# 125 MURRAY STREET,PERTH

## MECHANICAL SERVICES SPECIFICATION

**Prepared for:**

**SILVERLEAF INVESTMENTS PTY LTD**

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# DOCUMENT HISTORY

| Revision | Date Issued | Revision Comment | Author |
|---|---|---|---|
| 01 | 30 September 2016 | Issue for Tender | G Hesford |

# REVISIONS

| Revision | Section/Clause | Change |
|---|---|---|
| | | |

# 1.0 SCOPE

## 1.1 OVERVIEW

This section of the specification sets out the works expected to be carried out by a suitably experienced mechanical services company as a subcontractor to the Contractor.

Notwithstanding the segregation of the work described in this section, the Contractor retains full responsibility for provision of all work and associated work, specified or obvious required for the satisfactory installation and operation of the mechanical services.

## 1.2 SELECTED MECHANICAL CONTRACTORS

The mechanical services shall be undertaken by one of the following contractors:

- Jako Industries
- Envar
- Engie (formerly WAMS)
- MPM
- Centigrade Mechanical Services
- CMS

Other mechanical contractors may be offered as an alternative selection at time of Tender.

## 1.3 THE EXTENT OF WORK

### 1.3.1 DEMOLITION

The mechanical contractor shall be responsible for the demolition and disposal of all existing mechanical services that are not to be retained for ongoing use.

This shall include all:

- Equipment
- Ductwork, fittings & air diffusion
- Pipework
- Associated electrical & control work
- Associated hangers, supports, cable trays etc.

The Contractor shall be responsible and provide for:

- Removal & replacement of roof sheeting, insulation, purlins and bracing to facilitate removal of existing chillers and Lift Motor Room equipment
- Cranage of redundant chillers, air cooled condensers, pumps, pipework etc from the roof to ground level

## 1.4 RETAINED EQUIPMENT

The following equipment shall be retained and incorporated in the works:

- Basement carpark exhaust fan
- Basement Comms Room AC
- Basement substation ventilation system`
- 2 x Heating Water Units
- 2 x Heating Water Pumps
- Roof plantroom ventilation fan
- Roof MSSB
- Lift Motor Room ventilation cowl

The Roof MSSB shall be stripped of any CB's, contactors, overloads, switches, indicator lamps, terminal strips wiring etc associated with demolished equipment and the facia panel be made good.

Alternately the retained equipment currently served from the Roof MSSB may be rewired to the new MSSB R.01 and the existing Roof MSSB may be demolished.

It is recognised that no warranty can be given on retained and reused equipment, however upon re-commissioning the mechanical contractor shall provide a dilapidation report which shall identify any recommended repairs or upgrades to ensure a reasonable lifespan (5 – 7 years)will be achieved.

The mechanical contractor shall engage the manufacturer or their designated service agent to recommission the Heating Water Units and to contribute to the dilapidation report.

### 1.5 NEW WORKS

The mechanical services comprises the following major elements:

- Two (2) variable speed water cooled centrifugal compressor chillers
- Two (2) Chilled Water Pumps serving the chillers
- Three (3) Condenser Water Pumps serving the chillers
- Two (2) Primary Condenser Water Pumps
- Two (2) Secondary Condenser Water Pumps
- Two (2) Cooling Towers
- Two (2) Plate Heat Exchangers
- Three(3) Air Handling Units
- Seven (7) Water Cooled Package Units
- Multiple ventilation systems
- Associated Electrical Works
- Associated Pipework
- Direct Digital Control Systems
- Building Management System

## 2.0 ASSOCIATED WORK AND COORDINATION

### 2.1 SCOPE AND RESPONSIBILITY

The Contractor shall retain full responsibility for the provision and coordination of the services and associated works. Reference hereunder to various sub-contractor responsibilities is intended only to assist identification of normal coordinated provisions.

### 2.2 BY CONTRACTOR (BUILDER)

- Plantrooms documented in the Architectural documents
- Safe access to roofs and roof walkways.
- Placing and finishing of plinth concrete to be poured into metal edge forms (supplied and fixed by the mechanical contractor). Plinths to be installed for all floor mounted equipment. No metal edge forms required for external plinths.
- Clear openings through the building structure for passage of ductwork, pipes etc., and openings in doors or walls for the passage of return and relief air.
- Access openings in ceilings, bulkheads, walls and at other positions as required for adjustment and access by mechanical services contractor.
- Cutting, patching, framing up, furring in and making good associated with the building structure for the passage of pipes, ductwork, grilles, etc. Details will be supplied by the mechanical services contractor.
- Installation of door grilles, supplied by mechanical services contractor.
- Supply and installation external louvers complete with bird screens if required.
- All internal grilles nominated “By Builder”.
- Sealing airtight of ceilings plenums where used for passage of return air.
- Penetrations through roof and walls, including upstands, flashings, collars, soaker trays etc.
- Provision of temporary lighting, 415/240V power, gas, water and other services required for the installation and testing of the mechanical services.

### 2.3 BY ELECTRICAL SERVICES CONTRACTOR

- Submains terminated to main switches within MSSB’s
- 1 Ph & 3 Ph CB’s on GF Retail & Café DB’s for power to WCPU’s. All wiring thereafter by mechanical contractor
- Smoke detector installation to AS 1668.1 requirements. Mechanical subcontractor to install access panels in ductwork as required for access to duct mounted detectors.
- Fireman’s controls on FIP to AS 1668.1 requirements.
- Fire alarm cabling to MSSB’s and terminating to terminal strips within
- Plantroom lighting
- HLI to metering network to enable data gathering by the BMS for NABERS reporting

### 2.4 BY HYDRAULIC SERVICES SUBCONTRACTOR

- Plantroom drainage and AHU tundishes
- Tundishes and condensate drainage for WCPU’s
- Valved cold water feed including backflow prevention devices to Cooling Tower enclosure. Mechanical contractor to terminate to cooling towers and expansion tanks from this point
- Hose cocks in plantrooms and on roofs
- Natural gas mains terminating in isolating valve within plantroom. Mechanical contractor to terminate to HWU’s including fire solenoid valve
- DDC interfacing via terminal strips within switchboards or pump control panels for all hydraulic equipment to be monitored by the BMS
- Modbus interface for main water and gas meters for connection by the mechanical contractor

## 2.5 PROTECTION

The mechanical contractor shall at all times provide temporary protection by way of plastic or cloth drop sheets, plywood or similar sheeting etc. to all building surfaces, furniture fittings and equipment.

Works within existing tenancies in particular may require the installation and removal of protection on a daily basis such that works can be executed after hours and normal occupant activities may occur during normal hours.

## 2.6 COORDINATION OF ASSOCIATED WORKS

The Contractor shall ensure that all associated works required for the installation and operation of the mechanical services is adequately documented by way of shop drawings or specific instructions to the sub-trades.

**Pay early and particular attention to plantroom layouts** to ensure coordination of plinths, floor wastes, and tundishes as the positioning of these items occurs early in the construction sequence.

**Pay early and particular attention to electrical and fire services interfaces** by providing to the Project Manager detailed schedules of all connected loads, MSSB maximum demand calculations and fire signal requirements.

## 3.0 GENERAL REQUIREMENTS

### 3.1 SCHEDULES OF TECHNICAL DATA

Prior to ordering, submit for the Superintendent's approval, detailed schedules of technical data for plant or equipment, supported where requested, by manufacturer's literature.

### 3.2 CODES & AUTHORITIES

Comply with all requirements of Codes or Authorities having jurisdiction over the works. Allow for payment of all associated Authority fees and charges.

### 3.3 MANUFACTURER'S REQUIREMENTS

Install all equipment and systems to the specific requirements of manufacturers, including provision of ancillary or safety devices deemed necessary.

### 3.4 SAMPLES

Submit samples of the following for approval prior to finalisation of ordering.

- All types of air diffusion
- VAV diffusers
- Room temperature sensors
- After hours switches
- Modulating dampers
- Circular flexible ductwork
- Flexible duct connections
- All insulation materials and installation samples
- Refrigeration pipework and silver solder
- Fire rated sealants/materials

### 3.5 WORKMANSHIP

Employ suitably qualified tradespersons to carry out the works, including licensed tradespersons required by Authorities having jurisdiction.

Workmanship not consistent with good trade practice or standards or any plant deemed of inferior quality or quantity to that specified will be rejected and further replaced without cost to the Principal.

### 3.6 COORDINATION

Thoroughly coordinate the mechanical services with all other trades, particularly allowing adequate time and resource for the full and proper testing, commissioning and handover of these services.

### 3.7 PROTECTION

Cover up and protect all parts of the works during installation to prevent injury, ingress of dust and moisture, exposure to weather and to prevent accidental damage.

### 3.8 LEAD SERVICES COORDINATOR

The mechanical contractor shall provide a Lead Services Coordination whilst developing their REVIT model.

This role shall include producing a fortnightly coordinated Model to be distributed via Aconex in REVIT and Navisworks formats.

### 3.9 WORKSHOP DRAWINGS

Provide comprehensive drawings with all relevant information sufficient for review and to be used as the basis of commissioning records and as constructed drawings.

Drawings shall be prepared in REVIT 2016 and shall be submitted in 2D PDF format for approval.

### 3.10 ALTERNATIVES AND SUBSTITUTIONS

Alternatives and substitutions that enable the works to be executed more quickly, economically or effectively than specified may be suggested at any time.

Where the words “equal approved” are used in this Specification, the Contractor may request permission to substitute what is specified, providing certification is provided that the substitute is equal or better than that specified.

Acceptance of the substitute shall be entirely at the Superintendent’s discretion.

### 3.11 PROGRESS CLAIMS

Submit with each progress claim a spreadsheet providing the following detail for the mechanical services sub-contract.

| Item | Tender Amount | Complete | | Previous | | This Claim |
|---|---|---|---|---|---|---|
| | | % | $ | % | $ | $ |
| | | | | | | |
| | | | | | | |

Breakdown shall be to the Superintendent’s approval.

Identify variations separately.

### 3.12 FIRE & ACOUSTIC RATING OF PENETRATIONS

The mechanical services contractor shall assume full responsibility for sealing of all penetrations through fire and acoustically rated construction, including cosmetic flashings as required.

Submit intended methodology and samples of materials for Superintendent’s approval.

## 4.0 DESIGN CRITERIA

### 4.1 AIRCONDITIONING

| | | |
|---|---|---|
| Ambient Conditions | Summer | 36.7$^{O}$CDB / 22.1$^{O}$CWB |
| | Winter | 3.8$^{O}$CDB / 80%RH |
| Internal Conditions | Summer (Offices) | 24.0$^{O}$CDB/50%RH with space conditions controlled to maintain comfort levels and ABGR objectives |
| | Winter (Offices) | 21.0$^{O}$CDB/45%RH |
| | Summer (Retail Tenancies) | 24.0$^{O}$CDB/50%RH |
| | Winter (Retail Tenancies) | 20.0$^{O}$CDB/40%RH |
| Control Tolerance | Temperature (Offices) | $\pm$ 1.0$^{O}$C DB about set point. |
| | Temperature (Retail Tenancies) | $\pm$ 1.5$^{O}$C DB about set point. |
| | Humidity | No specific humidity controls; Resultant humidity levels are achieved by virtue of cooling coil performance. |
| Comfort Level Indices | Office Area Targets | -0.5 ≤ PMV ≥+0.5<br>PPD ≤10% |
| Occupancy | General office areas | 1 person/5.0 m$^2$ |
| | Retail | 1 person/6.0 m$^2$ |
| | GF Cafe | 10 people |
| | GF Lobby | 20 people |
| • Minimum Ventilation Rate | Offices | 7.5 l/s per person |
| | Retail | 7.5 l/s per person |
| Lighting | Office Areas | 15 W/m$^2$ |
| | Retail | 15 W/m$^2$ |
| Equipment | Office Areas | 25 W/m$^2$ |
| | Retail | 30 W/m$^2$ |
| | Lobbies, Foyers | 5 W/m$^2$ |
| Zone Control | VAV Zones | Perimeter @ 60 m$^2$ max |
| | | Interior @ 100 m$^2$ max |
| | After Hours | 1/3$^{rd}$ Floor |
| Noise Criteria | All Internal Areas | To AS 2107 recommended levels |
| | Property Boundaries | To local Council requirements |

### 4.2 VENTILATION SYSTEMS

The design of the ventilation systems has been based upon AS1668 Pt2.

## 5.0 EQUIPMENT

### 5.1 GENERAL

Provide equipment to minimum capacities and performance stated in the schedules.

Equipment shall be new, of proven design, installed and commissioned to the requirements of the manufacturer.

Install all equipment to ensure safe, efficient and reliable service fitted with safety guards and ancillary devices and so located to provide safe and ready access for servicing.

Provide nameplates indicating model and serial numbers plus essential operating data and capacities.

### 5.2 NOMINATED MANUFACTURE

Where a specific manufacture has been nominated and the words “equal approved” **are omitted**, the tender and shall be based on the inclusion of equipment of the nominated manufacture.

At time of tender, **the base tender shall include the nominated manufacturer(s)**, however, alternative manufacturers may be offered provided that:

- Cost differences are clearly identified
- Technical differences are clearly identified

### 5.3 EQUIPMENT SCHEDULES AND ORDERING

Capacity and performance data specified in schedules hereafter are the minimum requirements.

Prior to ordering, provide for approval detailed engineering calculations substantiating proposed ordering details. Calculations shall be accompanied by such items as:

- Statement as to methodology of calculation
- Capacity/duty curves, clearly marked with system curves and duty points
- Manufacturer’s literature
- Any further data considered essential to support equipment selection/orders

### 5.4 CHILLERS

Chillers shall be a YORK or SMARDT chillers incorporating the following features:

- VSD driven mag bearing compressor(s)
- 316 SS condenser tube sheets
- 316 SS condenser water boxes
- Accessible anode pockets in condenser headers including Magnesium elements
- Factory applied evaporator and suction pipework insulation (ARMAFLEX) to BCA Part J requirements
- High level (BACnet) interfacing capabilities for interface with BMS

The chiller controls shall initiate its respective CCW pump and drive its speed to maintain optimum refrigeration performance.

The chiller shall be factory tested with certified results signed off by the Superintendent prior to shipping (witness testing not required).

The chiller manufacturer/supplier shall be employed to site test, charge and commission the chiller and. shall be retained during the defects liability period to provide labour warranty and routine service.

### 5.5 COOLING TOWERS

Cooling towers shall be BAC PCT series fully conforming to the requirements of AS 3666.

Except for the fan and fan motor, construction shall be completely non-ferrous.

Tower structure shall be manufactured from fabricated/moulded high grade, high thermal resistance FRP. Internal and external surfaces shall be finished in a smooth gel coat to facilitate easy cleaning.

Drift eliminators shall be manufactured from PVC to provide a maximum drift loss of 0.02%.

Inlet louvers shall be manufactured from PVC and be designed to prevent splash out **with full water flow and no airflow**.

Water distribution system shall be constructed of PVC and incorporate clog resistant spray nozzles.

Wet deck shall be constructed of corrugated PVC material which shall be tightly packed and adequately restrained.

Basin shall be constructed of a single piece of moulded FRP with all surfaces sloping to the outlet/drain.

Basin fittings shall include stainless steel strainer basket, ball float valve, quick fill point and overflow drain.

Fan motor shall have IP56 protection with external surfaces painted to minimise corrosion.

Fan shall be CONFIMCO series, high efficiency low noise axial type, fitted to the motor via a Taperlock hub which shall restrain adjustable FRP blades.

Towers shall be provided with a galvanised ladder/access platform for accessing fan components.

Additional concrete strip plinths and/or HDG structure shall be provided to elevate the towers to ensure flooded pump suction and to bridge existing support provisions where required.

Provide fully galvanised access ladders, walkways, platforms and handrails to provide safe access to motors fans ad drives.

Submit full drawings from manufacturer of proposed installation for Superintendent's review and approval

### 5.6 WATER SERVICE PUMPS

Pumps shall be AJAX or GRUNDFOS horizontal, vertically split, end suction configuration pumps or equal approved.

Construction shall comprise:

- Cast iron casing
- Tempered C45 steel shaft
- Chrome nickel molybdenum steel shaft sleeve
- Bronze impeller
- Crane mechanical seal

Pump and motor shall be coupled via a spacer type flexible coupling and mounted on a rigid **hot dip galvanised** formed steel base.

Pump shall be selected to provide maximum efficiency at duty point with motor and impeller/casing size of adequate margin to permit 110% flow at corresponding system resistance.

Chilled water pump casings shall not be insulated.

Chilled water pumps shall incorporate a copper or 316 SS drip tray between the pump casing and mounting frame to collect and drain any condensate.

### 5.7 AIR HANDLING UNITS – MODULAR

#### 5.7.1 GENERAL

Modular air handling units shall be SAIVER, DAIKIN, GJ WALKER or SKILLED AIR series modular units or equal approved.

Modules shall comprise fan, coil, filters and mixing section. Fan sections shall contain a backward inclined DWDI laminar section fan independently sprung inside casing.

An accessible "spacer" section shall be provided between cooling and heating coils to provide a minimum 450 mm clearance.

Note that the manufacturer shall provide all upstream filter and mixing modules. These components shall not be manufactured as ductwork items.

Modulating dampers shall be as specified hereunder.

#### 5.7.2 CASINGS

Casings shall comprise a proprietary extruded aluminium perimeter frame mounted on a galvanised steel base.

Infill panels shall be of 50 mm thick sandwich panel construction comprising 0.6 mm inner and outer "Colorbond" skins with 50 mm expanded polyurethane core factory laminated to the skins.

Unit casing "K" value shall not exceed a value of 0.02 W/mK.

Panels shall be fixed to the perimeter frame through a self-locking mechanism such that removal will not affect the structural rigidity of the unit.

The casing shall incorporate a thermal break in the frame and panel design and shall have a Thermal Break Ratio of at least 0.75.

Hinged, lockable access doors (minimum 500 mm wide) shall be provided for regular service access into the fan, coil, filter and mixing sections as required by ASNZS3666.1

Where externally located, the unit shall be protected by a sloping roof constructed of COLORBOND ULTRASTEEL securely attached to the top of the unit.

Where heating and cooling coils are to be provided, the heating coil shall be located downstream of the cooling coil and the coils shall be separated by a minimum of 450 mm with this casing section fitted with a door to enable cleaning of all coil surfaces and drip trays.

### 5.7.3 FANS

Fans shall be double width double inlet centrifugal backward inclined type, constructed of galvanised steel. The fan impeller shall be statically and dynamically balanced. Fan bearings shall be plumber block mounted, self-aligning ball bearings hermetically sealed and designed for an operating life of 100,000 hours. Bearings shall be installed in grease relief housings with grease nipples and dust seals.

The fan motor shall be a four pole, three phase single speed motor protected to IP54 with class B insulation and rated for 415 VAC/50Hz and sized with sufficient capacity for 110% air volume at the corresponding system static pressure beyond the final design duty point.

The fan/motor drive shall have a minimum of two vee belt pulleys and. shall be secured to the shaft with Taperlock bushes and shaft keys.

Fan shaft shall be manufactured from mild steel.

The motor shall be mounted on a quick fit motor base to permit ease of belt and pulley adjustment and or changes without altering the alignment of either fan or motor.

The complete fan and motor combination shall be assembled on a galvanised steel sub frame which is supported by anti-vibration mounts fitted to tea unit caning.

The fan discharge is to be connected to the casing wall by a heavy duty vinyl flexible connection.

**Fans shall be selected to provide a minimum total efficiency of 75%. This may require the selection of larger than standard casings to achieve these efficiencies.**

Fans for variable air volume duty shall be selected to the following criteria.

- Maximum efficiency at 80% volume and corresponding system resistance
- Non surge operation from 30% to 110% volume at corresponding system resistances

### 5.7.4 CHILLED WATER COILS

Chilled water coils shall be constructed from 1.6 mm Galvabond steel tame and 1.6 mm 0D copper tubes expanded into die formed corrugated aluminium fin p1ates. Coils shall be factory tested to a pressure of2100 kPa.

Coils shall be selected for a maximum face velocity **less than 2.25 m/s** with a fin density not greater than 472 fins/m an air pressure drop not exceeding 120 Pa, and a water pressure drop not exceeding 40 kPa.

Coil headers shall be arranged for counter flow circuiting.

Condensate trays shall be Grade 304 stainless steel and designed to incorporate a 1:50 slope in both transverse and longitudinal directions to prevent stagnation as required by AS/NZS 3666.1.

Condensate drain connection shall be a minimum of 30 mm diameter stainless steel tube.
Coils shall be supported above the drip fray to permit cleaning of both the underside of the coil and the water collection surface of the tray.

Underside of drip trays is to be insulated with melamine foam to provide extra protection against condensation.

Where coils are double stacked a stainless steel intermediate condensate tray shall be provided and shall drain into the lower tray.

#### 5.7.5 HEATING WATER COILS

Heating water coils shall be constructed as described for chilled water coils.

Coils shall be selected for a maximum face velocity **less than 3.0 m/s** with a fin density not greater than 394 fins/m and a water pressure drop not exceeding 20 kPa.

#### 5.7.6 FILTER SECTION

Filter sections shall be constructed from the same materials and in the same fashion as the fan and coil sections.

Filters shall incorporate a 1.6 mm galvanised steel outer support frame with quick release clips to allow filter replacement.

Refer later hereunder for filter specifications.

Access doors shall be fully hinged and provided with lever action closers.

### 5.8 WATER COOLED PACKAGE UNITS

Water Cooled Package Units (WCPU's) shall be reverse cycle TEMPERZONE KY (Eco) series or equal approved with the following features:

- EC fan motors
- Removeable, powder coated and insulated condensate tray
- Acoustically lined compressor and fan compartments
- High & low pressure safeties which can be reset by isolating and re-establishing power to the unit
- Supplied with a TZT-100 networkable controller
- Fitted with electric heaters as scheduled hereinafter

### 5.9 PLATE HEAT EXCHANGERS

Plate Heat Exchangers shall be ALFA LAVAL model AQ4P having the following features:

- Mild Steel end plates
- 0.5 mm thick 316 stainless steel plates
- 10 bar design pressure
- 150 NB flanged connections

Plate heat exchangers shall be AHRI certified.

## 5.10 FANS

### 5.10.1 FAN TYPES

Fans shall be FANTECH or equal approved as follows:

| Type | • Model/Series |
|---|---|
| Axial (A) | AP |
| Plate Axial (AP) | CP |
| Ring Plate Axial (RPA) | RP |
| Roof Mounted Centrifugal (RMC) | C |
| Centrifugal (C) | AL |
| Roof Mounted Centrifugal – Kitchen Exhaust (RMC-KE) | CHD |
| Roof Mounted Smoke Spill (Axial) (RSS) | RSS |
| In line Mixed Flow (ILM) | TD |
| In Line Multi Mixed Flow (ILMM) | MM |
| In Line Centrifugal (ILC) | PC |
| Minivent Axial Supply (MVS) | MV |
| Mini Tube Axial (MTA) | MTA |
| Mixed Flow Fan (MMF) | MMD |
| Window Mounted Fans (WM) | EV |
| Ceiling Mounted Fans (CM) | ED |

### 5.10.2 GENERAL REQUIREMENTS

Materials of construction, motor insulation category and special finishes shall be provided to suit the nature of air handled.

Motor size shall be capable of handling 110% air volume at the corresponding system static pressure beyond the final design duty point.

Due allowance shall be made in sizing motors where dual drives are fitted.

All single phase fans shall be supplied with either a wall mounted or remote electronic speed controller.

## 5.11 FILTERS

### 5.11.1 HIGH EFFICIENCY – DEEP BED

These filters shall be installed in all AHU's.

Filters shall be CAMFIL HI-FLO M or HART type D70 incorporating synthetic disposable media having the following performance for a 610 x610 x 600 panel.

| | |
|---|---|
| Capacity (l/s) | 903 |
| Clean Resistance (Pa) | 50 |
| Minimum Efficiency - AS1324 No.1 (%) | 70.0 |
| Average Arrestance - AS1324 No 4 Dust (%) | 98.0 |
| Dust Holding Capacity - AS1324 No 4 Dust (g) | 654 |
| Final resistance (Pa) | 250 |
| EU Rating | F6 |

Filter face velocity shall not exceed 2.5m/s.

#### 5.11.2 FILTERS – HIGH EFFICIENCY PANEL

These filters shall be installed on all WCPU's.

Filters shall be HART MK80D or equal approved 50mm thick units having the following performance for a 610x610 panel.

| | |
|---|---|
| Clean Resistance (Pa) | 55 |
| Minimum Efficiency - AS1324 No.1 (%) | 37.0 |
| Average Arrestance - AS1324 No 4 Dust (%) | 93.1 |
| Dust Holding Capacity - AS1324 No 4 Dust (g) | 160 |
| Final resistance (Pa) | 250 |
| EU Rating | F4 |

Filter face velocity shall not exceed 1.75m/s.

### 5.12 ATTENUATORS

Attenuators shall be ADAMSSON, FANTECH or equal approved of the configuration shown and performance scheduled.

Where fitted in supply or return air streams or in conditions where casings are likely to promote condensation, externally insulate with thermal insulation as specified later herein.

Where handling grease laden or corrosive vapours, internal surfaces shall be lined with MELLINEX or equal approved.

### 5.13 VARIABLE SPEED DRIVES

Variable speed drives shall be DANFOSS or equal approved.

Drives shall not emit EMI, cause harmonic disturbance to building supplies or interference to data/communication or other electronic/electrical systems within the building.

Drives shall form part of the controls subcontract package such that the controls subcontractor retains full responsibility for compatibility with their controls system and for their programming.

### 5.1 VAV BOXES

#### 5.1.1 OVERVIEW

Variable Air Volume (VAV) Boxes shall consist of a damper, calibrated DDC controllers, temperature sensor (connected and provided with 10M of cable for future installation), electric duct heater elements and associated electronic control circuitry inclusive of solid-state relays.

Terminals shall be selected to provide the nominated design air quantity at an inlet velocity not exceeding 8.5 m/s. and a pressure drop of 40 Pa.

Airflow velocity sensors shall accurately measure airflows less than 2 m/s.

VAV boxes are to have a nominal maximum depth of 400mm (inclusive of mounting fittings). A label with the VAV box number, box size, and minimum/maximum airflow parameters shall be fitted to each VAV box.

Each VAV Box shall come with a dedicated DDC (BACnet or LON) controller and will be factory tested and calibrated.
Each VAV controller will be pre-programmed with all settings required to operate independently, inclusive of specific minimum and maximum airflow setting for each box size and location.

Factory tests will include the following tasks:

- Damper operation
- Airflow calibration (Minimum and Maximum airflow for each box)
- Heater operation (if fitted)
- Auxiliary Fan operation (if fitted)
- Safety circuit operation (s)

Factory witness testing by the Superintendent or Commissioning Manager will be required.

Suppliers that choose to manufacture outside the Perth metropolitan area will be required to pay the travelling costs of the owner's representatives in order for them to carry out witness testing.

#### 5.1.2 CONSTRUCTION

VAV boxes shall have a rigid steel casing and be constructed from 1.00mm Galva bond steel (minimum) with a leak rate not greater than 2% at test pressure of 250Pa across the box. Boxes will be selected to operate satisfactorily at 100pa max design inlet total pressure. Inlet pressures of 250 Pa will not cause excessive noise.

Hanger holes shall be provided on four corners for installation.

Interior surfaces shall be acoustically and thermally lined with (a minimum) 25mm thick glass fibre, with high density facing to comply with AS1530.4-2005. Insulating material shall be surface treated to prevent insulation erosion and shall have all cut edges securely clamped and covered against exposure to the air stream.

The volume control damper shall be 1.2mm thickness (galvanised or aluminium) blade and shall be positively fixed to a continuous stainless steel or aluminium shaft. Damper shafts shall turn in nylon bushes or bearings. Provide slotted end shafts to indicate damper position.

Each box shall be fitted with rigid inlet duct equal to at least four times the inlet diameter.

#### 5.1.3 ELECTRIC HEATERS

Electric heater elements shall be factory fitted, boxes shall incorporate fire rated linings, safety cut out thermostats and cut-out switches in accordance with all relevant standards. Heater controls shall utilise solid-state relays fitted with suitable sized heat sinks. Installation and construction shall comply with AS/NZS3102-2002. Heater status monitoring shall be provided for a DDC controller.

### 5.2 WATER TREATMENT SYSTEMS

#### 5.2.1 CLOSED CIRCUITS CLEANING

Provide adequate quantities of a mild phosphate based detergent for cleaning by recirculation using the system water pumps.

Continuously operate system for 24 hrs then drain down whilst continuously recirculating and making up until all residual detergent is expelled.

Open all high point vents and drain down through drain provisions.

Note that the cost of labour required for the cleaning and flushing processes has been included in the base contract sum.

#### 5.2.2 CLOSED CIRCUITS CHEMICAL DOSING

Provide a nitrate based inhibitor for corrosion control and control of microbiological activity.

Inject chemicals via dosing pot to maintain correct concentration.

#### 5.2.3 CONDENSER WATER SYSTEM CLEANING

Provide adequate quantities of a mild phosphate based detergent for cleaning by recirculation using the condenser water pump.

Continuously operate system for 24 hrs then drain down whilst continuously recirculating and making up until all residual detergent is expelled.

Note that the cost of labour required for the cleaning and flushing processes has been included in the base contract sum.

#### 5.2.4 MONITORING AND CONTROL EQUIPMENT

Install a cooling tower controller to monitor and control TDS, and to control biocide and corrosion inhibitor injection.

This controller shall be BACnet/Modbus enabled to provide connectivity with field devices and the main DDC

Integrate Modbus output of the cooling tower make up water meter to the injection rate of both biocide and inhibitor pumps.

Provide lock out facility via condenser water flow switch.

Provide CCW pump outputs to operate the CCW pump during scheduled injection of biocide outside normal operating hours.

The controller shall be mounted on a PVC panel with a prefabricated manifold containing the conductivity electrode, bleed solenoid, non-return valve, chemical injection dosing points and a sample valve.

Note that the chemical injection shall be to the CCW pump suction header and not into the tower basin or return line to the tower.

#### 5.2.5 DOSING EQUIPMENT

For each of the inhibitor and biocide systems install a positive displacement pump and a nominal 150 litre storage container from which the pumps shall draw their respective chemicals.

Wall mount the pumps at a height to ensure positive suction at all times.

Pump mounting brackets shall be of moulded/fabricated PVC.

Pumps or their piping circuits shall provide a method of monitoring flow.

#### 5.2.6 CHEMICALS-NON OXIDIZING BIOCIDE

Provide an Isothiazolone based broad spectrum biocide in sufficient quantities to maintain the required concentrations for the duration of the contract.

#### 5.2.7 CHEMICALS-OXIDIZING BIOCIDE

Provide sufficient quantities of a Bromine based biocide for regular dosing.

#### 5.2.8 CHEMICALS-INHIBITOR

Provide sufficient quantities of either a Molybdate or Zinc based scale and corrosion inhibitor that a**t all times is compatible with the biocides and system materials of construction**.

#### 5.2.9 WATER METERS

Water meters shall be WAWA approved and have MODBUS not pulsed outputs.

#### 5.2.10 ELECTRICAL

Provide all required electrical interfacing including:

- CCW pump interlock for out of normal hours dosing of biocide
- CCW flow switch interlock for operation of dosing pumps
- GPO for controller
- Wiring of solenoid valve, conductivity cell and dosing pumps (if not included by specialist contractor)
- Interface between pulse head cooling tower make up meter and water treatment controller

#### 5.2.11 BMS INTERFACE AND MONITORING

The following interfaces and monitoring shall be achieved.

- Cooling tower make up water consumption (with assigned high rate alarm)
- Chilled water make up consumption (with assigned high rate alarm)
- Biocide injection operation with logic alarm
- Inhibitor injection operation with logic alarm
- TDS with high limit alarm

#### 5.2.12 ATTENDANCE-MONTHLY

- Sample and test all circuits for pH, TDS, temperature, alkalinity, corrosion, scale build up and suspended solids using approved and calibrated instruments.
- Conduct pore plate tests for total bacterial count to AS 4276.3.1
- Conduct Legionella analysis to AS 3896
- Check condition and operation of all equipment
- Replenish materials
- Adjust dosing rates as required
- Inspect all wetted surfaces and report presence of algae, slime or bacterial growth

#### 5.2.13 ATTENDANCE-QUARTERLY

At minimum clean towers to AS 3666.3.

### 5.2.14 SERVICE REPORTS

Provide detailed service reports after each visit.

Copies shall be forwarded to the Proprietor and the Superintendent.

## 6.0 DUCTWORK, METALWORK AND FITTINGS

### 6.1 CONSTRUCTION, INSTALLATION & TESTING

Construct, install and test all airconditioning and ventilation ductwork to fully comply with AS4254-1995.

No deviation from this standard will be accepted without written approval of the Superintendent.

### 6.2 STATIC PRESSURE CLASSIFICATION

| Location/duty | Pressure Class |
|---|---|
| All AC system ductwork | 500 |
| All other ductwork | 250 |

Pressure Class 500 duct systems serving as supply air from fans to VAV box inlets shall be fully pressure tested to the requirements of SMACNA HVAC Air Duct Leakage Test Manual, Class 12.

All other duct systems shall be checked for audible leaks and sealed as required.

### 6.3 RIGID DUCTWORK

Construct rectangular ductwork as follows:

- Material shall be galvanised steel sheet
- Bends shall be radius (with vanes as required) in preference to square
- Square bends and any form of turning vanes shall not be used on exhaust systems

Construct all hangers and supports of galvanised materials, cold primed where cut on site.

### 6.4 CIRCULAR FLEXIBLE DUCTWORK

Circular flexible ductwork shall be BJC ENTERPRISES C5M or approved equivalent.

Insulated flexible duct runs shall not exceed three metres. Non insulated duct runs shall not exceed six metres.

Insulation shall comply with the requirements of BCA Part J.

Ducting shall be installed without restriction to airflow and be supported with Gutter Guard + 20mm wide straps at regular intervals to prevent sagging.

Connection to rigid elements shall be made using Norton Silverseal or Berh Manning EC800 mastic and non-slip PVC strapping.

### 6.5 CUSHION HEADS

Cushion heads shall be manufactured from GSS and incorporate internally adjustable split spigot dampers where serving diffusion located in plasterboard, mini-strip or generally inaccessible ceilings.

All cushion heads shall be internally insulated with 48kg/$m^3$, 38 mm thick fibreglass duct liner finished with matt faced duct liner.

### 6.6 DUCTWORK SPIGOTS

Take off spigots shall be of proprietary manufacture and incorporate a circular balancing damper. A robust, metal based locking mechanism shall be securely fixed to the side of the spigot with the damper rod keyed to the lever which in turn shall be locked to the body by a wingnut/bolt arrangement.

### 6.7 MODULATING DAMPERS

Modulating dampers shall be, manufactured by BULLOCK, or approved equal, constructed of aluminium and having “inflatable” blade seals and stainless steel edge slips.

### 6.8 DIFFUSERS, REGISTERS & GRILLES

#### 6.8.1 GENERAL

Provide diffusers, registers and grilles manufactured from aluminium extrusions, powder coat finished to an approved colour.

Where balancing devices are not provided in connecting ductwork, provide lightweight opposed blade dampers finished matt black.

Provide cores that are removable, but securely fixed. Secure equipment to ductwork by removing cores and using concealed fixings. Exposed fixings will be rejected.

Equipment shall be manufactured by HOLYOAKE, VARIFLOW or HART with NATA certified (or equivalent) performance data supplied.

#### 6.8.2 SWIRL DIFFUSERS

Swirl diffusers shall be used where shown on the drawings for both Constant Volume and VAV applications.

Diffusers shall be TROX, HOLYOAKE or equal approved.

#### 6.8.3 HIGH CAPACITY BARREL DIFFUSERS

High Capacity Barrel Diffusers shall be HOLYOAKE BRC series finished matt black.

#### 6.8.4 LOUVRE FACED CEILING DIFFUSERS

Provide one, two, three or four way directional cores as shown. Fit insulated cushion heads to all diffusers and support independently of the ceiling grid.

Control volume by butterfly dampers at the cushion head.

#### 6.8.5 LINEAR DIFFUSERS

Provide linear diffusers capable of diffusing air at an angle between $15^0$ & $90^0$ to the horizontal.

Diffusers shall be manufactured from extruded aluminium sections powder coated to selected colours.

Diffuser plenums shall be internally insulated as for ductwork specified hereafter.

Control volume by butterfly dampers at VAV box discharge ductwork/plenum.

Install mat black blanking strips in non-active slots.

Set all directional vanes to direct air away from facade.

#### 6.8.6 LINEAR BAR GRILLES

Linear Bar Grilles shall be HOLYOAKE LDH 1215 series or equal approved incorporating:

- 15 mm flange to the frame
- 3.15 mm blades with a $15^O$ downward facing lip/edge
- 12.5 mm spacing to blades
- Powder coat finish to Superintendent's direction

#### 6.8.7 REGISTERS

Install supply and exhaust air registers incorporating double deflection blades.

Attach registers to circular ductwork via short rectangular necks fixed to the circular duct by pop riveted internally concealed flanges.

Install SSD's to supply registers and OBD's to exhaust registers.

Utilise VARIFLOW metering plates to obviate air noise where required.

#### 6.8.8 EXHAUST GRILLES

Provide oblique egg crate cores or single chevron for all exhaust grilles. Install cores to point blades to adjacent wall to obscure sighting of internal components.

#### 6.8.9 RETURN AIR GRILLES

Provide single chevron crate cores for all return air grilles. Install cores to point blades to obscure sighting of internal components.

#### 6.8.10 DOOR GRILLES

Install door grilles incorporating adjustable frames and double chevron cores.

Do not fix with exposed fixings. Replace loose or rattling grilles.

Finish in anodised aluminium or powder coat enamel to selected colour.

## 7.0 PIPEWORK VALVES & FITTINGS

### 7.1 GENERAL

Erect piping with due regard to the requirements for control, operation, maintenance and safety of systems.

Place valves and fittings to permit easy operation and access. Provide adequate numbers of bends to promote sufficient flexibility to absorb vibration, expansion and contraction without causing stress within pipework or connecting equipment.

Install anchors and flexible connections where necessary to control or assist movement.

Submit detailed layouts, schematics and pipe sizing calculations prior to fabrication or installation.
Use only SBA 115 (15% silver) brazing alloy for all welded joints in copper pipework.

### 7.2 PIPEWORK MATERIAL

| **Service** | **Material** |
|---|---|
| CHW | Schedule 40 Mild Steel or Type B Copper |
| CCW Water | Type B Copper or Schedule 20 316 SS |
| Refrigeration Pipework | Copper complying with AS1677 and AS1571 |
| Drains Plantroom | Type D Copper |
| Drains Roof | UPVC |

### 7.3 SUPPORTS

Support all pipework with galvanised supports using where possible UNISTRUT or approved equal systems components.

Fix supports to the structure so as not to cause overloading or damage to the structure or adjacent surfaces. Use spreaders to achieve acceptable loadings.

Grade all pipework for easy drainage and venting.

Provide dielectric isolation of dissimilar hanging and pipe materials.

For insulated pipework, provide wooden spacer blocks or half round thick galvanised steel cladding to prevent crushing of insulation.

Provide spring hangers to supports within 3m of all spring mounted or vibrating equipment.

Use hanging rods and spacings as follows:

| **Nominal Size of Pipe (mm)** | **Steel Pipe** | **Copper Pipe** | **Minimum Hanger Rod Diameter** |
|---|---|---|---|
| 6 | 1000 | 600 | 6 |
| 10 | 1000 | 900 | 6 |
| 15 | 2000 | 1200 | 8 |
| 20 | 2500 | 1500 | 8 |
| 25 | 250 | 1500 | 10 |
| 32 | 3000 | 1800 | 10 |
| 40 | 3000 | 1800 | 10 |
| 50 | 3000 | 2400 | 10 |
| 65 | 3000 | 2400 | 15 |
| 80 | 4000 | 3000 | 15 |
| 100 | 4000 | 3600 | 20 |
| 150 to 300 dia | 5000 | 3600 | 20 |
| over 300 dia | | | to BS 3974 |

### 7.4 PIPEWORK EXPANSION AND CONTRACTION PROVISIONS

Install anchors, changes of direction and flexible pipe connections to cater for pipework expansion and contraction.

Submit detailed calculations for the Superintendent's approval of the expansion and contraction of the pipework systems, together with technical data of all fittings intended to be used.

Provide structural loads for the Superintendent's approval.

### 7.5 DRAINS

Provide 20mm drain down valves and all low points, coils and equipment.

### 7.6 AIR VENTS

Install in line accumulators at all high points to the following requirements:

- Up to 90 dia - pipe dia x 150 high
- 100 dia and greater - 100 dia x 2 pipe dia high

Fit accumulators with 10mm gate valve, with bleed line piped to a 10mm ball valve, 1500mm above floor level, visibly discharging to a tundish.

### 7.7 TESTING & CLEANING

During delivery and construction, maintain capped ends and take precautions to prevent ingress of foreign material.

Hydrostatically test pipework during construction and after completion at 1000kpa. Maintain test pressure for 24 hours.

Test drains and overflow pipework for leaks and unobstructed drainage.

When testing, add corrosion inhibitors and at all times maintain inhibitor levels.

Before placing into service, thoroughly flush systems with scouring agents. Clean strainers, empty all dirt pockets and drains. Repeat procedure until thoroughly clean. Refill with clean fluid and inhibitors.

### 7.8 VALVES & FITTINGS

#### 7.8.1 VALVES – WATER SERVICES

Valves shall be DURA, HYFLOW, JOHN or approved equal manufactured to relevant standards and accredited for compliance with AS3902.

| Duty | Type | Size | Make/Model |
|---|---|---|---|
| Isolating | Ball | to 50 mm | Dura Eagle |
| | Ball or Gate | to 80mm | Hyflow Brass AGA<br>Hyflow Brass |
| | Butterfly | 65mm upwards | Dura lugged butterfly |
| Balancing | Double Regulating | All sizes | Tour & Anderson S-TAT |
| Check | Swing | to 50mm | Hyflow Bronze |
| | Dual Flap | above 50mm | John 404a |

#### 7.8.2 TEST POINTS – WATER SERVICES

Provide BINDER fittings for all pressure and temperature test points.

#### 7.8.3 FLEXIBLE CONNECTIONS – WATER SERVICES

Provide neoprene body spherical, non-metallic flexible connections at pump suction and discharge.

## 8.0 INSULATION

### 8.1 GENERAL

Utilise appropriately skilled tradesmen for the application of insulation materials to high standards of neatness and workmanship.

Use materials that fully comply with AS1530 and the BCA. Provide prototypes of all insulation materials and installation techniques for approval, prior to construction.

Selection, installation and finishes of all insulation materials shall comply with AS4426-1997.

### 8.2 RECTANGULAR DUCTWORK INSULATION

Internally insulate all rectangular ductwork where shown on drawings with 48kg/m$^3$ fibreglass duct liner finished with perforated Sisalation 450.

Thickness shall be as detailed on the drawings.

### 8.3 CHILLED WATER PIPEWORK INSULATION

Insulate chilled water pipework with THERMOBREAK or SE Grade sectional polystyrene incorporating factory bonded Sizal 450 or equal approved vapour barrier.

Thicknesses shall be that required to achieve the requirements of BCA Part J.

Use aluminium sheet or **painted** GSS to clad all pipework, valves and fittings in the main plantroom only up to a height of 2 m.

Protect insulation exposed to elements with fully sealed aluminium cladding.

### 8.4 HEATING WATER PIPEWORK INSULATION

Insulate heating water pipework with sectional mineral wool or fibreglass bonded externally with aluminium foil laminate. Thermal conductivity of the insulation material shall be less than 0.043 W/mK.

Thicknesses shall be that required to achieve the requirements of BCA Part J.

Lap and seal external laminate with compatible adhesive.

Apply aluminium fixing bands at 450 mm centres.

Use aluminium sheet to clad all pipework, valves and fittings in the main plantroom within 2 m of floor level.

Protect insulation exposed to elements with fully sealed aluminium cladding.

### 8.5 REFRIGERATION PIPEWORK INSULATION

Refrigeration pipework insulation shall be AEROFLEX or ENSOLEX closed cell insulation applied in accordance with the manufacturer's requirements.

Alternatively it may be as specified for Chilled Water Pipework

Thickness shall be to the requirements of BCA Part J

Insulation shall be applied during the installation/construction of the piping systems and shall not be applied afterwards by splitting then subsequently gluing and taping.
Circumferential butt joints shall be fully glued using a compatible adhesive.

Ensure that insulation is not stretched leading to opening of circumferential joints.

Where exposed to the elements or likely to be subjected to mechanical damage install aluminium folded chequer plate covers suitably reinforced where subject to foot traffic.

### 8.6 RETURN AIR PLENUM

The main return air plenum at roof level shall be acoustically lined with 50 mm thick, 48kg/m$^3$ fibreglass duct liner finished with perforated Sisalation 450.

Install 20# perforated zinc anneal sheeting to the floor of the plenum.

## 9.0 ELECTRICAL

### 9.1 GENERAL

Provide all necessary electrical equipment and wiring to ensure the correct and safe operation of the works.

Comply in every respect with AS3000 and the requirements of Western Power.

Specifically comply with the Principal's standard requirements with respect to labelling, signage, wire numbering, documentation and drawings (in this matter, the mechanical services electrical installation is to follow normal, high quality commercial standards, e.g. switchboard construction, cable sizing, conduiting. The Principal's requirements are to be incorporated principally in areas of identification, documentation and ongoing maintenance aspects).

Obtain and lodge all necessary notices and permits. Pay all associated fees and charges.

### 9.2 OBVIOUS WORK

Provide electrical systems complete in all respects, including materials, fittings and work obviously necessary for the satisfactory functioning of the work even though such items may not be specifically detailed herein or on drawings.

### 9.3 DRAWINGS

Provide fully detailed drawings of the proposed electrical installation.

Prepare functional schematic drawings to illustrate electrical relationship, sequence of operation, control and protective functions.

Drawings shall show the following:

- Manufacturer's name and catalogue number of any standard equipment
- The general arrangement of equipment
- Full details of cabinet construction and dimensions
- The method of supporting busbars and protection/control equipment
- A description of all materials to be used
- Clearances between live parts and live parts to earth
- The wording of labels
- Busbar dimensions and cable ratings
- Wiring diagrams and schematics of instruments, protection and control circuits detailing wire and terminal numbers

On completion, revise drawings to "as installed" status. Provide a rolled laminated copy in the base of each switchboard.

### 9.4 MANDATORY FEATURES MSSB'S

Provide on switchboard fascia panel

- A-O-T or A-O switch for all connected devices
- Run & Fault light for all connected devices
- Lamp test switch

Provide phase failure relay protection.

Provide 20% spare capacity for future expansion.

DDC panels shall be incorporated into MSSB's.

### 9.5 MSSB CONSTRUCTION

MSSB's shall be Form 2B or 3BIH construction according to current rating.

All external MSSB's shall:

- Be manufactured from marine grade aluminium to minimum IP55 rating
- Contain control switches within
- Utilise a conventional LOCKWOOD keyed door lock to, not handle locks

### 9.6 KWHR METERS

kWhr meters shall be EDMI Mk10H DIN rail mounted meters

kWhr meters shall be installed to measure power consumed by:

- Central cooling plant items as a group
- Central heating plant items as a group
- Central SCCW plant as a group
- Air Handling units as a group
- Fans as a group

Refer MSSB Schedules for specific details.

### 9.7 EQUIPMENT CONNECTED TO TENANCY DB'S

The mechanical contractor shall wire the following equipment from CB's within the respective tenancy DB's.

- WCPU's G.01 – G.04 inclusive from the Retail Tenancy DB
- WCPU G.05 from the Cafe Tenancy DB
-

Appropriately rated CB's within the tenancy DB's shall be installed by the electrical contractor.

### 9.8 INTEGRATION WITH CONTROLS SYSTEM

Fully coordinate and integrate the electrical installation with the controls system, ensuring that all auxiliary contactors relay outputs, terminal strips, etc. are provided.

### 9.9 AS61000 COMPLIANCE

Ensure that all mechanical equipment that will be supplied and installed to the site shall conform to the emission limits stipulated by AS/NZS 61000 "Electromagnetic Compatibility (EMC)".

Note that any motors/compressors that are being controlled/driven by variable speed drives (VSD's) are a source of harmonics. Given this, all variable speed drives must incorporate Dual DC link choke harmonic filters, RFI filters or similar suppression devices to ensure that the harmonics generated by the complete drive mechanism shall not exceed the maximum current and voltage distortion as defined by AS/NZS 61000 on the low voltage system at the point of common coupling.

The equipment manufacturer shall be responsible to carry out all necessary calculations to confirm that the installation complies with this requirement.

A power quality audit will be carried out by the Electrical Services Trade prior to occupation and six (6) months after Practical Completion to confirm that the installation conforms to AS61000 requirement. If the mechanical system is found to be non-compliant, the installing Trade shall be responsible to carry out all necessary rectification without additional cost.

# 10.0 CONTROLS

## 10.1 GENERAL ARRANGEMENT

The control systems shall be a fully configured Direct Digital Control (DDC) arrangement to integrate the entire control functions of the works.

Small point controllers shall be linked on a LAN to DDC panel(s) located adjacent the MSSB's. DDC panels to have **15%** spare point capacity.

~~The chiller~~ Chillers shall be provided with a self-contained microprocessor based control module arranged to provide input/output signals compatible with the DDC/ICT system.

Master Controllers shall be provided for each AHU and FCU. Minor systems may utilise common Mater Controllers sensibly geographically arranged.

## 10.2 CONTROLS EQUIPMENT

### 10.2.1 ACCEPTABLE MANUFACTURER

Controls equipment shall be supplied by one of the following companies:

- Johnson
- Innotech
- Delta
- Leopard
- Honeywell
- Sauter
- Siemens

As noted in Section 5, VSD's shall form part of the controls subcontract.

The controls subcontractor shall procure and program all VSD's and deliver to the mechanical electrical subcontractor FIS for installation thereof.

## 10.3 FUNCTIONAL DESCRIPTIONS – BASE BUILDING

### 10.3.1 OVERVIEW

Generally the existing control logic shall be retained with the exception of the following specific requirements

### 10.3.2 MASTER SET POINT (MSP)

Arrange all temperature controls to accept MSP functionality.

### 10.3.3 CHILLER THERMAL OUTPUT & COP CALCULATION

If the chiller HLI does not provide chiller thermal output a COP output then these performance parameters shall be calculated by the DDC using evaporator PD to calculate flow, evaporator flow and return temperatures from the chiller HLI and compressor input kW form the chiller HLI

### 10.3.4 CHILLER SEQUENCING

At 70% (adjustable) valve opening, initiate lead chilled water pump. Upon making of flow switch, initiate chiller control sequence.

Chiller to sequence internal components through self-contained controls to maintain leaving chilled water temperature.

Once lead chiller has reached optimum load point using compressor input kW (nominally 80%) and supply water temperature set point has been exceed constantly for a determined margin and time, initiate the lag chilled water pump and subsequently the lag chiller start sequence.

In parallel with chiller load point, if the evaporator flow exceeds 120% for 5 minutes (adjustable) the next machine shall be sequenced to start.

All sequencing points point shall be determined by optimised COP calculation.

At 5% valve position shut down the chilled water pump provided chiller is not operational.

Leaving chilled water temperature shall be rescheduled from 12 degrees to 6.5 degrees by high selected (most demand) AHU supply air temperature once the AHU economy cycle has been fully utilised and the AHU chilled water valve is 100% open.

#### 10.3.5 CHILLED WATER PUMP VSD CONTROL

Remote system DP shall be the control variable input to the CHWP VSD's with evaporator flow limited to 125% design.

#### 10.3.6 CHILLED WATER BYPASS CONTROL

The two bypass vales shall sequenced to maintain the minimum flow requirements of each evaporator by low selection of evaporator DP's.

#### 10.3.7 COOLING TOWER VALVES& FAN VSD CONTROL

Cooling tower fan sequencing and speed shall be governed by a common water temperature leading to the pumps.

The fans of all towers shall operate in parallel at all times.

The fans shall not operate until CCW pumps are operating at 100% flow or the common temperature exceeds 22 degrees.

If the common temperature exceeds 28 degrees and either pump is not at 100% flow an alarm shall be generated.

If CH-01 only is operating, isolate two cells on a rotation basis.

If only one base load chiller operating, isolate one cell on a rotation basis.

If no fans are operating and the water temperature is too cold for the operating chiller, isolate towers successively until the minimum temperature is achieved by natural draft.

#### 10.3.8 CONDENSER WATER VSD CONTROL

CCWP speed shall be controlled by the respective chiller.

#### 10.3.9 WATER TREATMENT PLANT

The WTP shall be initiated whenever a CCW pump is in operation.

Should the CCW system not operate for 24 hrs the lag CCW pump shall operate for not less than 10 mins every 24 hrs to ensure that treatment levels are maintained.

The filtration pump shall initially set to operate after hours for a period of 15 minutes per tower, however its operation shall not be coincident with the lag CCW operating in the above sequence.

#### 10.3.10 HEATING WATER SYSTEM

At 20% (adjustable) valve opening, initiate lead heating water pump. Upon making of flow switch, initiate boiler control sequence.

As load increases, utilise a common return water sensor to determine that the lead boiler can no longer meet demand and initiate the lag heating water pump and boiler.

As load decreases shut off the lead boiler and thence pump when the common return water temperature clearly indicates that demand can be satisfied by one boiler.

At 5% valve position shut down the lead heating water boiler water pump and thence pump.

Ensure appropriate pump run on times to dissipate residual boiler heat.

The HTGW bypass valve shall be modulated by a low select of DP over each HWU.

#### 10.3.11 SECONDARY CONDENSER COOLING WATER SYSTEM

The SCCW system pumps shall be initiated by a demand call from any attached unit.

Once initiated pumps shall continue to operate for 5 mins (adjustable) after loss of the demand call.

The duty SCWP speed shall be controlled by the system DPS.

The duty PCWP shall initially start at minimum speed (nominally 20%).

The primary side control valve shall modulate flow through the heat exchanger to maintain the SCW leaving water temperatures as follows:

- Zero flow @ 16 degrees
- 100% flow @ 28 degrees

Thereafter the PCWP pump speed shall ramp to 100% @ 30 degrees.

#### 10.3.12 AHU'S (VAV)

Room temperature will be the primary initiator (after time control) for all control functions.

Temperature above set point will sequentially:

- Increase air volume delivered by respective VAV diffuser
- Modulate economy cycle to full outside air
- Modulate chilled water valve to fully open

Temperature below set point will sequentially:

- Decrease air volume
- Modulate economy cycle to full return air
- Modulate HTGW flow to AHU heating coil
- Modulate the electric heater bank(s) by time modulated pulsing of solid state control relays.

VAV terminal small point controllers shall enable remote monitoring and adjustment of all parameters including:

- Minimum and maximum air volume
- Current air volume
- Inlet static pressure
- Temperature set point and dead bands
- Current temperature
- Heating demand

#### 10.3.13 AHU'S (CV)

Room air temperature will be the primary initiator (after time control) for all control functions.

Economy cycles, chilled water valve and heating water valve shall be sequenced accordingly to maintain set temperatures.

#### 10.3.14 AHU SAF VSD CONTROL

Provide static pressure sensors to each VAV system, outputs of which shall control the variable speed drives to maintain required system static pressures.

Static pressure setpoint shall be rescheduled by a "dissatisfied flow" algorithm which will look at a percentage of boxes not achieving volume setpoint and rescheduling the static pressure in increments over a period of time until all boxes are "satisfied".

Provide percentage volume/flow indication through DDC system.

Where VSD's are fitted to CV systems they shall be manually set during commissioning.

#### 10.3.15 ECONOMY CYCLE

All room sensor/controller outputs shall be capable of being selected to drive the economy cycle and chilled and heating water system operation.

Return, relief and outside air dampers shall be modulated to maintain the building at positive pressure relative to outside.

Ambient high temperature and enthalpy shall cause dampers to revert to full return air cycle.

All AHU and FCU mixing plenums incorporating economy cycle dampers shall be fitted with extended bulb temperature sensors to ensure that through monitoring of the mixed air temperature that economy cycle dampers are correctly sequenced and fully seal when closed.

#### 10.3.16 WARM UP SEQUENCE

Provide an early morning warm up sequence initiated when overnight ambient falls below 15.0$^{o}$CDB (adjustable).

- Initiate system start time 30 minutes (adjustable) earlier than normal start time
- Drive all VAV boxes fully open where applicable
- Close minimum outside air dampers
- Revert to normal cycle when common return air reaches 20.0$^{o}$CDB
- Lock out cooling operation for a further period of 15 minutes (adjustable)

#### 10.3.17 OPTIMISED START

An optimised start routine shall be provided for both cooling and heating-+ operation to ensure that design conditions prevail at the commencement of Trading Hours.

This program shall have an inbuilt learning algorithm to ensure that the run times are minimised.

#### 10.3.18 $CO_2$ &MINIMUM OUTSIDE AIR CONTROL

The minimum outside air dampers on all VAV AHU's shall be fitted with air flow measuring stations.

Minimum OA dampers on all AHU's shall be modulated from minimum to maximum air flow according to CO2 set point with the $CO_2$ sensor located in the return air duct

### 10.4 SMOKE EXHAUST FAN

SEF R.01 shall be initiated on receipt of any fire alarm other than a Basement fire alarm.

Air flow DP switches shall be fitted to provide required FIP positive operational status.

### 10.5 ROTATION

Utilise the BMS to rotate lead/lag and duty standby plant on a weekly, time or load basis as appropriate

### 10.6 FIRE MODE OPERATION

In conjunction with the Fire Services contractor, develop a comprehensive Cause and Effect matrix to satisfy the requirements of the BCA, AS1668.1 and any alternate solutions developed in the Fire Safety Engineering Report.

Submit for the Superintendent's approval.

### 10.7 CHILLED & HEATING WATER CONTROL VALVES

Valves shall be PICV equal percentage modified ball valves or plug valves.

### 10.8 AIR FLOW MEASURING STATIONS

Air flow measuring stations shall be DWYER STRA series or equal approved.

### 10.9 REPORTING FUNCTIONALITY

Provide necessary software to generate all trends, logs and energy reporting in MS Office formats.

Construct energy consumption reports in formats to be directed by the Superintendent.

### 10.10 FLOW & ENERGY MEASUREMENTS

Install SIEMENS MAGFLOW 5100 series energy meters or equal approved where indicated on the schematic drawings to measure CHW & HTGW flow & energy.

Install flow meters to measure all water consumed and disposed by the cooling towers and water treatment plant.

All flow and energy meters shall be monitored by the DDC system.

## 11.0 NOISE & VIBRATION

### 11.1 GENERAL

Take all practical measures to minimise the transmission of vibration and noise to occupied spaces.

Provide noise level calculations to demonstrate that selection and operation of system components will meet specified levels.

Undertake noise level tests to the direction of the Superintendent.

### 11.2 VIBRATION ISOLATION

At minimum, the following vibration isolation shall be provided.

| Item | Requirement |
|---|---|
| Chillers & Cooling Towers | Ribbed neoprene between heavy gauge galvanised metal bearing plates |
| Pumps | Concrete filled inertia bases. Double deflection RIS mounts. Flexible pipework connections |
| Plantroom pipework | 1st two hangers each side of vibration isolated equipment to have 25 mm deflection spring hangers |

### 11.3 PENETRATIONS

Acoustically seal pipes ducts and conduiting penetrations through plantroom walls.

Provide a minimum clearance of 20mm between components and structure, acoustically sealing this gap.

Provide details of all such penetrations for approval.

## 12.0 PAINTING AND IDENTIFICATION

### 12.1 GENERAL

Utilise qualified tradesmen skilled in the painting, labelling and finishing of mechanical services.

Utilise first grade quality materials, suitable for the environment encountered and applied to manufacturer's requirements.

Equipment manufacturers' standard finish and colours are generally acceptable, however shall be touched up or repainted entirely to repair any blemish or damage caused during transit or installation.

Paint **all surfaces of services installed in plantrooms or exposed to view**, including plinth surrounds supports, etc.

Submit schedule of proposed application processes, materials and colours for approval.

Include particular requirements of the Principal's finishes, colours and identification.

### 12.2 PAINTING OF EXTERNAL ELEMENTS

For painting of all elements exposed to external environment, utilise materials containing corrosion inhibitors.

### 12.3 IDENTIFICATION

Colour code all equipment, ductwork, piping and conduits. Identify all pipework in accordance with AS1345. Label all equipment to accord with identification on drawings.

Lettering, arrows and safety colours may be SAFETYMAN or approved equal.

Equipment labels shall be engraved TRAFOLYTE.

### 12.4 PROJECT SPECIFIC REQUIREMENTS

Painting shall be undertaken to the following:

- All mechanical services components within the three roof plantrooms
- All exposed mechanical services in the Basement Carpark including repainting of the carpark exhaust ductwork
- Exposed ductwork emanating from the western side of the roof AHU plantroom
- SEF R.01 and associated ductwork
- SPF R.01, SPF R.02, TEF R.01 and associated ductwork.

Do not paint any pipework or equipment within the Cooling Tower enclosure.

Identification throughout the project as per Clause 12.3.

## 13.0 PROJECT COMPLETION

### 13.1 GENERAL

Utilise qualified tradesmen, skilled i the testing, commissioning and instruction in the use of mechanical services.

Provide a commissioning engineer on site throughout the testing and commission period. The engineer shall hold MSCA accreditation from the AMCA commissioning Course.

Commissioning goals shall include:

- To provide the most efficient system operation
- To meet design parameters
- To meet design quantities
- To achieve occupant comfort

Commissioning staff shall return to the systems as often as required to complete fine tuning of controls, air flows, water flows, etc. to achieve these goals.

The commissioning engineer shall retain responsibility for and attend all ongoing testing and commissioning checks required through the defects liability period.

### 13.2 WATER SYSTEMS

Balance flow rates to -0%+10% of design quantities.

Achieve primary balance by pressure drops over calibrated double regulating valves, then correlate pressure drops over control valves, coils and evaporators, plus pump performance.

### 13.3 AIR SYSTEMS

Balance flow rates to -0%+10% of design quantities.

Achieve primary balance using calibrated hoods measuring outlet flows, then correlate with Pitot traverses, fan performance and anemometer readings over filters, coils, return air grilles, etc.

Attain balance by adjusting fan speeds or blade pitches.

### 13.4 TESTING & COMMISSIONING

Provide for approval a detailed testing and commissioning procedure including program, methodology and samples of all proposed records.

Ensure that all identification/marking systems as shown on as installed drawings correlate with data sheets and commissioning records.

### 13.5 WATER TREATMENT

Ensure water systems are correctly dosed and all chemical levels recorded at date of Practical Completion.

### 13.6 HANDOVER

The commissioning engineer shall fully instruct the Principal in the operation and control of the works and handover requisite manuals and warranty certificates.

### 13.7 COMPLIANCE CERTIFICATE

Issue a certificate of compliance prior to granting of Practical Completion. This certificate shall state that the complete installation complies with all requirements of the contract including relevant Codes, Standards and Authority requirements.

### 13.8 WARRANTIES

Include within the O&M Manuals copies of equipment warranties made in favour of Federation Centres.

### 13.9 PRACTICAL COMPLETION

The works shall not be granted Practical Completion until the following is achieved.

- All systems fully tested and commissioned to the Superintendent's satisfaction
- Testing and commissioning records have been submitted and accepted
- All major items noted in the Practical Completion inspection report have been completed

- As installed drawings have been submitted
- Draft edition of O&M manuals has been submitted
- Principal instruction has been effected
- Compliance Certificate has been issued

## 14.0 MANUALS

### 14.1 OBJECTIVES

The layout and content of the manuals shall achieve the following objectives:

- Provide a record of as installed works
- Provide operating instructions
- Provide maintenance instructions
- Provide a detailed record of testing and commissioning date
- Provide details that will enable:
- Ordering of replacement components
- Re-engineering of systems to cater for tenancy changes, system expression, etc.

### 14.2 MANUAL FORMAT

Provide three copies of all manuals and associated materials.

Provide separate manuals for all Majors and Mini-Majors

Provide foolscap, vinyl covered, three ring binders. Emboss front cover and spine with gold lettering, identifying project and service. Insert a front flysheet relating this information and additionally providing Contractor and Engineer details.

Insert as constructed drawings folded and heavily reinforced at post holes.

Provide segmented, clear vinyl slip to contain disk copies of all drawings.

Disks shall contain:

- PDF version of the full contents of the O&M Manuals
- PDF Version of all Drawings
- REVIT, Navisworks and DWG format of all Drawings

### 14.3 MANUAL CONTENTS

Fly Sheet

As previously described

Important Notes:

Concise, important notes relating to emergency procedures or do's and don'ts.

Index

Design Criteria

Set out final design criteria agreed.

Systems Description

Brief description of systems and their operation.

Operating Instructions

Detailed operating descriptions and instructions for:

- Normal
- Fire
- Emergency/fault conditions

Maintenance Instructions

Provide an annual schedule of all maintenance requirements. For each item, summarise manufacturer's requirements. Provide a schedule of all lubricants.

Equipment Schedules

Provide detailed schedules of all equipment showing type, manufacture, capacity, operating parameters, model Nos., serial Nos., manufacturer and supplier names and contact details.

Testing & Commissioning Data

Warranties

As Installed Drawings

### 14.4 AS INSTALLED DRAWINGS

Drawings shall include, but not be confined to:

- Plant layouts (minimum scale 1:50)
- Duct and equipment layouts including control element locations
- Pipework layout and details with all valves clearly shown and numbered
- Switchboard and control panel diagrams
- Wiring and control diagrams
- Piping and air side schematics, if these have been included in the tender drawings
- Ceiling space sections to indicate typical clearances
- A valve schedule which when read in conjunction with the pipework layout details the function of each valve
- 'As-Installed' drawings shall be incorporated in the operating and maintenance manuals
- Fire rated penetrations
- Manufacturer's requirements
- Fire rated penetrations
- Manufacturer's requirements.

Pay particular attention to the inclusion of identification of all elements subject to testing and commissioning records such that drawings and commissioning records correlate.

## 15.0 DEFECTS PERIOD OBLIGATIONS

### 15.1 ROUTINE MAINTENANCE

Routinely maintain equipment and systems as detailed in the O&M manuals **on a monthly basis**.

### 15.2 SERVICE CALL OUTS

Attend to service call outs within 2 hours. No charges shall be applied to any call outs unless the cause can clearly demonstrated to be the Principal at fault.

### 15.3 WARRANTY

Warrant the works for labour and materials for the duration of the Defects Liability Period.

### 15.4 RECORDS

Monthly, submit to the Principal and Superintendent, a summary of all attendances, servicing and maintenance activities, accompanied by signed records of each event.

### 15.5 PERFORMANCE TESTING

In the presence of the Superintendent, conduct performance tests at times of design ambient conditions, to demonstrate performance and capacity of the systems.

Prior to tests, submit a detailed testing procedure including program, methodology and samples of all proposed records.

### 15.6 FINE TUNING

On a quarterly basis undertake fine tuning of the controls systems to the direction of the Superintendent.

This process shall at minimum involve:

- Review of trend logs
- Review of control changes during the past 3 months
- Review of afterhours logs
- Adjustment of control parameters to improve energy efficiency
- Updating of the controls FD
- Providing a summary report on tuning work undertaken in the quarter

## 16.0 TECHNICAL SCHEDULES

### 16.1 CHILLERS

| | Unit | CH 01 & CHR 02 |
|---|---|---|
| No. Off | | 2 |
| Capacity Each | kWr | 450 |
| Compressor | | |
| No Off | | Single or Multiple |
| Type | | VSD Mag Bearing |
| Min. Chiller Capacity | % | 15 |
| Refrigerant | | R134a |
| IPLV (min) | kWe/kWr | 10.9 |
| Evaporator | | |
| Flow | l/s | 15.3 |
| Inlet Temp | $^{O}C$ | 14.0 |
| Outlet Temp | $^{O}C$ | 7.0 |
| Max Water PD | kPa | 35 |
| Condenser | | |
| Flow | l/s | 22.7 |
| Inlet Temp | $^{O}C$ | 29.5 |
| Outlet Temp | $^{O}C$ | 35.0 |
| Max Water PD | kPa | 45 |

## 16.2 COOLING TOWERS

| | Unit | CT 01 &CT02 |
|---|---|---|
| No. Off | | 2 |
| No. Cells Each | | 1 |
| Capacity Each | kW | 670 |
| Water Flow Each | l/s | 29.2 |
| Water On | $^{O}$C | 35.0 |
| Water Off | $^{O}$C | 29.5 |
| Ambient | $^{O}$CWB | 24.0 |
| Distribution Nozzles | Type | Low Pressure Drop |
| Fan | No Off | 1 |
| - Type | | Low Noise |
| - Motor (Maximum) | kW | 2 x 7.5 |
| - Motor Efficiency | | AS 1359.5 High Efficiency |
| - Fan Starting | | VSD |
| - Fan Shaft | Type | 316 SS |
| Hardware | Type | 304 SS |
| Noise Level SWL (dB)<br>63Hz<br>125Hz<br>250Hz<br>500 Hz<br>1000Hz<br>2000Hz<br>4000Hz<br>8000Hz | | <br>90<br>90<br>89<br>87<br>83<br>78<br>72<br>64 |

## 16.3 PUMPS

| | Unit | CHWP 01 & 02 | CWP 02 & 03 |
|---|---|---|---|
| No. Off | | 2 | 2 |
| Flow Each | l/s | 15.3 | 22.7 |
| Head | kPa | 200 | 180 |
| Minimum Efficiency | % | 75.0 | 75.0 |
| Motor Speed | r/s | 24 | 24 |
| Motor Size | kW | 5.5 | 7.5 |
| Motor Starting | | VSD | VSD |
| Motor Efficiency | | AS 1359.5 High Efficiency | AS 1359.5 High Efficiency |

| | Unit | PCWP 01 & 02 | SCWP 01 & 02 |
|---|---|---|---|
| No. Off | | 2 | 2 |
| Flow Each | l/s | 13.7 | 13.7 |
| Head | kPa | 150 | 200 |
| Minimum Efficiency | % | 75.0 | 75.0 |
| Motor Speed | r/s | 24 | 24 |
| Motor Size | kW | 3.0 | 3.0 |
| Motor Starting | | VSD | VSD |
| Motor Efficiency | | AS 1359.5 High Efficiency | AS 1359.5 High Efficiency |

### 16.4 PLATE HEAT EXCANGERS

| | | HX R.01 | HX R.02 |
|---|---|---|---|
| Location | | Roof | Roof |
| Serving | | SCCW | SCCW |
| Capacity | (kW) | 315 | 315 |
| Hot Side | | | |
| WQ | (l/s) | 13.7 | 13.7 |
| EWT | ($^{O}$C) | 35.5 | 35.5 |
| LWT | ($^{O}$C) | 30.0 | 30.0 |
| PD | (kPa) | 30.0 | 30.0 |
| Cold Side | | | |
| WQ | (l/s) | 13.7 | 13.7 |
| EWT | ($^{O}$C) | 28.5 | 28.5 |
| LWT | ($^{O}$C) | 34.0 | 34.0 |
| PD | (kPa) | 30.0 | 30.0 |

## 16.5 AIR HANDLING AND FAN COIL UNITS

**Common Conditions/Requirements**

| | | |
|---|---|---|
| Max Cooling Coil Air PD | Pa | 120 |
| Max Cooling Coil Water PD | kPa | 40 |
| Chilled Water On/Off | $^{O}C$ | 7.0/14.0 |
| Max Heating Coil Air PD | Pa | 30 |
| Max Heating Coil Water PD | kPa | 20 |
| Heating Water On/Off | $^{0}C$ | 80.0/60.0 |
| Motor Efficiency | | AS 1359.5 High Efficiency |

**Common Note**

External fan static pressure refers to pressure loss in the ductwork system and **excludes** losses across internal components such as coils and filters (allow mid-life loss of 150 Pa).

| Tag | No. | Air Quantity | | Cooling | | | | Heating | | SA Fan | | RA Fan | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SAQ | OAQ | GTH | GTSH | Air On | | | Air On | Ext. Static | kW | Ext. Static | kW |
| | | l/s | l/s | kW | kW | CDB | CWB | kW | CDB | | | | |
| AHU 01 | 1 | 7023 | 1569 | 147 | 127 | 27.4 | 18.5 | 75 | 16.4 | 250 | 5.5 | 220 | 5.5 |
| AHU 02 | 1 | 5583 | 1440 | 128 | 109 | 28.5 | 18.8 | 65 | 15.8 | 250 | 5.5 | 220 | 5.5 |
| AHU 03 | 1 | 16653 | 5558 | 405 | 336 | 29.5 | 19.3 | 160 | 14.6 | 250 | 15.00 | 220 | 11.00 |

## 16.6 WATER COOLED PACKAGE UNITS

| Tag | No. | Air Quantity | | Cooling | | | | Heater |
|---|---|---|---|---|---|---|---|---|
| | | SAQ | OAQ | GTH | GTSH | Air On | | |
| | | l/s | l/s | kW | kW | CDB | CWB | kW |
| WCPU G.01 | 1 | 450 | 90 | 7.7 | 6.2 | 26.9 | 18.3 | 4.0 |
| WCPU G.02 | 1 | 750 | 160 | 14.1 | 10.9 | 26.7 | 18.2 | 6.0 |
| WCPU G.03 | 1 | 600 | 125 | 11.8 | 9.2 | 26.7 | 18.2 | 6.0 |
| WCPU G.04 | 1 | 550 | 55 | 11.2 | 8.6 | 25.3 | 16.9 | 6.0 |
| WCPU G.05 | 1 | 750 | 90 | 13.6 | 10.6 | 25.6 | 17.0 | 6.0 |
| WCPU G.06 | 1 | 700 | 150 | 14.0 | 10.5 | 26.8 | 18.3 | 6.0 |
| WCPU G.07 | 1 | 450 | 130 | 8.1 | 6.4 | 28.3 | 19.4 | 5.0 |
| WCPU M.01 | 1 | 830 | 350 | 18.6 | 15.0 | 29.4 | 19.7 | 9.0 |

## 16.7 ATTENUATORS

| Location | Roof | Roof | Roof |
|---|---|---|---|
| Designation | ATT-SPF R.01 | ATT-SPF R.02 | ATT-SEF R.01 |
| Quantity | 1 | 1 | 1 |
| Air Volume (L/s) | 6000 | 6000 | 6000 |
| Pressure Drop (Pa) | 2 | 2 | 27 |
| Type | Circ. | Circ. | Rect. |
| Ext Diameter (mm) | 970 | 970 | N/A |
| Length (mm) | 1500 | 1500 | 1200 |
| Width (mm) | 800 | 800 | 1050 |
| Height (mm) | N/A | N/A | 1050 |
| Insertion Loss 63Hz | 5 | 5 | 4 |
| Insertion Loss 125Hz | 8 | 8 | 8 |
| Insertion Loss 500Hz | 22 | 22 | 31 |
| Insertion Loss 1000Hz | 23 | 23 | 34 |
| Insertion Loss 2000Hz | 16 | 16 | 27 |
| Insertion Loss 4000Hz | 15 | 15 | 18 |
| Insertion Loss 8000Hz | 10 | 10 | 13 |
| Insertion Loss 250Hz | 12 | 12 | 18 |

## 16.8 VAV BOXES

| Line | Tag | Type | Vmax | Vmin | Inlet Dims. | | EDH |
|---|---|---|---|---|---|---|---|
| | | | l/s | l/s | Width | Height | kW |
| 1 | VAV-L1-C1 | Standard | 90 | 36 | 100 | 150 | N/A |
| 2 | VAV-L1-C2 | Standard | 320 | 128 | 200 | 200 | N/A |
| 3 | VAV-L1-C3 | Standard | 320 | 128 | 200 | 200 | N/A |
| 4 | VAV-L1-C4 | Standard | 410 | 164 | 300 | 200 | N/A |
| 5 | VAV-L1-C5 | Standard | 320 | 128 | 200 | 200 | N/A |
| 6 | VAV-L1-C6 | Standard | 300 | 120 | 200 | 200 | N/A |
| 7 | VAV-L1-C7 | Standard | 465 | 186 | 300 | 200 | N/A |
| 8 | VAV-L1-C8 | Standard | 90 | 36 | 100 | 150 | N/A |
| 9 | VAV-L1-N1 | Electric Reheat | 470 | 188 | 300 | 200 | 1.5 |
| 10 | VAV-L1-N2 | Electric Reheat | 460 | 184 | 300 | 200 | 1.5 |
| 11 | VAV-L1-S1 | Electric Reheat | 360 | 144 | 300 | 200 | 1.5 |
| 12 | VAV-L1-S2 | Electric Reheat | 350 | 140 | 300 | 200 | 1.5 |
| 13 | VAV-L2-C1 | Standard | 430 | 172 | 300 | 200 | N/A |
| 14 | VAV-L2-C2 | Standard | 320 | 128 | 200 | 200 | N/A |
| 15 | VAV-L2-C3 | Standard | 405 | 162 | 300 | 200 | N/A |
| 16 | VAV-L2-C4 | Standard | 320 | 128 | 200 | 200 | N/A |
| 17 | VAV-L2-C5 | Standard | 470 | 188 | 300 | 200 | N/A |
| 18 | VAV-L2-C6 | Standard | 470 | 188 | 300 | 200 | N/A |
| 19 | VAV-L2-N1 | Electric Reheat | 485 | 194 | 300 | 200 | 1.5 |
| 20 | VAV-L2-N2 | Electric Reheat | 485 | 194 | 300 | 200 | 1.5 |
| 21 | VAV-L2-S1 | Electric Reheat | 360 | 144 | 300 | 200 | 1.5 |
| 22 | VAV-L2-S2 | Electric Reheat | 350 | 140 | 300 | 200 | 1.5 |
| 23 | VAV-L3-C1 | Standard | 430 | 172 | 300 | 200 | N/A |
| 24 | VAV-L3-C2 | Standard | 320 | 128 | 200 | 200 | N/A |
| 25 | VAV-L3-C3 | Standard | 410 | 164 | 300 | 200 | N/A |
| 26 | VAV-L3-C4 | Standard | 320 | 128 | 200 | 200 | N/A |
| 27 | VAV-L3-C5 | Standard | 475 | 190 | 300 | 200 | N/A |
| 28 | VAV-L3-N1 | Electric Reheat | 450 | 180 | 300 | 200 | 1.5 |
| 29 | VAV-L3-N2 | Electric Reheat | 450 | 180 | 300 | 200 | 1.5 |
| 30 | VAV-L3-S1 | Electric Reheat | 360 | 144 | 300 | 200 | 1.5 |
| 31 | VAV-L3-S2 | Electric Reheat | 350 | 140 | 300 | 200 | 1.5 |
| 32 | VAV-L4-C1 | Standard | 465 | 186 | 300 | 200 | N/A |
| 33 | VAV-L4-C2 | Standard | 320 | 128 | 200 | 200 | N/A |
| 34 | VAV-L4-C3 | Standard | 410 | 164 | 300 | 200 | N/A |
| 35 | VAV-L4-C4 | Standard | 320 | 128 | 200 | 200 | N/A |
| 36 | VAV-L4-C5 | Standard | 475 | 190 | 300 | 200 | N/A |
| 37 | VAV-L4-N1 | Electric Reheat | 485 | 194 | 300 | 200 | 1.5 |
| 38 | VAV-L4-N2 | Electric Reheat | 485 | 194 | 300 | 200 | 1.5 |
| 39 | VAV-L4-S1 | Electric Reheat | 360 | 144 | 300 | 200 | 1.5 |
| 40 | VAV-L4-S2 | Electric Reheat | 350 | 140 | 300 | 200 | 1.5 |
| 41 | VAV-L5-C1 | Standard | 465 | 186 | 300 | 200 | N/A |
| 42 | VAV-L5-C2 | Standard | 320 | 128 | 200 | 200 | N/A |
| 43 | VAV-L5-C3 | Standard | 410 | 164 | 300 | 200 | N/A |
| 44 | VAV-L5-C4 | Standard | 320 | 128 | 200 | 200 | N/A |

| Line | Tag | Type | Vmax | Vmin | Inlet Dims. | | EDH |
|---|---|---|---|---|---|---|---|
| | | | l/s | l/s | Width | Height | kW |
| 45 | VAV-L5-C5 | Standard | 475 | 190 | 300 | 200 | N/A |
| 46 | VAV-L5-N1 | Electric Reheat | 485 | 194 | 300 | 200 | 1.5 |
| 47 | VAV-L5-N2 | Electric Reheat | 485 | 194 | 300 | 200 | 1.5 |
| 48 | VAV-L5-S1 | Electric Reheat | 360 | 144 | 300 | 200 | 1.5 |
| 49 | VAV-L5-S2 | Electric Reheat | 350 | 140 | 300 | 200 | 1.5 |
| 50 | VAV-L6-C1 | Standard | 465 | 186 | 300 | 200 | N/A |
| 51 | VAV-L6-C2 | Standard | 320 | 128 | 200 | 200 | N/A |
| 52 | VAV-L6-C3 | Standard | 410 | 164 | 300 | 200 | N/A |
| 53 | VAV-L6-C4 | Standard | 320 | 128 | 200 | 200 | N/A |
| 54 | VAV-L6-C5 | Standard | 475 | 190 | 300 | 200 | N/A |
| 55 | VAV-L6-N1 | Electric Reheat | 485 | 194 | 300 | 200 | 1.5 |
| 56 | VAV-L6-N2 | Electric Reheat | 485 | 194 | 300 | 200 | 1.5 |
| 57 | VAV-L6-S1 | Electric Reheat | 360 | 144 | 300 | 200 | 1.5 |
| 58 | VAV-L6-S2 | Electric Reheat | 350 | 140 | 300 | 200 | 1.5 |
| 59 | VAV-L7-C1 | Standard | 465 | 186 | 300 | 200 | N/A |
| 60 | VAV-L7-C2 | Standard | 320 | 128 | 200 | 200 | N/A |
| 61 | VAV-L7-C3 | Standard | 410 | 164 | 300 | 200 | N/A |
| 62 | VAV-L7-C4 | Standard | 320 | 128 | 200 | 200 | N/A |
| 63 | VAV-L7-C5 | Standard | 475 | 190 | 300 | 200 | N/A |
| 64 | VAV-L7-N1 | Electric Reheat | 485 | 194 | 300 | 200 | 1.5 |
| 65 | VAV-L7-N2 | Electric Reheat | 485 | 194 | 300 | 200 | 1.5 |
| 66 | VAV-L7-S1 | Electric Reheat | 360 | 144 | 300 | 200 | 1.5 |
| 67 | VAV-L7-S2 | Electric Reheat | 350 | 140 | 300 | 200 | 1.5 |
| 68 | VAV-L8-I1 | Standard | 450 | 180 | 300 | 200 | N/A |
| 69 | VAV-L8-I2 | Standard | 340 | 136 | 200 | 200 | N/A |
| 70 | VAV-L8-I3 | Standard | 430 | 172 | 300 | 200 | N/A |
| 71 | VAV-L8-I4 | Standard | 340 | 136 | 200 | 200 | N/A |
| 72 | VAV-L8-I5 | Standard | 490 | 196 | 300 | 200 | N/A |
| 73 | VAV-L8-N1 | Electric Reheat | 430 | 172 | 300 | 200 | 1.5 |
| 74 | VAV-L8-N2 | Electric Reheat | 380 | 152 | 300 | 200 | 1.5 |
| 75 | VAV-L8-S1 | Electric Reheat | 375 | 150 | 300 | 200 | 1.5 |
| 76 | VAV-L8-S2 | Electric Reheat | 365 | 146 | 300 | 200 | 1.5 |

## 16.9 FANS & COWLS

| Location | Roof | Roof | Roof | Ground | Roof | Roof | Roof |
|---|---|---|---|---|---|---|---|
| Designation | SEF R.01 | SPF R.01 | SPF R.02 | TEF G.01 | TEF R.01A & B | TEF R.02A & B | EF R.01 |
| Fan Quantity | 1 | 1 | 1 | 1 | 2 | 2 | 1 |
| Impeller Type | Axial | Axial | Axial | Centrifugal | Axial | Mixed Flow | Centrifugal |
| Air Volume (L/s) | 6000 | 6000 | 6000 | 610 | 2250 | 1015 | 400 |
| Static Pressure (Pa) | 200 | 200 | 200 | 125 | 250 | 250 | 100 |
| Fan Speed (RPM) | 1440 | 1440 | 1440 | 900 | 1440 | 1173 | 660 |
| Motor Power | 2.2 kW | 2.42 kW (AOM) | 2.42 kW (AOM) | 0.44 kW | 1.65 kW (AOM) | 1.1 kW | 0.15 kW |
| Electrical Supply | 415V 3ph 50Hz | 415V 3ph 50Hz | 415V 3ph 50Hz | 415V 3ph 50Hz | 415V 3ph 50Hz | 415V 3ph 50Hz | 415V 3ph 50Hz |
| Inlet dB(A) | 71 @ 3m | 70 @ 3m | 70 @ 3m | 46 @ 3m | 53 @ 3m | 48 @ 3m | 41 @ 3m |
| Design Selection | APS1004GA3/15 | AP0804KP6/27+C2 | AP0804KP6/27+C2 | TILD456 | AP0564LP12/26 | PUD454DD | CD458D |

| Location | Roof | Roof | Roof |
|---|---|---|---|
| Designation | RC.01 | RC.02 | RC.03 |
| Fan Quantity | 1 | 1 | 1 |
| Air Volume (L/s) | 2250 | 1015 | 0 |
| Static Pressure (Pa) | 30 | 30 | 0 |
| Design Selection | RVV4 | RVV3 | RV3 |

**17.0**

## 17.0 MSSB SCHEDULES

| Level | Location | MSSB | Metering By | Tag | ITEM | kW | Phase | Start | FLA | EMD Normal | | | EMD Essential | | | Rec. Submain | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Metering Tag | | | | | | | R | Y | B | R | Y | B | Normal | Ess |
| **Roof** | **Plantroom** | **R.01** | **Mechanical** | | | | | | | | | | | | | **500** | |
| | | | R.01.01 | CH 01 | Chiller 01 | | 3 | VSD | 132.0 | 120.0 | 120.0 | 120.0 | | | | | |
| | | | R.01.01 | CH 02 | Chiller 02 | | 3 | VSD | 132.0 | 120.0 | 120.0 | 120.0 | | | | | |
| | | | R.01.01 | CT 01 | Cooling Tower 01 | 4.00 | 3 | VSD | 8.0 | 8.0 | 8.0 | 8.0 | | | | | |
| | | | R.01.01 | CT 02 | Cooling Tower 02 | 4.00 | 3 | VSD | 8.0 | 8.0 | 8.0 | 8.0 | | | | | |
| | | | R.01.02 | HW 01 | Heating Water Unit 01 | 1.50 | 3 | DOL | | | | | | | | | |
| | | | R.01.02 | HW 02 | Heating Water Unit 02 | 1.50 | 3 | DOL | | | | | | | | | |
| | | | R.01.01 | CHWP 01 | Chilled Water Pump 01 | 11.00 | 3 | VSD | 21.0 | 15.0 | 15.0 | 15.0 | | | | | |
| | | | R.01.01 | CHWP 02 | Chilled Water Pump 02 | 11.00 | 3 | VSD | 21.0 | 15.0 | 15.0 | 15.0 | | | | | |
| | | | R.01.01 | CWP 01 | Condenser Water Pump 01 | 11.00 | 3 | VSD | 21.0 | 15.0 | 15.0 | 15.0 | | | | | |
| | | | R.01.01 | CWP 02 | Condenser Water Pump 02 | 11.00 | 3 | VSD | 21.0 | 15.0 | 15.0 | 15.0 | | | | | |
| | | | R.01.02 | HWP 01 | Heating Water Pump 01 | 3.00 | 3 | VSD | 6.0 | | | | | | | | |
| | | | R.01.02 | HWP 02 | Heating Water Pump 02 | 3.00 | 3 | VSD | 6.0 | | | | | | | | |
| | | | R.01.03 | PCWP 01 | Primary Condenser Water Pump 01 | 3.00 | 3 | VSD | 6.0 | 5.0 | 5.0 | 5.0 | | | | | |
| | | | R.01.03 | PCWP 02 | Primary Condenser Water Pump 02 | 3.00 | 3 | VSD | 6.0 | 5.0 | 5.0 | 5.0 | | | | | |
| | | | R.01.03 | SCWP 01 | Secondary Condenser Water Pump 01 | 5.50 | 3 | VSD | 10.0 | 8.0 | 8.0 | 8.0 | | | | | |
| | | | R.01.03 | SCWP 02 | Secondary Condenser Water Pump 02 | 5.50 | 3 | VSD | 10.0 | 8.0 | 8.0 | 8.0 | | | | | |
| | | | R.01.03 | AHU 01 | Air Handling Unit 01 - North RAF | 5.50 | 3 | VSD | 10.0 | 8.0 | 8.0 | 8.0 | | | | | |
| | | | R.01.03 | AHU 02 | Air Handling Unit 01 - Centre RAF | 5.50 | 3 | VSD | 10.0 | 8.0 | 8.0 | 8.0 | | | | | |
| | | | R.01.03 | AHU 03 | Air Handling Unit 01 - Centre RAF | 11.00 | 3 | VSD | 21.2 | 18.0 | 18.0 | 18.0 | | | | | |
| | | | R.01.04 | TEF R.01 | Toilet Exhaust Fan R.01 - Duty | 2.24 | 3 | VSD | 4.6 | 4.0 | 4.0 | 4.0 | | | | | |
| | | | R.01.04 | TEF R.01 | Toilet Exhaust Fan R.01 - Standby | 2.24 | 4 | VSD | 4.6 | | | | | | | | |
| | | | R.01.04 | TEF R.02 | Toilet Exhaust Fan R.02 - Duty | 0.77 | 5 | VSD | 1.8 | 1.5 | 1.5 | 1.5 | | | | | |
| | | | R.01.04 | TEF R.02 | Toilet Exhaust Fan R.02 - Standby | 0.77 | 6 | VSD | 1.8 | | | | | | | | |
| | | | R.01.01 | | Controls | | 1 | DOL | 1.8 | | | 10.0 | | | | | |
| | | | | | | | | | | **381.5** | **381.5** | **391.5** | | | | | |

| Level | Location | MSSB | Metering By | Tag | ITEM | kW | Phase | Start | FLA | EMD Normal | | | EMD Essential | | | Rec. Submain | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Metering Tag | | | | | | | R | Y | B | R | Y | B | Normal | Ess |
| **Roof** | **Plantroom** | **R.02** | **Mechanical** | | | | | | | | | | | | | | **60** |
| | | | R.02.01 | AHU R01 | Air Handling Unit 01 - North SAF | 5.50 | 3 | VSD | 10.0 | | | | 8.0 | 8.0 | 8.0 | | |
| | | | R.02.01 | AHU R02 | Air Handling Unit 01 - Centre SAF | 5.50 | 3 | VSD | 10.0 | | | | 8.0 | 8.0 | 8.0 | | |
| | | | R.02.01 | AHU R03 | Air Handling Unit 01 - South RAF | 15.00 | 3 | VSD | 29.2 | | | | 25.0 | 25.0 | 25.0 | | |
| | | | R.02.02 | SPF 01 | Stair Pressurisation Fan 01 | 2.20 | 3 | VSD | 4.4 | | | | | | | | |
| | | | R.02.02 | SPF 02 | Stair Pressurisation Fan 02 | 2.20 | 3 | VSD | 4.4 | | | | | | | | |
| | | | R.02.02 | SEF 01 | Smoke Exhaust Fan 01 | 2.20 | 3 | VSD | 4.4 | | | | | | | | |
| | | | R.02.01 | | Controls | | 1 | DOL | 10.0 | | | | 5.0 | | | | |
| | | | | | | | | | | | | | **46.0** | **41.0** | **41.0** | | |
| | | | | | | | | | | | | | | | | | |
| **Typ. Floor** | **Elec Room** | ***.01** | | VAV *N.01 EDH | VAV EDH | 1.20 | 1 | DOL | 5.0 | 5.0 | | | | | | **15** | |
| | | | | VAV *N.02 EDH | VAV EDH | 1.20 | 1 | DOL | 5.0 | | 5.0 | | | | | | |
| | | | | VAV *S.01 EDH | VAV EDH | 1.50 | 1 | DOL | 6.3 | | | 6.3 | | | | | |
| | | | | VAV *S.02 EDH | VAV EDH | 1.50 | 1 | DOL | 6.3 | 6.3 | | | | | | | |
| | | | | | Controls | | | | 5.0 | | 5.0 | | | | | | |
| | | | | | | | | | | **11.3** | **10.0** | **6.3** | | | | | |
| | | | | | | | | | | | | | | | | | |
| **GF** | **Control Room** | **G.01** | **Mechanical** | | | | | | | | | | | | | **25** | |
| | | | | WCPU G.07 | WCPU - Entry Lobby | | 1 | DOL | 11.2 | | | 11.2 | | | | | |
| | | | | WCPU M.01 | WCPU - Mezzanine | | 3 | DOL | 13.1 | 13.1 | 8.8 | 8.5 | | | | | |
| | | | | TEF G01 | Toilet Exhaust Fan - Duty | 0.44 | 3 | DOL | 1.2 | 1.2 | 1.2 | 1.2 | | | | | |
| | | | | TEF G01 | Toilet Exhaust Fan - Standby | 0.44 | 3 | DOL | 1.2 | | | | | | | | |
| | | | | | Controls | | | | | | 5.0 | | | | | | |
| | | | | | | | | | | **14.3** | **15.0** | **20.9** | | | | | |

| Level | Location | MSSB | Metering By | Tag | ITEM | kW | Phase | Start | FLA | EMD Normal | | | EMD Essential | | | Rec. Submain | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Metering Tag | | | | | | | R | Y | B | R | Y | B | Normal | Ess |
| **Basement** | **Carpark** | **B.01** | **Mechanical** | | | | | | | | | | | | | | |
| | | | | EAF B01 | Carpark Exhaust Fan | 3.00 | 3 | VSD | 6.0 | 5.0 | 5.0 | 5.0 | | | | **15** | |
| | | | | | Controls | | | | | 2.0 | | | | | | | |
| | | | | | | | | | | **7.0** | **5.0** | **5.0** | | | | | |

## 17.1 DDC SCHEDULE

| MSSB | Tag | Description | AI | AO | DI | DO | HLI | Point Loc'n | Comment |
|---|---|---|---|---|---|---|---|---|---|
| **R.01** | Weather Station 01 | **Outside Air Economy Cycle Inputs** | | | | | | MSSB | VAISALA HMT series ±2% accuracy |
| | | Ambient Dry Bulb | 1 | | | | | MSSB | |
| | | Ambient RH | 1 | | | | | MSSB | |
| | Weather Station 02 | **Outside Air Economy Cycle Inputs** | | | | | | MSSB | VAISALA HMT series ±2% accuracy |
| | | Ambient Dry Bulb | 1 | | | | | MSSB | |
| | | Ambient RH | 1 | | | | | MSSB | |
| | | **Chilled Water System** | | | | | | | |
| | | System Differential Pressure | 1 | | | | | | |
| | | Bypass Valve | | 1 | | | | | |
| | | **Heating Water System** | | | | | | | |
| | | Bypass Valve | | 1 | | | | | |
| | | **Water Treatment System** | | | | | | | |
| | | Controller | | | | | 1 | | |
| | | Make-up Water Meter | 1 | | | | | | |
| | | Bleed Water Meter | 1 | | | | | | |
| | | **Fire Indicator Panel** | | | | | | | |
| | | GFA | | | | | | | Utilise incoming fire signal |
| | CH 01 | Chiller 01 | | | | | 1 | MSSB | HLI via VSD |
| | | Evaporator DP | 1 | | | | | MSSB | |
| | | Condenser DP | 1 | | | | | | |
| | CH 02 | Chiller 02 | | | | | 1 | MSSB | HLI via VSD |
| | | Evaporator DP | 1 | | | | | MSSB | |
| **MSSB** | **Tag** | **Description** | **AI** | **AO** | **DI** | **DO** | **HLI** | **Point Loc'n** | **Comment** |
| | | Condenser DP | 1 | | | | | | |
| | CT 01 | Cooling Tower | | | | | | | |
| | | Fan | | | | | 1 | VSD | HLI via VSD |
| | | Inlet Valve | | | | 1 | | MSSB | |
| | | Outlet Valve | | | | 1 | | MSSB | |
| | | Outlet Temp | 1 | | | | | MSSB | |

| MSSB | Tag | Description | AI | AO | DI | DO | HLI | Point Loc'n | Comment |
|---|---|---|---|---|---|---|---|---|---|
| | CT 02 | Cooling Tower | | | | | | | |
| | | Fan | | | | | 1 | VSD | HLI via VSD |
| | | Inlet Valve | | | | 1 | | MSSB | |
| | | Outlet Valve | | | | 1 | | MSSB | |
| | | Outlet Temp | 1 | | | | | MSSB | |
| | HWU 01 | Heating Water Unit | | | 1 | 1 | | MSSB | Initiate,Status/Fault |
| | | Flow Temp | 1 | | | | | MSSB | |
| | | DPS | 1 | | | | | MSSB | |
| | HWU 02 | Heating Water Unit | | | 1 | 1 | | MSSB | Initiate,Status/Fault |
| | | Flow Temp | 1 | | | | | MSSB | |
| | | DPS | 1 | | | | | MSSB | |
| | CHWP 01 | Chilled Water Pump 01 | | | | | 1 | VSD | HLI via VSD |
| | CHWP 02 | Chilled Water Pump 02 | | | | | 1 | VSD | HLI via VSD |
| | CWP 01 | Condenser Water Pump 01 | | | | | 1 | VSD | HLI via VSD |
| | CWP 02 | Condenser Water Pump 02 | | | | | 1 | VSD | HLI via VSD |
| | HWP 01 | Heating Water Pump 01 | | | | | 1 | VSD | HLI via VSD |
| | HWP 02 | Heating Water Pump 02 | | | | | 1 | VSD | HLI via VSD |
| | PCWP 01 | Primary Condenser Water Pump 01 | | | | | 1 | VSD | HLI via VSD |
| | PCWP 02 | Primary Condenser Water Pump 02 | | | | | 1 | VSD | HLI via VSD |
| | SCWP 01 | Secondary Condenser Water Pump 01 | | | | | 1 | VSD | HLI via VSD |
| | HX-01 | Heat Exchanger | | | | | | MSSB | |
| | | Primary Inlet Temp | 1 | | | | | MSSB | |
| | | Primary Outlet Temp | 1 | | | | | MSSB | |
| | | Primary Control Valve | | 1 | | | | | |
| | | Sec. Inlet Temp | 1 | | | | | MSSB | |
| | | Sec. Outlet Temp | 1 | | | | | MSSB | |
| | HX-02 | Heat Exchanger | | | | | | MSSB | |
| | | Primary Inlet Temp | 1 | | | | | MSSB | |
| | | Primary Outlet Temp | 1 | | | | | MSSB | |
| | | Primary Control Valve | | 1 | | | | | |

| MSSB | Tag | Description | AI | AO | DI | DO | HLI | Point Loc'n | Comment |
|---|---|---|---|---|---|---|---|---|---|
| | | Sec. Inlet Temp | 1 | | | | | MSSB | |
| | | Sec. Outlet Temp | 1 | | | | | MSSB | |
| | TEF R.01 | Toilet Exhaust Fan R.01 - Duty | | | | | 1 | VSD | HLI via VSD |
| | TEF R.01 | Toilet Exhaust Fan R.01 - Standby | | | | | 1 | VSD | HLI via VSD |
| | TEF R.02 | Toilet Exhaust Fan R.02 - Duty | | | | | 1 | VSD | HLI via VSD |
| | TEF R.02 | Toilet Exhaust Fan R.02 - Standby | | | | | 1 | VSD | HLI via VSD |
| **R.02** | AHU 01 | Air Handling Unit | | | | | | | |
| | | Supply Air Fan | | | | | 1 | VSD | HLI via VSD |
| | | Supply Air Static | 1 | | | | | MSSB | |
| | | Return Air Fan | | | | | 1 | VSD | HLI via VSD |
| | | Supply Air Temp | 1 | | | | | MSSB | |
| | | RA Temp | 1 | | | | | MSSB | |
| | | Air on Coil DB | 1 | | | | | | |
| | | CHW Valve | | 1 | | | | MSSB | |
| | | HW Valve | | 1 | | | | | |
| | | Min OA Damper | | 1 | | | | MSSB | |
| | | RA Dampers | | 1 | | | | MSSB | |
| | | Econ Dampers | | 1 | | | | MSSB | |
| | | Filter DP | 1 | | | | | MSSB | |
| | AHU 02 | Air Handling Unit | | | | | | | |
| | | Supply Air Fan | | | | | 1 | VSD | HLI via VSD |
| | | Supply Air Static | 1 | | | | | MSSB | |
| | | Return Air Fan | | | | | 1 | VSD | HLI via VSD |
| | | Supply Air Temp | 1 | | | | | MSSB | |
| | | RA Temp | 1 | | | | | MSSB | |
| | | Air on Coil DB | 1 | | | | | | |
| | | CHW Valve | | 1 | | | | MSSB | |
| | | HW Valve | | 1 | | | | | |
| | | Min OA Damper | | 1 | | | | MSSB | |
| | | RA Dampers | | 1 | | | | MSSB | |

| MSSB | Tag | Description | AI | AO | DI | DO | HLI | Point Loc'n | Comment |
|---|---|---|---|---|---|---|---|---|---|
| | | Econ Dampers | | 1 | | | | MSSB | |
| | | Filter DP | 1 | | | | | MSSB | |
| | AHU 03 | Air Handling Unit | | | | | | | |
| | | Supply Air Fan | | | | | 1 | VSD | HLI via VSD |
| | | Supply Air Static | 1 | | | | | MSSB | |
| | | Return Air Fan | | | | | 1 | VSD | HLI via VSD |
| | | Supply Air Temp | 1 | | | | | MSSB | |
| | | RA Temp | 1 | | | | | MSSB | |
| | | Air on Coil DB | 1 | | | | | | |
| | | CHW Valve | | 1 | | | | MSSB | |
| | | HW Valve | | 1 | | | | | |
| | | Min OA Damper | | 1 | | | | MSSB | |
| | | RA Dampers | | 1 | | | | MSSB | |
| | | Econ Dampers | | 1 | | | | MSSB | |
| | | Filter DP | 1 | | | | | MSSB | |
| | SPF 01 | Stair Pressurisation Fan 01 | | | | | 1 | VSD | HLI via VSD |
| | SPF 02 | Stair Pressurisation Fan 02 | | | | | 1 | VSD | HLI via VSD |
| | SEF 01 | Smoke Exhaust Fan 01 | | | | | 1 | VSD | HLI via VSD |
| **L04 - L08 (5 off)** | | RA Damper | | | | 5 | | | |
| | | SA Dampers | | | | 15 | | | |
| | | Tenant OA Damper | | | | 5 | | | |
| | | Tenant Dirty Exh Damper | | | | 5 | | | |
| | | VAV's | | | | | 45 | 45 | Small point controllers |
| | | Tenant SCCW Cooling Demand | | | 15 | | | | Allow 3 tenants per floor |
| **L01 - L03 (3 off)** | | RA Damper | | | | 3 | | | |
| | | SA Dampers | | | | 9 | | | |
| | | Tenant OA Damper | | | | 3 | | | |
| | | Tenant Dirty Exh Damper | | | | 3 | | | |
| | | VAV's | | | | | 31 | 45 | Small point controllers |
| | | Tenant SCCW Cooling Demand | | | 9 | | | | Allow 3 tenants per floor |

| MSSB | Tag | Description | AI | AO | DI | DO | HLI | Point Loc'n | Comment |
|---|---|---|---|---|---|---|---|---|---|
| **G.01** | WCPU G.07 | WCPU - Entry Lobby | | | | | 1 | | |
| | WCPU M.01 | WCPU - Mezzanine | | | | | 1 | | |
| | TEF G01 | Toilet Exhaust Fan - Duty | | | 1 | 1 | | | +ve flow sensing via smart current switches |
| | | Toilet Exhaust Fan - Standby | | | 1 | 1 | | | +ve flow sensing via smart current switches |
| **B.01** | EAF B01 | Carpark Exhaust Fan | | | | | 1 | VSD | HLI via VSD |
| | | CO Sensors | | 3 | | | | | |
| | | **Hydraulic Services** | | | | | | | |
| | | Main Gas Meter | 1 | | | | | | Located @ site boundary |
| | | Main Water Meter | 1 | | | | | | Located @ site boundary |
| | | Pump Status | | | 3 | | | | Located in Basement |
| | | Pump Alarms | | | 3 | | | | Located in Basement |
| | | **Fire Services** | | | | | | | |
| | | Jacking Pump Status | | | 1 | | | | Located in Basement Pump Room |
| | | **Electrical Services** | | | | | | | |
| | | Metering Systems | | | | | 1 | | HLI to Integrated Metering System |

# 19.0 TENDER SCHEDULES

## 19.1 PROPOSED MECHANICAL SERVICES CONTRACTOR

| Item | Details |
|---|---|
| Company | |
| Contact for Tender Queries | |

## 19.2 MECHANICAL SERVICES CONTRACTOR - KEY PERSONNEL

| Role | Name |
|---|---|
| Project Manager | |
| Project Engineer | |
| Site Manager | |
| Commissioning Engineer | |

## 19.3 EQUIPMENT SCHEDULES

| Item | Manufacturer | Series/Model |
|---|---|---|
| Chillers | | |
| Cooling Towers | | |
| Pumps | | |
| Plate Heat Exchangers | | |
| Air Handling Units | | |
| Water Cooled Package Units | | |
| VAV Boxes | | |
| Fans | | |
| Filters | | |
| Attenuators | | |
| Air Diffusion | | |
| Vibration Isolation | | |

## 19.4 SCHEDULE OF SUB CONTRACTORS

| Trade | Company |
|---|---|
| Ductwork Manufacture | |
| Ductwork Installation | |
| Electrical | |
| Controls | |
| Piping | |
| Water Treatment | |
| Painting | |
| Commissioning | |

## 19.5 TENDER SUM BREAKDOWN (EXCL GST)

| Item | Total |
|---|---|
| Mobilisation | |
| Equipment supply | |
| Equipment install | |
| Ductwork manufacture | |
| Ductwork installation | |
| Diffusion equipment supply | |
| Pipework | |
| Pipework Insulation | |
| Electrical | |
| Controls | |
| Engineering & drafting | |
| O&M Manuals, As Con Drawings | |
| Commissioning | |
| Principal Instruction | |
| 12 months DLP Warranty, Maintenance & Fine Tuning | |
| Cranage & cartage | |
| Project Management, Supervision | |
| Miscellaneous | |
| **Totals** | |

| | |
|---|---|
| Mechanical Contractor:…… | Signature:…..…… |
| Date:…… | Name:…… |