐	……
	Refrigerant R410A	☐	……

Sect. Ref	Technical Requirement	Complies	Comment

5.18 VRV / VRF

5.18.1	Preferred Suppliers - used	☐	.....
5.18.2	General	☐	.....
	Location – no noise and/or aesthetic issues	☐	.....
	Multi-stage Inverter driven	☐	.....
	Fins coated with epoxy or durable finish	☐	.....
	Weatherproof powder coated anti-corrosion	☐	.....
	Metal trunking/sheathing; no exposed insulation	☐	.....
	Insulation of refrigerant pipework-Armaflex	☐	.....
	BACnet HLI for BMCS interfacing	☐	.....
	Refrigerant R410A	☐	.....

5.19 REFRIGERANTS and REFRIGERATION PIPEWORK

5.19.1	Acceptable refrigerant type to be used	☐	.....
5.19.2	Refrigerant Recovery	☐	.....
	Reclaimed and disposed of within guidelines	☐	.....
	Certification of recovery submitted to MUP	☐	.....
5.19.3	Refrigerant Pipe Work	☐	.....
5.19.4	Pipes	☐	.....
	Copper hard drawn, pipe wall thickness to AS	☐	.....
	Necessary circuit accessories	☐	.....
	Provide for charging and withdrawal of refrigerant	☐	.....
	Straight lines, positive oil return	☐	.....
5.19.5	External Trunking	☐	.....
	Mechanically protected, water-shedding	☐	.....
	Zinc coated, rectangular, colorbond matched	☐	.....
5.19.6	Pipe Joints	☐	.....
	Silver solder	☐	.....
	Pre-form bends, no flattening or corrugation	☐	.....
5.19.7	Pipe Supports	☐	.....
	Restrained vertically and horizontally	☐	.....
	Vibration is not transmitted to the building structure	☐	.....
	Supports – zinc plated galvanised steel	☐	.....
	Anchors and guides for long pipes	☐	.....
	No saddle supports for pipes > DN 25	☐	.....
	Anchors and guides for long pipes	☐	.....
	Insulated pipe support as per requirements	☐	.....
	Pipe support spacing as per Table	☐	.....
5.19.8	Thermal Insulation	☐	.....
	Armaflex or approved equivalent > 19mm thickness	☐	.....
	End joints neatly glued and taped	☐	.....
	Not split or zippered	☐	.....

Sect. Ref	Technical Requirement	Complies	Comment

5.20 DUCTWORK

5.20.1 General - Design and installation meets AS4254 ☐ ……

a. configuration assists in balancing ☐ ……
b. Within specified velocities for acoustic levels ☐ ……
c. Friction loss < 0.8 Pa/m ☐ ……
d. Balancing dampers at each floor and branch ☐ ……
e. Spigot dampers at each flexible duct connection ☐ ……
d. Avoid balancing dampers at diffusers or behind grilles ☐ ……

5.20.2 Duct Leakage Testing ☐ ……

a. Designer specifies duct leakage class and allowable leakage rates ☐ ……
b. Leakage test in accordance with SMACNA Standard ☐ ……

5.20.3 Flexible Duct

As per AS4254.1 and requirements ☐ ……

5.20.4 Flexible Connections – refer AS4254.2 ☐ ……

Isolate from ductwork - airtight flexible connections ☐ ……
Heavy duty, waterproof ☐ ……
Meets other requirements ☐ ……

5.20.5 Volume Control Dampers ☐ ……

Free of rattles, fluttering or slack movement ☐ ……
Meets other requirements ☐ ……

5.20.6 Splitter Dampers ☐ ……

Fabricated to meet requirements ☐ ……

5.20.7 Motorised Dampers ☐ ……

As per Volume Control Dampers (5.19.5) ☐ ……
Meets other requirements ☐ ……

5.20.8 Non-Return Dampers ☐ ……

As per Volume Control Dampers (5.19.5) ☐ ……
Meets other requirements ☐ ……

5.20.9 Access Openings – Location ☐ ……

Door - in each section of AHU for maintenance ☐ ……
Panel – next to each component inside the duct requiring regular inspection and maintenance ☐ ……

5.20.10 Access Panels ☐ ……

Personnel access – minimum 450 x 600mm ☐ ……
Hand access – minimum 200 x 300mm ☐ ……
Construction to meet requirements ☐ ……

Sect. Ref	Technical Requirement	Complies	Comment
5.20.11	Access Doors	☐	……
	Construction to meet requirements	☐	……
5.20.12	Insulation	☐	……
	All supply and return ductwork must meet NCC/BCA "deemed to satisfy" (DTS) requirements	☐	……
5.20.13	Ductwork Installation	☐	……
	Cleaned prior to commissioning	☐	……
	Meets requirements	☐	……
5.20.14	Leakage Testing Procedures	☐	……
	Test method SMACNA HVAC Air Duct Leakage	☐	……
	Maximum leakage rate to AS 4254.2	☐	……
	Test method as per requirements	☐	……

5.21 AIR GRILLES and DIFFUSERS

5.21.1	General	☐	……
	Provides adequate air movement without draft	☐	……
	Provision for air pattern adjustments	☐	……
5.21.2	Exhaust Grilles	☐	……
	Egg-crate type with 12mm x 12mm core	☐	……
	Integral opposed blade volume control dampers	☐	……
5.21.3	Plenum Boxes	☐	……
	As per requirements	☐	……
5.21.4	Door Grilles	☐	……
	As per requirements	☐	……
5.21.5	Undercutting of Doors - not acceptable	☐	……

5.22 VIBRATION / NOISE

5.22.1	Machinery	☐	……
	As per requirements	☐	……
5.22.2	Piping	☐	……
	As per requirements	☐	……
5.22.3	Ductwork	☐	……
	As per requirements	☐	……
5.22.4	Flexible Connections for Pipework	☐	……
	As per requirements	☐	……
5.22.5	Flexible Connections for Ductwork	☐	……
	As per requirements	☐	……
5.22.6	Pump Inertia Bases	☐	……
	All pumps must be mounted on inertia bases	☐	……
	Inertia bases fitted with spring isolators	☐	……
	Flexible connections that isolate vibrations	☐	……

Sect. Ref	Technical Requirement	Complies	Comment

5.23 MECHANICAL SWITCHBOARDS

5.23.1	General	☐	……
	Main Switch without opening switchboard	☐	……
	Escutcheon plate for physical protection	☐	……
5.23.2	Form of Separation	☐	……
	As per project requirements and guiding principles	☐	……
5.23.3	Metalwork	☐	……
	a. minimum 2mm thick bright steel sheet	☐	……
	b. lift-off hinges, locking handle, MUP 92286 key	☐	……
	c. large panels with fitted D handles	☐	……
	d. escutcheon plates and hinged panels can be undone without the use of tools	☐	……
	e. cabinet mounted on a welded channel steel frame	☐	……
5.23.4	KWH Meters	☐	……
	Meter, C/Ts and comms. interface supplied by Contractor	☐	……
	Installation as per requirements	☐	……
5.23.5	Finish	☐	……
	Painted as per requirements and approved colours	☐	……
	Distribution Board labelled correctly	☐	……
5.23.6	Labels	☐	……
	Labelling as per requirements	☐	……
5.23.7	Fuses	☐	……
	Fixture for spare fuse cartridges	☐	……
5.23.8	Size of Control Panel	☐	……
	> 20% additional spare capacity	☐	……
5.23.9	Approved Component Suppliers	☐	……
	Meets equipment specifications as listed	☐	……

5.24 PAINTING Table

	As per Standard Approved Colours eg:	☐	……
▪	Pipework - Green (Jade/Emerald)	☐	……
▪	Ductwork - Shoji White	☐	……
▪	Plant Rooms - Grey	☐	……
▪	Electrical Boards - Orange, White interior & plate	☐	……
▪	BMCS Boards - Orange, White interior & plate	☐	……
▪	Cable Trays - Orange	☐	……
▪	Plinths - Black top, yellow edges	☐	……

5.25 LABELLING

5.25.1	General	☐	……
5.25.2	Equipment Labelling	☐	……

Sect. Ref	Technical Requirement	Complies	Comment

5.26 SERVICE ACCESS / SAFETY REQUIREMENTS

5.26.1 General ☐ ……

a. position to optimise maintenance and repairs ☐ ……
b. plant in ceiling spaces only in offices ☐ ……
c. unacceptable - plant within tight spaces ☐ ……
d. all motors with isolators ☐ ……
e. manufacturers access requirement + 20% ☐ ……
f. plant above 3m – permanent stair and work platform ☐ ……
g. trip hazards painted yellow with black strip ☐ ……
h. electrical hazards identified and labelled ☐ ……
i. yellow walkways around plant in plant rooms ☐ ……
j. chemical hazards to be labelled and clearance lines to be painted; paperwork on-site ☐ ……
k. confined spaces note and signage applied ☐ ……
l. fixed switchable lights in AHU chambers ☐ ……
m. access complies with WHS requirements ☐ ……

5.27 REDUNDANT EQUIPMENT

All redundant equipment removed ☐ ……

Surfaces and finishes made good ☐ ……

5.28 PRODUCT SUPPORT / EXPERIENCE REQUIREMENTS

All products supported locally and internationally by factory trained service networks ☐ ……
Parts available for 10 years ex-stock ☐ ……
Products with established reliability ☐ ……
Proven installation history in Australia, 8 years operation ☐ ……
Spares readily available ☐ ……

5.29 COMMISSIONING

Comprehensive plan ☐ ……
ITPs for all major items ☐ ……
Commissioning methodology statement ☐ ……
Shop drawings prior to commencement of construction ☐ ……

6. QUALITY CONTROL

6.1 Design Standard Compliance ☐ ……

6.2 Design Standard Certification ☐ ……

a. Letter of Certification - Design and documentation ☐ ……
b. Letter of Certification - Tender ☐ ……
c. Letter of Certification - Construction ☐ ……

7.1 APPENDIX 1 – Standard Drawings

Contractor must use latest version at date of project.

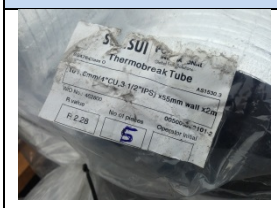
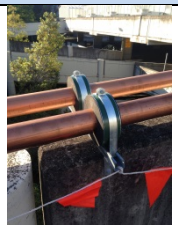
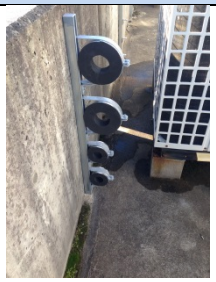
No.	Description	Complies
1	MSD-01 Branch Valve Detail	
2	MSD-02 PICCV coil connection	
3	MSD-03 Heat Recovery unit	
4	MSD-04 Air and Dirt Separator	
5	MSD-05 Fan Coil Unit installation	
6	MSD-06 Pump installation	
7	MSD-07 Coil connections	
8	MSD-08 Valve tag details	
9	MSD-09 Piping support	

7.2 APPENDIX 2 – MQU Guidelines

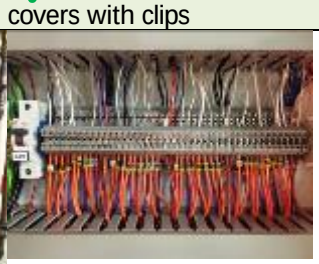
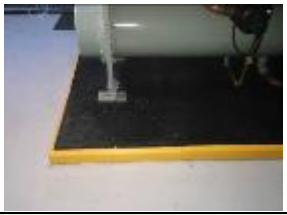
Contractor must use latest version at date of project.

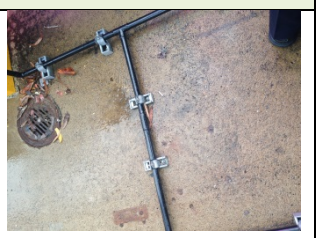
No.	Description	Complies
1	MUP Mechanical Services Design Standard V1.2	
2	MUP Electrical Services Standard V1.0	
3	MUP Hydraulics Standard V1.0	
4	MUP Guideline Design Standard for BMS V2.0	
5	BMS Alarm Subsystem Specification V2.0	
6	BMS Configuration Management Plan Part A V0.1	
7	BMS Example Graphic screens	

7.3 APPENDIX 3 – Compliant and Non-Compliant Works - Examples

PIPEWORK INSULATION and SHEATHING			
			
✓ Correct R rating	✓ 50mm width, metal continuous under bracket	✓ Pipe supports	✓ Green colourbond sheathing
			
✓ Correct labelling	✓ Pipework supported	✓ All fittings as per design guidelines	✓
			
X Wrong colour and poor pipe joins	**X Poorly supported pipe runs**	**X Non-galvanised sheathing**	**X Gaps in sheathing**
			

MECHANICAL WORKS CHECKLIST

X **Poor joint sealing**	X **Non-galvanised fittings**	X **Swarf and rust on metal work**	X **Touch-up paint scratches**
BMS CONTROLS			
			
✓ Cable tray - Orange	✓ Actuators with metal covers with clips	✓	✓
 			
X **BMS panel interior - must be white**	X **BMS wiring - not fully labelled**	X **Non-waterproof enclosure for actuators**	X **A4 document holder inside door of panels**
			
X **BMS panel lables – holding screws required**	X	X	
OTHER WORKS			
			
✓ **Correct plinth painting**	✓	✓	✓

			
X **No sharp protrusions**	X **No sharp edges**	X **Seal valve penetrations**	X **Cover trip hazards**