

**ST ALOYSIUS COLLEGE  
GYMNASIUM AND  
CLASSROOMS FITOUT**

**SPECIFICATION FOR  
MECHANICAL SERVICES**

**CONSTRUCTION ISSUE**



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**SCHEDULE OF CONTENTS**


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	<b>PAGE NO.</b>
<b>SECTION 1</b>	<b>DESCRIPTION OF INSTALLATION.....1</b>
1.1	GENERAL.....1
1.2	DESCRIPTION OF THE INSTALLATION .....1
1.3	SCHEDULE OF DRAWINGS .....1
<b>SECTION 2</b>	<b>PERFORMANCE AND GUARANTEE.....2</b>
2.1	GENERAL.....2
2.2	DESIGN CRITERIA .....2
2.3	BUILDING DETAILS.....5
<b>SECTION 3</b>	<b>GENERAL REQUIREMENTS .....6</b>
3.1	GENERAL.....6
3.2	WORKS PROGRAMME .....6
3.3	WORKING DIMENSIONS AND TOLERANCES .....6
3.4	PERMITS, NOTICES AND INSPECTIONS.....6
3.5	STANDARDS.....6
3.6	MATERIALS EQUIPMENT AND WORKMANSHIP .....7
3.7	SEALANTS, ADHESIVES AND COATINGS.....7
3.8	SETTING OUT OF OPENINGS AND MAKING GOOD .....7
3.9	ELECTRICAL INTERFERENCE .....8
3.10	BALANCING AND PHASE ROTATION .....8
3.11	PENETRATIONS THROUGH STRUCTURE .....8
3.12	CHASING .....8
3.13	FIXINGS.....8
3.14	WELDING .....9
3.15	FLAME CUTTING.....9
3.16	CO-ORDINATION OF INSTALLATION.....9
3.17	STORAGE AND PROTECTION.....9
3.18	SAMPLES.....10
3.19	SITE CLEANLINESS AND RUBBISH REMOVAL .....10
3.20	CONSTRUCTION DRAWINGS.....10
3.21	CONSTRUCTION DESIGN CALCULATIONS.....11
3.22	EARTHQUAKE LOADING PROVISIONS .....11
3.23	QUALITY ASSURANCE .....11
3.24	MAINTENANCE AND SERVICING ACCESS .....11
<b>SECTION 4</b>	<b>PLANT AND EQUIPMENT .....11</b>
4.1	GENERAL.....11
4.2	AIR CONDITIONING UNITS - MULTI SYSTEM TYPE .....12
4.3	AIR CONDITIONING UNITS - CASSETTE TYPE .....21
4.4	ENERGY RECOVERY VENTILATOR UNITS.....24
4.5	FANS - ROOF MOUNTED .....26
4.6	FANS - MIXED FLOW IN-LINE .....27
4.7	EVAPORATIVE COOLING UNITS.....30
4.8	FUME CUPBOARDS.....31
4.9	ROTARY VENTILATORS.....33
4.10	SAFETY STORAGE CABINETS .....34

	PAGE NO.
<b>SECTION 5</b>	<b>PIPING SYSTEMS .....34</b>
5.1	GENERAL.....34
5.2	SCHEDULE OF MATERIALS.....35
5.3	SUPPORT AND EXPANSION SYSTEMS .....35
5.4	JOINTS AND FITTINGS - COPPER, REFRIGERATION SERVICES .....36
5.5	GRADIENTS AND DRAINS .....36
5.6	TESTING OF PIPING.....36
<b>SECTION 6</b>	<b>AIR DISTRIBUTION SYSTEMS.....36</b>
6.1	GENERAL.....36
6.2	SCHEDULE OF CONSTRUCTION AND INSTALLATION STANDARDS .....37
6.3	CIRCULAR FLEXIBLE DUCTWORK .....37
6.4	SUPPORTS, REINFORCEMENT AND BRACING .....38
6.5	SUPPORTS, UPVC DUCTWORK SYSTEMS .....38
6.6	DUCT MOVEMENT AND VIBRATION.....39
6.7	FLEXIBLE CONNECTIONS .....39
6.8	LEAK TESTING .....39
6.9	BALANCING DAMPERS .....39
6.10	SCHEDULE OF ACOUSTIC LINING .....40
6.11	ACOUSTIC LINING MATERIALS AND INSTALLATION .....40
6.12	AIR DIFFUSION EQUIPMENT .....41
<b>SECTION 7</b>	<b>THERMAL INSULATION .....42</b>
7.1	GENERAL.....42
7.2	SCHEDULE OF INSULATION .....42
7.3	PIPING SYSTEMS INSULATION.....42
7.4	AIR DISTRIBUTION SYSTEMS INSULATION .....43
<b>SECTION 8</b>	<b>ELECTRICAL .....43</b>
8.1	GENERAL.....43
8.2	SCHEDULE OF ELECTRICAL WORKS .....43
8.3	INSTALLATION STANDARDS.....44
8.4	WIRING SYSTEMS .....44
8.5	SWITCHGEAR AND CONTROLGEAR ASSEMBLIES (SCA).....46
8.6	SCHEDULE OF SCA.....51
8.7	SCHEDULE OF POWER SUPPLIES.....55
<b>SECTION 9</b>	<b>CONTROLS.....55</b>
9.1	GENERAL.....55
9.2	SCHEDULE OF CONTROLS SYSTEMS.....55
9.3	CONTROLS HARDWARE.....55
9.4	DIRECT DIGITAL CONTROL SYSTEM (DDC) .....56
9.4.1	GENERAL.....56
9.4.2	CONTROL UNITS.....56
9.4.3	CONTROLLERS .....56
9.4.4	SOFTWARE.....57
9.5	CONTROL FUNCTIONS AND SEQUENCE OF OPERATION.....58

<b>SECTION 10</b>	<b>GENERATED NOISE AND VIBRATION CONTROL .....</b>	<b>60</b>
10.1	GENERAL.....	60
10.2	SCHEDULE OF GENERATED NOISE AND VIBRATION CONTROL SYSTEMS .....	60
10.3	VIBRATION ISOLATION MOUNTS .....	61
<b>SECTION 11</b>	<b>PAINTING IDENTIFICATION AND LABELLING .....</b>	<b>62</b>
11.1	GENERAL.....	62
11.2	SCHEDULE OF PAINTING AND FINISHES.....	62
11.3	PLANT AND EQUIPMENT .....	63
11.4	PIPING SYSTEMS .....	63
11.5	AIR DISTRIBUTION SYSTEMS .....	63
11.6	IDENTIFICATION AND LABELLING .....	64
11.7	SCHEDULE OF COLOURS .....	64
<b>SECTION 12</b>	<b>TESTING AND COMMISSIONING .....</b>	<b>64</b>
12.1	GENERAL.....	64
12.2	INSPECTION AND TEST PLANS .....	65
12.3	PRE-COMMISSIONING PROCEDURES .....	65
12.4	COMMISSIONING PROCEDURES .....	65
12.5	INSTRUMENTATION .....	66
12.6	PERFORMANCE TESTS .....	67
12.7	BUILDING TUNING.....	67
12.8	COMMISSIONING AND PERFORMANCE DATA .....	67
12.9	POST CONTRACT DRAWINGS.....	67
12.10	INSTALLATION MANUAL .....	67
12.11	MAINTENANCE AND TESTING OF SAFETY INSTALLATIONS LOG BOOK INSERTS .....	69
12.12	HANDING OVER AND PRINCIPALS INSTRUCTION .....	69
<b>SECTION 13</b>	<b>MAINTENANCE AND SERVICING .....</b>	<b>70</b>
13.1	GENERAL.....	70
13.2	SCHEDULE OF MAINTENANCE AND SERVICING REQUIREMENTS .....	70
13.3	DOCUMENTATION OF MAINTENANCE AND SERVICING .....	71
13.4	RECTIFICATION OF DEFECTS .....	72
<b>SECTION 14</b>	<b>ASSOCIATED WORKS .....</b>	<b>72</b>
14.1	GENERAL.....	72
14.2	SCHEDULE OF SITE PROVISIONS.....	72
14.3	SCHEDULE OF ASSOCIATED WORKS .....	72
14.4	SCHEDULE OF TERMINATION POINTS.....	72
14.5	PENETRATIONS.....	73
14.6	ENCLOSURES.....	73

**TENDER FORM****TECHNICAL DATA SCHEDULE**





## 1 DESCRIPTION OF INSTALLATION

### 1.1 GENERAL

The Mechanical Services installation described in this Specification is associated with the fitout of the St Aloysius College gymnasium and classrooms.

The site for the project is Angas St, Adelaide, South Australia.

### 1.2 DESCRIPTION OF THE INSTALLATION

Include the following systems and services:-

- air conditioning incorporating air cooled, reverse cycle, variable refrigerant volume systems to general learning areas, computer laboratories, canteen, health care area, offices, weights room, tutorial areas, meeting rooms and uniform shop
- air conditioning incorporating air cooled, cooling only, split system cassette unit to the server room
- air to air, thermal heat recovery ventilator units combined with ducted outdoor and return air systems to provide ventilation to all designated areas
- toilet exhaust system to the ground floor toilets and amenities
- fume cabinet exhaust and storage ventilation systems to the lab preparation area
- kitchen exhaust system to the ground floor canteen
- evaporative cooling incorporating make-up air to the canteen
- piping systems associated with the above systems
- air distribution systems associated with the above systems
- electrical services associated with the above systems
- controls associated with the above systems
- generated noise and vibration control associated with the above systems
- painting, identification and labelling of the plant, equipment, piping systems, air distribution systems, electrical services and control systems associated with the above systems
- testing and commissioning of the above systems
- provision of installation manuals, as installed drawings and inserts for the Maintenance and Testing of Safety Installations Log Book for the above systems
- maintenance and servicing, warranty and defects liability for a period of 52 weeks from the date of practical completion.

### 1.3 SCHEDULE OF DRAWINGS

Drawings associated with, and forming part of, this Specification are scheduled below. The arrangements and details are approximate only. Check all dimensions and building details prior to proceeding with the work.

Drawing No.	Title
52894A M-01	Mechanical Services Site Plan and Drawing Index
52894A M-02	Mechanical Services Ground Floor Air Conditioning Arrangement
52894A M-03	Mechanical Services First Floor Air Conditioning Arrangement
52894A M-04	Mechanical Services Second Floor Air Conditioning Arrangement
52894A M-05	Mechanical Services Third Floor Air Conditioning Arrangement
52894A M-06	Mechanical Services Roof Plan Air Conditioning Arrangement
52894A M-07	Mechanical Services Sections, Details and Legend of Symbols.

## 2 PERFORMANCE AND GUARANTEE

### 2.1 GENERAL

Guarantee the plant and equipment to provide the specified capacities, performance and automatic operation.

Ensure all connected systems operate in a stable, safe and automatic manner to provide optimum efficiency at both full and part load.

Select all system components for continuous, safe, unattended operation at the specified design criteria conditions.

Commission and test the plant to ensure compliance with the performance and guarantee requirements.

### 2.2 DESIGN CRITERIA

Design criteria associated with the installation are listed below.

Item	Design Criteria
Extreme ambient conditions under which all plant shall operate	46.0°C dry bulb maximum 24.0°C wet bulb maximum Full solar load.  -2.0°C dry bulb minimum.
External ambient conditions for air conditioning plant full load performance	38.0°C dry bulb maximum 21.0°C wet bulb maximum Full solar load.  7.0°C dry bulb minimum Zero solar load.
External ambient conditions for water cooled heat rejection plant and evaporative cooling system full load performance	38.0°C dry bulb maximum 22.5°C wet bulb maximum.
Internal conditions for air conditioning plant full load performance	27.0°C dry bulb maximum - teaching areas 24.0°C dry bulb maximum - office areas 60.0% relative humidity maximum with humidity varying depending on ambient and internal loads.  20.0°C dry bulb minimum.
Internal conditions for evaporative cooling plant full load performance	27.0°C dry bulb maximum relative humidity varying depending on ambient wet bulb temperature.
Controls tolerance for air conditioning plant performance	± 2.0°C dry bulb.
Outside air	12 L/s/person - general teaching areas 10 L/s/person - office areas
Supply air	6 L/s/m <sup>2</sup> minimum

Item	Design Criteria
Exhaust air	To requirements of Australian Standard 1668.2 - The use of mechanical ventilation and air conditioning in buildings - Mechanical ventilation for acceptable indoor-air quality.
Infiltration	0.5 air changes per hour all perimeter areas.
Occupancy	31 persons - typical general teaching area 4 persons - canteen (staff) 10 persons - canteen (students) 4 persons - health care 4 persons - meeting rooms 2 persons - offices.
Hours of operation	8.30am - 5.00 pm - offices 8.00am - 3.30 pm - general teaching areas 8.00am - 3.30 pm - canteen.
Internal heat gains - people	70 W per person, sensible 60 W per person, latent.
Internal heat gains - lighting	15 W/m <sup>2</sup>
Internal heat gains - power	15 W/m <sup>2</sup> - meeting rooms
Internal heat gains - special equipment	200 W - general teaching areas 200 W - offices 200 W/computer - computer labs - 1 computer/person - computer labs 2000 W - server room.
Air filtration	Dry media disposable filters, average filtration efficiency to Australian Standard 1324.2 - Air filters for use in general ventilation and air conditioning - Methods of test. Test dust no. 1 - 20%, test dust no. 2 - 98%.
Fume cupboard chemical use	sulphuric acid hydrochloric acid sodium hydroxide sulphur dioxide sulfur nitrogen dioxide iodine methanol methylated spirits.

Item	Design Criteria
Maximum noise levels under all conditions of plant operations	<p>35 dBA - classrooms single cell            40 dBA - classrooms large            45 dBA - computer rooms teaching            35 dBA - meeting rooms            40 dBA - laboratories teaching            50 dBA - corridors and lobbies            40 dBA - office areas            35 dBA - tutorial rooms            50 dBA - toilet and change rooms</p> <p>All other areas to the requirement of Australian Standard 2107 - Acoustics - Recommended design sound levels and reverberation times for building interiors.</p>
Maximum noise levels at adjoining property boundaries	Not to exceed levels specified for commercial properties and residential properties in the Environmental Protection Act.
Maximum vibration levels in occupied areas	Vibration levels (acceleration $m/s^2$ ) not to exceed Curve 1 vibration levels indicated in Australian Standard 2670 - Evaluation of human exposure to whole-body vibration.
Equipment balancing criteria - maximum allowable vibration levels (maximum peak to peak displacement mm)	<p>0.10 - under 10 r/s fans            0.075 - 10-16 r/s fans            0.050 - 17-35 r/s fans            0.025 - over 35 r/s fans            0.025 - compressors</p> <p>All other equipment not to exceed limits set in Australian Standard 1359 - Rotating electrical machines - General requirements and Australian Standard 2625 - Rotating and reciprocating machinery - Mechanical vibration.</p>
Air diffusion equipment	<p>0.25 m/s maximum terminal velocity in occupied zone - air conditioning systems.</p> <p>0.75m/s maximum terminal velocity in occupied zone - evaporative cooling systems.</p>
Electricity supply	<p>400/230 volts, +10%, -6%, 3 phase, 4 wire, 50 Hz in accordance with ETSA Utilities Service Rules and Conditions of Supply.</p> <p>Design and utilise only systems and equipment to be capable of guaranteed rated performance on both present and future supply voltages.</p>

Item	Design Criteria
Voltage drop	<p>Voltage drop at switchboards limited to 2.5% (maximum) of nominal LV supply voltage of 400 volt, 3 phase.</p> <p>Voltage drop at final distribution points limited to 5% (maximum) of nominal LV supply voltage of 400 volt, 3 phase.</p>
Electromagnetic emission	In accordance with Australian/New Zealand Standard 4251.1 - Electromagnetic compatibility - Generic emission standard - Residential, commercial and light industry.
Electromagnetic immunity	In accordance with Australian/New Zealand Standard 4252.1 - Electromagnetic compatibility - Generic immunity standard - Residential, commercial and light industry.

### 2.3 BUILDING DETAILS

Construction details of the major building elements affecting plant performance and installation are listed below:-

Building Element	Construction Details
Glazing (glazing performance based on ASHRAE guidelines and at 3.33 m/s external air velocity and 0 m/s internal air velocity)	<p>Western - 6mm single clear. Overall Thermal Transmission Co-efficient 5.6 W/m<sup>2</sup>K. Glass Shade Co-efficient 0.8.</p> <p>Northern - 6mm single clear. Overall Thermal Transmission Co-efficient 5.7 W/m<sup>2</sup>K. Glass Shade Co-efficient 0.71.</p>
Floor structure	<p>Slab on ground - Cast in-situ floor concrete raft floor slab.</p> <p>Suspended floor - post tensioned band beams with 'Bondek' type infill suspended floor structure.</p>
Wall construction	<p>Northern - 200mm precast concrete with 25mm air gap, Aircell "Retrosshield" insulation, 25mm air gap and 13mm gypsum board. Overall Thermal Transmission Co-efficient 0.553 W/m<sup>2</sup>K.</p> <p>General - 175mm precast concrete with 25mm air gap, Aircell "Retrosshield" insulation, 25mm air gap and 13mm gypsum board. Overall Thermal Transmission Co-efficient 0.556 W/m<sup>2</sup>K.</p>
Ceiling construction	600mm x 600mm tee-bar 2 way suspension system with lay-in mineral fibre tiles.

### 3 GENERAL REQUIREMENTS

#### 3.1 GENERAL

The following clauses set out the general requirements for the works. These requirements are not intended to cover all aspects of the installation and must be read in conjunction with the Conditions of Contract, Special Conditions of Contract, other sections of the Specification and the drawings.

#### 3.2 WORKS PROGRAMME

Provide all necessary details to enable the development of a detailed construction programme. Prior to signing the contract agree in writing a detailed time schedule for the works.

Include in the time schedule the following, and any other critical dates:-

- receipt of architectural and services drawings to allow commencement of the preparation of construction drawings
- submission of construction drawings
- workshop fabrication schedule
- ordering and delivery of plant and materials
- free access for entry and installation of plant and equipment
- receipt of permanent power
- commencement and completion of first and second fix
- authorities permit applications
- acceptance testing and plant commissioning.

Order and deliver all plant and equipment to site in time to ensure compliance with the construction programme.

#### 3.3 WORKING DIMENSIONS AND TOLERANCES

Check on site at regular intervals the building working dimensions, tolerances and the setting out of the associated works. Immediately report any discrepancy.

#### 3.4 PERMITS, NOTICES AND INSPECTIONS

Make applications, obtain all permits, and arrange testing, all as necessary for the installation and placing into operation of the works where required by any Authority including:-

- Department for Transport, Energy and Infrastructure - SafeWork SA
- Department for Transport, Energy and Infrastructure - The Office of the Technical Regulator
- ETSA Utilities.

Provide all associated documentation required for the applications.

Pay all associated fees.

#### 3.5 STANDARDS

Comply in all respects with the requirements of the current standards applicable to the works in respect of equipment, materials, workmanship and installation techniques.

Comply with the following standards and regulations:-

- Building Code of Australia
- Australian Standards
- ETSA Utilities Supply Regulations

- Department of Health Regulations
- Australian Communications Authority Regulations
- SA Government Acts governing the works
- Occupational Health and Safety Regulations.

### 3.6 MATERIALS EQUIPMENT AND WORKMANSHIP

Obtain approval for and maintain uniformity of the manufacturer and type of all materials and equipment. Use only new, current manufacture, first quality materials and equipment.

Comply with the manufacturer's recommendations in respect to installation techniques and the requirements for associated materials, equipment, components and devices.

Ensure compatibility of materials and equipment with the installed environment in respect of ambient temperatures, utilities supplies and vibration.

### 3.7 SEALANTS, ADHESIVES AND COATINGS

Utilise sealants and adhesives having VOC emissions (excluding water and exempt compounds) not more than 70g/L.

Site applied paint systems must comply with the following VOC emission limits:-

- |  |                    |
|--|--------------------|
| • solvent based coatings                 | - less than 200g/L |
| • interior/exterior gloss                | - less than 75g/L  |
| • exterior semi gloss                    | - less than 70g/L  |
| • interior latex undercoat               | - less than 65g/L  |
| • latex primers for galvanised/zincalume | - less than 60g/L  |
| • exterior latex undercoat               | - less than 65g/L  |
| • exterior timber primer/flat/low sheen  | - less than 50g/L  |
| • interior semigloss/low sheen/flat      | - less than 16g/L  |
| • interior flat - ceilings               | - less than 14g/L. |

### 3.8 SETTING OUT OF OPENINGS AND MAKING GOOD

Provide details and set out exact locations of all equipment, accessories and associated works including:-

- penetrations through ceiling, structure and all other building elements
- fixings
- equipment support bases
- temporary and permanent access.

Provide information and prepare construction drawings to detail the above requirements in such time as to ensure delays do not occur to the construction works.

Obtain written approval for all ducts, recesses and penetrations in structural elements not shown on the architectural and structural drawings.

Check on site the setting out of all equipment, penetrations, fixings, support bases, inserts, recesses and access provisions prior to the forming of the element, confirm acceptance and take responsibility for accuracy.

### 3.9 ELECTRICAL INTERFERENCE

Design and use electrical equipment which will not cause interference with electronic and electrical equipment in the vicinity. In the event that the inherent characteristics of equipment make interference possible, fit effective suppressors to eliminate the interference.

Maintain radio and television interference level within the limits set out in Australian/New Zealand Standard 1044 - Limits and methods of measurement of radio disturbance characteristics of electrical motor-operated and thermal appliances for household and similar purposes, electric tools and similar electric apparatus.

Maintain electrical disturbances within the limits set out in Australian Standard 2279 - Disturbances in mains supply networks. Comply with Australian Standard 4252 - Electromagnetic compatibility - Generic immunity standard.

### 3.10 BALANCING AND PHASE ROTATION

Balance each section of the installation evenly over all phases and ensure that phase rotation is correct throughout.

### 3.11 PENETRATIONS THROUGH STRUCTURE

Check the location of blockouts for major penetrations prior to the pouring of concrete.

Provide and place into position 1.6mm sleeves or cast insitu fire stop collars for minor penetrations.

Check the location of roof penetrations prior to the cutting of the openings.

Provide all information in adequate time to allow the works to be completed in accordance with the construction programme. Pay all costs for additional works associated with the late provision of information and/or the failure to check the location of penetrations and sleeves prior to their formation.

Provide treatment to the penetrations as follows:-

- ductwork and air diffusion equipment penetrating fire rated floors - provide fire dampers, fire retardant sealing and flashing angles
- insulated copper pipework penetrating fire rated floors - replace the insulation with an approved fire retardant insulation, vapour sealed as necessary, pack around the insulation with an approved fire resistant joint filler equal to "Hilti CP620" to maintain the integrity of the fire barrier
- cable and cable trays penetrating fire rated walls and floors - pack around penetrations with fire retardant pillows suitably supported to maintain the integrity of the fire barrier
- acoustic barrier and plantroom wall/floor penetrations - pack penetrations with 70kg/m<sup>3</sup> fibreglass or rockwool and seal airtight with flashing angles and mastic. Ensure ducts and pipes do not come into contact with the barriers/walls
- exposed penetrations - flash pipework and ductwork penetrations where exposed to view with sheet metal escutcheon plates
- external wall penetrations - seal with silicon sealant and install weatherproof overflashings.

### 3.12 CHASING

Conceal all services. Install services as follows:-

- cavity walls, hollow block and dry walls - install services concealed within cavity.

Chasing will not be permitted.

### 3.13 FIXINGS

Carry out fixings by drilling holes and utilising metal expansion devices.



Where approved and where complying with site safety standards low velocity explosive power tools may be utilised for the fixing of static plant and equipment such as cable trays, ductwork and the like.

In all circumstances use metal expansion devices for fixing to all plant and equipment subject to vibration.

Obtain approval for the location of all fixings.

Do not use plastic or wooden plugs.

### **3.14 WELDING**

Carry out welding using competent, qualified tradesmen holding a current certificate of competency to carry out structural welding. Ensure all surfaces are clean and free from scale, grease and grime.

Obtain hot work permit from project safety officer.

Ensure all welds are uniform, predominantly smooth, free of spatter and conform to the minimum requirements of Australian Standard 1554 - Structural steel welding and Australian Standard 1674.1 - Safety in welding and allied processes - Fire precautions. Provide suitable fire extinguishers whenever welding is carried out on site.

### **3.15 FLAME CUTTING**

Do not carry out flame cutting in members carrying stress at the time of cutting or members that will later be subjected to stress or without prior approval.

Do not use flame cutting equipment to enlarge holes or slots through which bolts will pass unless prior approval has been received. Provide suitable fire extinguishers whenever flame cutting is carried out on site.

Obtain hot work permit from project safety officer.

Ensure all flame cutting conforms to the minimum requirements of and Australian Standard 1674.1 - Safety in welding and allied processes - Fire precautions.

### **3.16 CO-ORDINATION OF INSTALLATION**

Co-ordinate the installation of the works with all trades to ensure a logical, sequenced approach. Pay all costs associated with delays, re-work, making good or additional works resulting from delays, or deficiencies in co-ordination of the works or provision of information.

Prior to the installation of wall mounted equipment, such as thermostats and control panels, co-ordinate with the Architectural, furniture and electrical services layouts.

Prior to the installation of ceiling mounted equipment such as air diffusion equipment, co-ordinate with the Architectural, Electrical and Fire Protection Services layouts.

### **3.17 STORAGE AND PROTECTION**

Store and protect all materials and equipment required for the works. Obtain approval for the location of the storage areas on site.

Immediately, upon delivery to site, stack and protect from the weather, dampness and dust all materials and equipment. Provide a storage shed and/or enclosures as necessary for the security of the materials and equipment. Cover the ends of all open ducts, pipes and conduits to prevent the ingress of foreign matter.

Protect the building surfaces from damage potentially arising from the storage of materials and equipment. Make good any damage arising from the storage procedures.

### 3.18 SAMPLES

Submit the following samples and equipment, fittings and accessories to obtain approval prior to ordering:-

- air outlets
- thermostats
- control panels including accessories.

Provide samples of each item clearly identified with the manufacturer's and supplier's names.

On acceptance mark the samples with the date approved, name of approving authority, specification reference clause and area where items are to be used.

Deliver the samples to the site office at least 14 days before approval is required.

The approved samples may be used in the installation. If not, the samples will be retained on site until the completion of the works.

### 3.19 SITE CLEANLINESS AND RUBBISH REMOVAL

Remove from site all rubbish, debris, material cuttings and other redundant materials which result from the works, progressively and whenever directed. Comply with the site requirements with respect to the recycling of materials.

### 3.20 CONSTRUCTION DRAWINGS

Prepare and submit for review 1 plain paper and 1 electronic copy of construction drawings based on the drawings accompanying the Specification.

Prepare drawings to approved scales on sheets of the same size as the drawings accompanying the Specification.

Provide fully dimensioned construction drawings prepared, utilising computer aided drafting, DWG CAD format - Autocad Version 2007 (or later) and in accordance with Australian Standard 1100 - Technical drawing detailing the following parts of the work:-

- associated works including penetrations through the structure, ceiling access, electrical terminations and other termination points
- ductwork and pipework arrangements including details of construction, supports and fixing
- plant arrangements including manufacturer's details of equipment and loads placed on the building structure
- reflected ceiling plans detailing air outlet locations, sizes and air quantities
- automatic controls schematics including controls equipment
- electrical schematics, power and control wiring diagrams detailing the interconnection of all electrical components utilising a fully cross referenced grid system of component numbering and contact numbering with wiring coded and numbered
- switchgear and control assembly (SCA) drawings incorporating an electrical components list detailing the ratings, manufacturer, type and model of each device used.

A CD-ROM containing Autocad release 2007 files of the Mechanical Services tender drawings will be provided to the successful Tenderer, at no cost, as an aid to preparing the above drawings.

Prior to submitting manufacturer's construction drawings for review, suitably stamp, date and endorse each drawing as inspected and if necessary, add comments.

Submit construction drawings in adequate time for the building construction programme to be complied with. Allow 15 working days for the return of the endorsed construction drawings, including 5 working days for inspection by the Building Engineering Services Consulting Engineers.

Prepare and submit a schedule of construction drawings detailing inspected drawings, current drawings submitted for inspection, dates for re-submission for non-satisfactory drawings, date for submission of outstanding drawings.

Inspection of the drawings by the reviewing authority is carried out to determine if the intent of the contract documents has generally been complied with. Such inspection does not relieve the responsibility for contractual obligations including ensuring that the work is complete, accurate and correct.

Where drawings are returned for amendment, amend and resubmit within sufficient time to prevent delays to the execution of the works.

### 3.21 CONSTRUCTION DESIGN CALCULATIONS

Prepare and submit for review design calculations on which plant equipment and material selections have been made.

The calculations shall include but not be limited to:-

- fan static calculations.

### 3.22 EARTHQUAKE LOADING PROVISIONS

Provide supports, restraints and baffles, designed and certified by a Structural Consulting Engineer, to all plant, equipment, tanks, pipework, isolation mounts and ductwork in accordance with Australian Standard 1170.4 - SAA Loading Code - Earthquake loads.

Importance Factor	I = 1.0	Acceleration Coefficient	$\alpha = 0.10$
Probability Factor	$K_p = 1.0$	Site Factor	S = 1.25

### 3.23 QUALITY ASSURANCE

Implement a quality system for the works in accordance with Australian/New Zealand Standard ISO 9000.1 - Guidelines for selection and use and Australian/New Zealand Standard ISO 9001 - Quality systems - Model for quality assurance in design, development, production, installation and servicing.

### 3.24 MAINTENANCE AND SERVICING ACCESS

Arrange all plant and equipment to provide minimum access and maintenance requirements in accordance with the equipment manufacturers recommendations and the requirements of the Occupational Health, Safety and Welfare Act and Regulations.

## 4 PLANT AND EQUIPMENT

### 4.1 GENERAL

Supply and install plant and equipment in accordance with the requirements of this specification.

Include all incidental and ancillary equipment necessary for the completion of the installation, the safe and efficient operation of the plant and the maintenance of the plant including the following items:-

- flexible connections and isolation mounts
- belt drive and coupling guards, safety railings, mesh fan guards, warning lights and alarms, electrical interlocks, earthing
- lubricating facilities, access panels, gauge connections, manufacturer's name plates.

Obtain approval for the manufacturer of all plant and equipment prior to ordering.

Guarantee the plant and equipment to provide the specified capacities and performance in the installed environment without objectionable noise and vibration.

Accept responsibility for assessment of the actual system resistances and pressures, submit for approval copies of all associated calculations, and order equipment to suit same.

Provide fully certified and guaranteed performance data, including capacities, energy consumption and efficiency for the specified design and part load conditions for all plant and equipment.

Provide fully certified and guaranteed sound power level data at full load conditions for all plant and equipment.

#### **4.2 AIR CONDITIONING UNITS - MULTI SYSTEM TYPE**

Supply and install air cooled, reverse cycle, multi system type, air conditioning units incorporating indoor units of ducted fan coil, cassette, under ceiling, floor console and wall mounted configuration as nominated, complying with the following performance and construction criteria.

Provide systems of variable refrigerant heat recovery (simultaneous heat/cool) type.

Compressors:-

- hermetic type variable speed inverter driven operating on Refrigerant R407c, R134a or R410a
- complete with vibration isolation mounts and filter/drier.

Fans - supply air (ducted fan coil type):-

- double width, double inlet, forward curved centrifugal type incorporating self aligning ball type bearings
- constructed from zinc coated steel
- maximum fan discharge velocity 8 m/s.

Fans - supply air (cassette, under ceiling, floor mounted console and wall mounted type):-

- centrifugal type incorporating self aligning ball type bearings
- constructed from zinc coated steel or injection moulded plastic
- maximum fan discharge velocity 5 m/s.

Fans - condenser air:-

- aerofoil axial flow or propeller direct drive type with aluminium blades and hub operating at a maximum speed of 24 r/s
- galvanised guard mesh to fan discharges.

Fan motors and drives:-

- squirrel cage induction type drip proof for supply air fans and totally enclosed fan cooled weatherproof type for condenser fans
- maximum operating speed 24 r/s
- direct drive, to incorporate 3 fan speed tappings or adjustable potentiometer (supply air fan drives only).

**Coils:-**

- direct expansion aluminium fin copper tube type
- serpentine type with interleaved circuits and distributors arranged to ensure even distribution of liquid refrigerant
- maximum face velocity 2.5 m/s evaporator coils and 3.75 m/s condenser coils and maximum fin spacing 550 fins/m
- galvanised steel or aluminium frame.

**Electrical/Controls:-**

- mount all electrical components within a separate weatherproof compartment
- incorporate safety and operating controls including automatic re-set low and high pressure switches
- incorporate hot gas defrost cycle
- incorporate isolating switch on each indoor unit
- wire each indoor unit from its respective system outdoor unit, balance all phases and incorporate circuit breakers within the unit casing or a separate enclosure
- label all components
- provide wiring diagram, complete with protective finish and schedule of fan and compressor motor fixed permanently within the electrical component
- incorporate hard wired remote control panel providing on/off control, time switch control, fan speed control and set point adjustment.

**Casings:-**

- fabricate from galvanised sheet steel, folded and braced
- complete with airtight, gasketed access panels
- internally insulated with 25mm resin bonded matt black or aluminium foil faced fibreglass adhered to all internal surfaces
- incorporate galvanised steel or non-corrosive material, 1 piece drip tray under the coil sections. Insulate and vapour seal the underside of the drip trays
- 25mm screwed, trapped, drain connection
- incorporate dry media air filters
- fabricate all brackets, bracing and fixings from galvanised steel
- baked enamel, powder coat or high quality injection moulded plastic finish
- incorporate condensate pump within the unit casing
- incorporate outside air connections where outside air is to be introduced via the air conditioning system including modification units as required to achieve the specified outside air flow rates.

**Branch Selector Boxes:-**

- incorporate appropriate drainage to tundish when drain connection is required.

Performance criteria:-

<b>Designation</b>	<b>ACU G-1</b>	<b>ACU G-2</b>	<b>ACU G-3</b>
Total sensible cooling capacity – kW	6	5.0	2.5
Total cooling capacity – kW	6	5.0	2.5
Total heating capacity – kW	2.5	4.0	2.0
Evaporator coil air on – cooling db°C/wb°C	27.3/19.3	27.4/19.4	27.5/19.5
Evaporator coil air on – heating db°C	19.8	19.3	19.8
Condenser coil air on – cooling db°C	40	40	40
Condenser coil air on – heating db°C	7	7	7
Supply air quantity – L/s	475	395	170
Outside air quantity – L/s	70	0	40
Configuration/system type	Ceiling Cassette	Ceiling Cassette	Ceiling Cassette
Corresponding condensing unit	ACC 4a	ACC 4b	ACC 4b
<b>Designation</b>	<b>ACU G-4</b>	<b>ACU G-5</b>	<b>ACU G-6</b>
Total sensible cooling capacity - kW	2.5	1.5	1.5
Total cooling capacity - kW	2.5	1.5	1.5
Total heating capacity - kW	2.0	1.5	1.5
Evaporator coil air on - cooling db°C/wb°C	27.6/19.6	27.6/19.6	27.7/19.6
Evaporator coil air on - heating db°C	19.0	19.0	18.8
Condenser coil air on - cooling db°C	40	40	40
Condenser coil air on - heating db°C	7	7	7
Supply air quantity - L/s	180	100	90
Outside air quantity - L/s	50	30	30
Configuration/system type	Ceiling Cassette	Ceiling Cassette	Ceiling Cassette
Corresponding condensing unit	ACC 4b	ACC 4b	ACC 4b
<b>Designation</b>	<b>ACU G-7</b>	<b>ACU G-8</b>	<b>ACU G-9</b>
Total sensible cooling capacity - kW	8.0	8.0	1.5

<b>Designation</b>	<b>ACU G-7</b>	<b>ACU G-8</b>	<b>ACU G-9</b>
Total cooling capacity - kW	8.0	8.0	1.5
Total heating capacity - kW	4.5	4.5	1.5
Evaporator coil air on - cooling db°C/wb°C	27.0/19.7	27.0/19.0	27.3/19.0
Evaporator coil air on - heating db°C	20.0	20.0	19.6
Condenser coil air on - cooling db°C	40	40	40
Condenser coil air on - heating db°C	7	7	7
Supply air quantity - L/s	605	605	120
Outside air quantity - L/s	0	0	10
Configuration/system type	Ceiling Cassette	Ceiling Cassette	Ceiling Cassette
Corresponding condensing unit	ACC 2a	ACC 2a	ACC 2c

<b>Designation</b>	<b>ACU G-10</b>	<b>ACU G-11</b>	<b>ACU G-13</b>
Total sensible cooling capacity - kW	8.0	8.0	5.0
Total cooling capacity - kW	8.0	8.0	5.0
Total heating capacity - kW	4.5	4.5	4.0
Evaporator coil air on - cooling db°C/wb°C	27.0/19.3	27.0/19.0	27.4/19.4
Evaporator coil air on - heating db°C	20.0	20.0	19.3
Condenser coil air on - cooling db°C	40	40	40
Condenser coil air on - heating db°C	7	7	7
Supply air quantity - L/s	605	605	395
Outside air quantity - L/s	0	0	0
Configuration/system type	Ceiling Cassette	Ceiling Cassette	Ceiling Cassette
Corresponding condensing unit	ACC 2a	ACC 2a	ACC 4b

<b>Designation</b>	<b>ACU 1-1</b>	<b>ACU 1-2</b>	<b>ACU 1-3</b>
Total sensible cooling capacity - kW	8.5	8.5	8.0
Total cooling capacity - kW	8.5	8.5	8.0
Total heating capacity - kW	6.5	7.0	7.0

<b>Designation</b>	<b>ACU 1-1</b>	<b>ACU 1-2</b>	<b>ACU 1-3</b>
Evaporator coil air on - cooling db°C/wb°C	27.0/19.0	27.0/19.0	27.0/19.0
Evaporator coil air on - heating db°C	20.0	20.0	20.0
Condenser coil air on - cooling db°C	40	40	40
Condenser coil air on - heating db°C	7	7	7
Supply air quantity - L/s	595	585	540
Outside air quantity - L/s	0	0	0
Configuration/system type	Ceiling Cassette	Ceiling Cassette	Ceiling Cassette
Corresponding condensing unit	ACC 3a	ACC 3a	ACC 3a

<b>Designation</b>	<b>ACU 1-4</b>	<b>ACU 1-5</b>	<b>ACU 1-6</b>
Total sensible cooling capacity - kW	5.0	8.0	8.0
Total cooling capacity - kW	5.0	8.0	8.0
Total heating capacity - kW	4.5	8.0	8.0
Evaporator coil air on - cooling db°C/wb°C	27.0/19.0	27.0/19.0	27.0/19.0
Evaporator coil air on - heating db°C	20.0	20.0	20.0
Condenser coil air on - cooling db°C	40	40	40
Condenser coil air on - heating db°C	7	7	7
Supply air quantity - L/s	345	345	555
Outside air quantity - L/s	0	0	0
Configuration/system type	Ceiling Cassette	Ceiling Cassette	Ceiling Cassette
Corresponding condensing unit	ACC 3a	ACC 3a	ACC 3b

<b>Designation</b>	<b>ACU 1-7</b>	<b>ACU 1-8</b>	<b>ACU 1-9</b>
Total sensible cooling capacity - kW	2.5	2.5	2.0
Total cooling capacity - kW	2.5	2.5	2.0
Total heating capacity - kW	2.5	2.5	1.5
Evaporator coil air on - cooling db°C/wb°C	27.1/19.1	27.1/19.7	27.7/19.1
Evaporator coil air on - heating db°C	19.8	19.8	18.8



<b>Designation</b>	<b>ACU 1-7</b>	<b>ACU 1-8</b>	<b>ACU 1-9</b>
Condenser coil air on - cooling db°C	40	40	40
Condenser coil air on - heating db°C	7	7	7
Supply air quantity - L/s	190	185	120
Outside air quantity - L/s	10	10	40
Configuration/system type	Ceiling Cassette	Ceiling Cassette	Ceiling Cassette
Corresponding condensing unit	ACC 3b	ACC 3b	ACC 3b

<b>Designation</b>	<b>ACU 1-10</b>	<b>ACU 1-11</b>	<b>ACU 1-12</b>
Total sensible cooling capacity - kW	7.0	7.0	8.0
Total cooling capacity - kW	7.0	7.0	8.0
Total heating capacity - kW	7.0	7.0	7.0
Evaporator coil air on - cooling db°C/wb°C	27.0/19.0	27.0/19.0	27.0/19.0
Evaporator coil air on - heating db°C	20.0	20.0	20.0
Condenser coil air on - cooling db°C	40	40	40
Condenser coil air on - heating db°C	7	7	7
Supply air quantity - L/s	520	520	590
Outside air quantity - L/s	0	0	0
Configuration/system type	Ceiling Cassette	Ceiling Cassette	Ceiling Cassette
Corresponding condensing unit	ACC 2c	ACC 2c	ACC 2b

<b>Designation</b>	<b>ACU 1-13</b>	<b>ACU 1-14</b>	<b>ACU 1-15</b>
Total sensible cooling capacity - kW	8.0	9.5	9.5
Total cooling capacity - kW	8.0	9.35	9.5
Total heating capacity - kW	7.0	5.5	5.5
Evaporator coil air on - cooling db°C/wb°C	27.0/19.0	27.0/19.0	27.0/19.0
Evaporator coil air on - heating db°C	20.0	20.0	20.0
Condenser coil air on - cooling db°C	40	40	40
Condenser coil air on - heating db°C	7	7	7

<b>Designation</b>	<b>ACU 1-13</b>	<b>ACU 1-14</b>	<b>ACU 1-15</b>
Supply air quantity - L/s	590	710	710
Outside air quantity - L/s	0	0	0
Configuration/system type	Ceiling Cassette	Ceiling Cassette	Ceiling Cassette
Corresponding condensing unit	ACC 2b	ACC 2b	ACC 2b

<b>Designation</b>	<b>ACU 1-16</b>	<b>ACU 1-17</b>	<b>ACU 1-18</b>
Total sensible cooling capacity - kW	5.0	5.0	8.0
Total cooling capacity - kW	5.0	5.0	8.0
Total heating capacity - kW	4.5	4.5	8.0
Evaporator coil air on - cooling db°C/wb°C	27.0/19.0	27.0/19.0	27.0/19.0
Evaporator coil air on - heating db°C	20.0	20.0	20.0
Condenser coil air on - cooling db°C	40	40	40
Condenser coil air on - heating db°C	7	7	7
Supply air quantity - L/s	345	345	555
Outside air quantity - L/s	0	0	0
Configuration/system type	Ceiling Cassette	Ceiling Cassette	Ceiling Cassette
Corresponding condensing unit	ACC 1b	ACC 1b	ACC 1b

<b>Designation</b>	<b>ACU 1-19</b>	<b>ACU 1-20</b>	<b>ACU 1-21</b>
Total sensible cooling capacity - kW	2.5	2.0	2.5
Total cooling capacity - kW	2.5	2.0	2.5
Total heating capacity - kW	2.5	1.5	2.5
Evaporator coil air on - cooling db°C/wb°C	27.1/19.1	27.7/19.7	27.1/19.1
Evaporator coil air on - heating db°C	19.8	18.8	19.8
Condenser coil air on - cooling db°C	40	40	40
Condenser coil air on - heating db°C	7	7	7
Supply air quantity - L/s	190	120	185
Outside air quantity - L/s	10	40	10

<b>Designation</b>	<b>ACU 1-19</b>	<b>ACU 1-20</b>	<b>ACU 1-21</b>
Configuration/system type	Ceiling Cassette	Ceiling Cassette	Ceiling Cassette
Corresponding condensing unit	ACC 1b	ACC 1b	ACC 1b

<b>Designation</b>	<b>ACU 1-22</b>	<b>ACU 1-23</b>	<b>ACU 1-24</b>
Total sensible cooling capacity - kW	8.5	8.5	9.0
Total cooling capacity - kW	8.5	8.5	9.0
Total heating capacity - kW	7.0	7.0	8.0
Evaporator coil air on - cooling db°C/wb°C	27.0/19.0	27.0/19.0	27.0/19.0
Evaporator coil air on - heating db°C	20	20	20.0
Condenser coil air on - cooling db°C	40	40	40
Condenser coil air on - heating db°C	7	7	7
Supply air quantity - L/s	570	600	620
Outside air quantity - L/s	0	0	0
Configuration/system type	Ceiling Cassette	Ceiling Cassette	Ceiling Cassette
Corresponding condensing unit	ACC 1a	ACC 1a	ACC 1a

<b>Designation</b>	<b>ACU 1-25</b>	<b>ACU 2-1</b>
Total sensible cooling capacity - kW	2.5	5.5
Total cooling capacity - kW	2.5	5.5
Total heating capacity - kW	2.5	4.0
Evaporator coil air on - cooling db°C/wb°C	27.1/22.2	27.3/19.3
Evaporator coil air on - heating db°C	19.8	19.5
Condenser coil air on - cooling db°C	40	40
Condenser coil air on - heating db°C	7	7
Supply air quantity - L/s	200	380
Outside air quantity - L/s	10	50
Configuration/system type	Ceiling Cassette	High Wall
Corresponding condensing unit	ACC 3b	ACC 4a

Cooling capacities are nett cooling capacities, add fan motor gains and refrigerant piping gains to obtain required cooling capacity. Select outdoor units based on the scheduled maximum instantaneous cooling capacity plus fan motor and refrigerant piping gains. Do not include any additional diversity.

Design and select refrigeration systems and condensers such that the air conditioning units continue to operate satisfactorily at ambient conditions 5°C above and 5°C below the condenser coil air on cooling and heating conditions, respectively, without exceeding the manufacturer's recommended safety control limits.

Noise levels:-

Limit noise levels to the following maximum values (octave band sound pressure levels, dB 20uPa) at all operating conditions.

Hz		63	125	250	500	1000	2000
<b>ACU G-1</b>	SPL radiated - evaporator	34	36	37	35	31	25
<b>ACU G-2</b>	SPL radiated - evaporator	37	38	37	33	29	22
<b>ACU G-3</b>	SPL radiated - evaporator	29	36	36	36	33	25
<b>ACU G-4</b>	SPL radiated - evaporator	28	34	33	32	30	23
<b>ACU G-5</b>	SPL radiated - evaporator	28	33	32	30	28	22
<b>ACU G-6</b>	SPL radiated - evaporator	28	33	32	30	28	22
<b>ACU G-7</b>	SPL radiated - evaporator	38	39	40	38	34	27
<b>ACU G-8</b>	SPL radiated - evaporator	38	39	40	38	34	27
<b>ACU G-9</b>	SPL radiated - evaporator	38	39	40	38	34	27
<b>ACU G-10</b>	SPL radiated - evaporator	38	39	40	38	34	27
<b>ACU G-11</b>	SPL radiated - evaporator	38	39	40	38	34	27
<b>ACU G-13</b>	SPL radiated - evaporator	37	38	37	33	29	22
<b>ACU 1-1</b>	SPL radiated - evaporator	38	39	40	38	39	27
<b>ACU 1-2</b>	SPL radiated - evaporator	38	39	40	38	37	27
<b>ACU 1-3</b>	SPL radiated - evaporator	38	39	40	38	37	27
<b>ACU 1-4</b>	SPL radiated - evaporator	37	38	37	33	29	22
<b>ACU 1-5</b>	SPL radiated - evaporator	37	38	37	33	29	22
<b>ACU 1-6</b>	SPL radiated - evaporator	38	39	40	38	34	27
<b>ACU 1-7</b>	SPL radiated - evaporator	29	36	36	36	33	25
<b>ACU 1-8</b>	SPL radiated - evaporator	29	36	36	36	33	25
<b>ACU 1-9</b>	SPL radiated - evaporator	28	33	32	30	28	22

Hz		63	125	250	500	1000	2000
<b>ACU 1-10</b>	SPL radiated - evaporator	34	36	37	35	31	25
<b>ACU 1-11</b>	SPL radiated - evaporator	34	36	37	35	31	25
<b>ACU 1-12</b>	SPL radiated - evaporator	38	39	40	38	27	27
<b>ACU 1-13</b>	SPL radiated - evaporator	38	39	40	38	37	27
<b>ACU 1-14</b>	SPL radiated - evaporator	38	39	40	38	37	27
<b>ACU 1-15</b>	SPL radiated - evaporator	38	39	40	38	37	27
<b>ACU 1-16</b>	SPL radiated - evaporator	34	36	37	35	35	25
<b>ACU 1-17</b>	SPL radiated - evaporator	34	36	37	35	31	25
<b>ACU 1-18</b>	SPL radiated - evaporator	38	39	40	38	34	27
<b>ACU 1-19</b>	SPL radiated - evaporator	29	36	36	36	33	25
<b>ACU 1-20</b>	SPL radiated - evaporator	28	33	32	30	28	22
<b>ACU 1-21</b>	SPL radiated - evaporator	29	36	36	36	33	25
<b>ACU 1-22</b>	SPL radiated - evaporator	38	39	40	38	34	27
<b>ACU 1-23</b>	SPL radiated - evaporator	38	39	40	38	34	27
<b>ACU 1-24</b>	SPL radiated - evaporator	38	39	40	38	34	27
<b>ACU 1-25</b>	SPL radiated - evaporator	29	36	36	36	33	25
<b>ACU 2-1</b>	SPL radiated - evaporator	29	32	34	31	27	19
<b>ACC-1a</b>	SPL radiated - condensing unit	58	64	59	58	52	46
<b>ACC-1b</b>	SPL radiated - condensing unit	58	64	59	58	52	46
<b>ACC-2a</b>	SPL radiated - condensing unit	62	61	60	60	55	48
<b>ACC-2b</b>	SPL radiated - condensing unit	62	61	60	60	55	48
<b>ACC-2c</b>	SPL radiated - condensing unit	59	63	60	58	53	47
<b>ACC-3a</b>	SPL radiated - condensing unit	62	61	60	60	55	48
<b>ACC-3b</b>	SPL radiated - condensing unit	59	63	63	58	57	47
<b>ACC-4a</b>	SPL radiated - condensing unit	64	63	61	61	56	50
<b>ACC-4b</b>	SPL radiated - condensing unit	62	61	60	60	55	48

#### 4.3 AIR CONDITIONING UNITS - CASSETTE TYPE

Supply and install air cooled, cooling only, split system, cassette type, air conditioning units complying with the following performance and construction criteria.

Compressors:-

- hermetic type operating at 48 r/s on Refrigerant 407c, R410a or R134a
- incorporate inverter drive
- motors suitable for direct on line starting
- complete with vibration isolation mounts and filter/drier.

Fans - supply air:-

- centrifugal type incorporating self aligning ball type bearings
- constructed from zinc coated steel
- maximum fan discharge velocity 5 m/s.

Fans - condenser air:-

- aerofoil axial flow or propeller direct drive type with aluminium blades and hub operating at a maximum speed of 24 r/s
- galvanised guard mesh to fan discharges.

Fan motors and drives:-

- squirrel cage induction type drip proof for supply air fans and totally enclosed fan cooled weatherproof type for condenser fans
- maximum operating speed 24 r/s
- direct drive, to incorporate 3 fan speed tapplings or adjustable potentiometer (supply air fan drives only).

Coils:-

- direct expansion aluminium fin copper tube type
- serpentine type with interleaved circuits and distributors arranged to ensure even distribution of liquid refrigerant
- maximum face velocity 2.5 m/s evaporator coils and 3.75 m/s condenser coils and maximum fin spacing 550 fins/m
- galvanised steel or aluminium frame.

Electrical/Controls:-

- mount all electrical components within a separate weatherproof compartment
- incorporate safety and operating controls including automatic re-set low and high pressure switches
- incorporate hot gas defrost cycle
- incorporate weatherproof isolating switch on the condensing unit
- label all components
- provide wiring diagram, complete with protective finish and schedule of fan and compressor motor fixed permanently within the electrical compartment
- incorporate remote control panel providing on/off control, time switch control, fan speed control and supply air quantity control

- incorporate temperature sensor within turn air stream of unit generally, remote at control panel when outdoor air is introduced to the unit.

Casings:-

- fabricate from galvanised sheet steel, folded and braced
- complete with airtight, gasketed access panels
- internally insulated with 25mm resin bonded matt black or aluminium foil faced fibreglass adhered to all internal surfaces
- incorporate galvanised steel, 1 piece drip tray under the coil sections. Insulate and vapour seal the underside of the drip trays
- 25mm screwed, trapped, drain connection
- incorporate dry media air filters
- fabricate all brackets, bracing and fixings from galvanised steel
- baked enamel finish
- incorporate condensate pump within the unit casing
- install condensing units on folded galvanised top hat sections.

Performance criteria:-

<b>Designation</b>	<b>ACU G-12</b>
Total sensible cooling capacity - kW	4.0
Total cooling capacity - kW	4.0
Total heating capacity - kW	1.5
Evaporator coil air on - cooling db°C/wb°C	24/17
Evaporator coil air on - heating db°C	20
Condenser coil air on - cooling db°C	40.0
Condenser coil air on - heating db°C	7.0
Supply air quantity - L/s	300
Outside air quantity - L/s	0
Supply air fan motor drive type	Turbo fan
Cooling stages	Infinite
Inverter drive	Required
Condenser fan type	Propeller
Condenser fan motor drive type	Direct
Remote control panel	Wireless

Cooling capacities are nett cooling capacities, add fan motor gains to obtain required cooling capacity.

Design and select refrigeration systems and condensers such that the air conditioning units continue to operate satisfactorily at ambient conditions 5°C above and 5°C below the condenser coil air on cooling and heating conditions, respectively, without exceeding the manufacturer's recommended safety control limits.

Noise levels:-

Limit noise levels to the following maximum values (octave band sound pressure levels, dB 20uPa) at all operating conditions.

Hz	63	125	250	500	1000	2000
<b>ACU G-12</b> SWL evaporator	56	55	54	49	47	38
SWL condensing unit	53	52	51	51	48	42

#### 4.4 ENERGY RECOVERY VENTILATOR UNITS

Supply and install ventilation units complying with the following performance and construction criteria.

Fans:-

- double width double inlet, forward curved type incorporating self aligning ball bearings selected for 100,000 hours operating life
- locate lubricators on the outside of the air handling units
- construct casings and impellers from galvanised steel
- maximum fan discharge velocity 8 m/s.
- Incorporate filters of the extended media panel type on both outdoor and return air intakes. Filters are to comply with Australian Standard 1324.2 - Air filters for use in general ventilation and air conditioning - Application performance construction and Australian Standard 1324.2 - Air filters for use in general ventilation and air conditioning - Methods of test:-
  - Classification:-
    - performance rating - F5
    - type - Type 1
    - class - Class A.

Fan motors and drives:-

- totally enclosed fan cooled type to IP54 (minimum), 240 V, 1 phase
- maximum operating speed 24 r/s
- motor power sufficient to supply 110% of the design air quantity against the corresponding system pressure increase with the air filters operating at half of their dust holding capacity
- direct drive type suitable for variable speed control.

Casings:-

- fabricate from not less than 1.2mm colorbond sheet steel, folded, braced and fully weatherproof
- complete with airtight, gasketed access panels
- internally insulated with 25mm aluminium foil faced fibreglass
- fabricate all brackets, bracing and fixings from galvanised steel.



Heat exchanger:-

- counter flow latent air to air heat exchanger designed for 80% heat reclaim from exhaust air
- constructed from proprietary paper type latent heat exchange material.

Performance criteria:-

<b>Designation</b>	<b>ERV G-1</b>	<b>ERV G-2</b>	<b>ERV 1-1</b>
Air off conditions - db°C/wb°C	29.2/18.1	29.2/18.1	29.2/18.1
Outside/supply air quantity - L/s	400	400	380
Exhaust air quantity - L/s	365	365	345
Estimated external static resistance - Pa	165	180	180
Minimum supply air fan motor power - kW	0.24	0.24	0.24
<b>Designation</b>	<b>ERV 1-2</b>	<b>ERV 1-3</b>	<b>ERV 1-4</b>
Air off conditions - db°C/wb°C	29.2/18.1	29.2/18.1	29.2/18.1
Outside/supply air quantity - L/s	380	380	520
Exhaust air quantity - L/s	345	345	475
Estimated external static resistance - Pa	180	180	155
Minimum supply air fan motor power - kW	0.24	0.24	0.24
<b>Designation</b>	<b>ERV 1-5</b>	<b>ERV 1-6</b>	<b>ERV 1-7</b>
Air off conditions - db°C/wb°C	29.2/18.1	29.2/18.1	29.2/18.1
Outside/supply air quantity - L/s	380	380	380
Exhaust air quantity - L/s	345	345	345
Estimated external static resistance - Pa	155	165	210
Minimum supply air fan motor power - kW	0.24	0.24	0.24
<b>Designation</b>	<b>ERV 1-8</b>	<b>ERV 1-9</b>	<b>ERV 1-10</b>
Air off conditions - db°C/wb°C	29.2/18.1	29.2/18.1	29.2/18.1
Outside/supply air quantity - L/s	380	380	380
Exhaust air quantity - L/s	345	345	345
Estimated external static resistance - Pa	200	155	155
Minimum supply air fan motor power - kW	0.24	0.24	0.24

<b>Designation</b>	<b>ERV 1-11</b>	<b>ERV 1-12</b>	<b>ERV 1-13</b>
Air off conditions - db°C/wb°C	29.2/18.1	29.2/18.1	29.2/18.1
Outside/supply air quantity - L/s	380	380	380
Exhaust air quantity - L/s	345	345	345
Estimated external static resistance - Pa	190	190	180
Minimum supply air fan motor power - kW	0.24	0.24	0.24

#### **4.5 FANS - ROOF MOUNTED**

Supply and install roof mounted fans complying with the following performance and construction criteria.

Fans:-

- aerofoil axial flow or propeller direct drive type with aluminium impellers (where KEF) and either aluminium or GRP impellers (other applications) and aluminium hubs
- backward curved centrifugal type constructed from zinc coated steel.

Fan motors and drives:-

- totally enclosed fan cooled type to IP54 (minimum) incorporating Class "H" insulation where the application is kitchen exhaust (denoted KEF)
- direct drive with multiple speed operation where specified
- suitable for 240 V, 1 phase or 415 V, 3 phase 50 Hz supply as specified
- motor power sufficient to supply 110% of design air quantity against the corresponding system pressure increase
- provide sealed for life ball type bearings.

Cowls, bodies and skirts:-

- fully weatherproof incorporating weather skirt
- manufacture from fibreglass, spun aluminium or galvanised steel
- paint to match roof colour
- incorporate hinged or bolted access to fan and motor
- incorporate bird mesh and back draught shutters
- incorporate back draught shutter restraining devices of "Maglok" manufacture or equal approved.

Performance criteria:-

<b>Designation</b>	<b>KEF-1</b>
Capacity - L/s	2200
Estimated static pressure - Pa	160
Fan type	Aerofoil

<b>Designation</b>	<b>KEF-1</b>
Minimum fan diameter - mm	620
Fan speed control	2 speed
Maximum fan speed - r/s	23
Motor type - V/phase	415/3
Discharge arrangement	Vertical

Estimated static pressure does not include pressure losses through the cowl and back draught shutters.

Noise levels:-

Limit noise levels to the following maximum values (octave band sound power levels, dB re 1 pW).

Hz	63	125	250	500	1000	2000
<b>SWL-KEF-1</b>	26	27	23	14	13	12

#### 4.6 FANS - MIXED FLOW IN-LINE

Supply and install centrifugal, in-line fans complying with the following performance and construction criteria.

Casings:-

- either moulded fibreglass or hot dipped galvanised steel
- incorporating flanges or spigots for duct connections, mounting feet and non-return dampers
- incorporate access panels
- externally located terminal boxes on fan casings.

Motors and drives:-

- direct drive type
- totally enclosed fan cooled motors to IP44 (minimum), 415 V, 3 phase or 240 V, 1 phase (as scheduled)
- motor power sufficient to supply 110% of design air quantity against the corresponding system increase
- sealed for life bearings.

Impellers:-

- backward curved type
- galvanised steel construction.

Sound Attenuators:-

- incorporate sound attenuators where indicated on drawings complying with the following performance specification (Static Insertion Loss, dB):-

<b>Hz</b>	<b>63</b>	<b>125</b>	<b>250</b>	<b>500</b>	<b>1000</b>	<b>2000</b>
<b>SA 1-1</b>	5	7	10	26	44	23
<b>SA 1-2</b>	5	7	10	26	44	23

Performance criteria:-

<b>Designation</b>	<b>OAF G-1</b>	<b>OAF G-2</b>	<b>OAF G-3</b>
Capacity - L/s	70	75	75
Estimated static pressure - Pa	105	105	105
Fan speed control	N/A	N/A	N/A
Maximum fan speed - r/s	35	35	35
Motor type - volts/phase	240/1	240/1	240/1

<b>Designation</b>	<b>OAF G-4</b>	<b>OAF G-5</b>	<b>OAF G-6</b>
Capacity - L/s	40	50	30
Estimated static pressure - Pa	65	60	85
Fan speed control	N/A	N/A	N/A
Maximum fan speed - r/s	32	32	31
Motor type - volts/phase	240/1	240/1	240/1

<b>Designation</b>	<b>OAF G-7</b>	<b>OAF G-8</b>	<b>OAF 1-1</b>
Capacity - L/s	30	20	20
Estimated static pressure - Pa	85	70	70
Fan speed control	N/A	N/A	N/A
Maximum fan speed - r/s	31	25	25
Motor type - volts/phase	240/1	240/1	240/1

<b>Designation</b>	<b>OAF 1-2</b>	<b>OAF 1-3</b>	<b>OAF 1-4</b>
Capacity - L/s	40	20	40
Estimated static pressure - Pa	70	70	70
Fan speed control	N/A	N/A	N/A
Maximum fan speed - r/s	32	25	32
Motor type - volts/phase	240/1	240/1	240/1

<b>Designation</b>	<b>OAF 1-5</b>	<b>OAF 2-1</b>	<b>TEF G-1</b>
Capacity - L/s	305	50	240
Estimated static pressure - Pa	140	85	85
Fan speed control	N/A	N/A	N/A
Maximum fan speed - r/s	46	37	42
Motor type - volts/phase	240/1	240/1	240/1

<b>Designation</b>	<b>TEF G-2</b>
Capacity - L/s	50
Estimated static pressure - Pa	50
Fan speed control	N/A
Maximum fan speed - r/s	31
Motor type - volts/phase	240/1

Noise levels:-

Limit noise levels to the following maximum values (octave band sound power levels, dB re 1 pW).

<b>Hz</b>	<b>63</b>	<b>125</b>	<b>250</b>	<b>500</b>	<b>1000</b>	<b>2000</b>
<b>SWL-OAF G-1</b>	-	51	63	54	54	54
<b>SWL-OAF G-2</b>	-	51	63	54	54	54
<b>SWL-OAF G-3</b>	-	51	63	54	54	54
<b>SWL-OAF G-4</b>	-	50	55	58	57	52
<b>SWL-OAF G-5</b>	-	50	55	58	57	52
<b>SWL-OAF G-6</b>	-	48	56	57	54	53
<b>SWL-OAF G-7</b>	-	48	56	57	54	53
<b>SWL-OAF G-8</b>	-	44	48	51	50	45
<b>SWL-OAF 1-1</b>	-	44	48	51	50	45
<b>SWL-OAF 1-2</b>	-	50	55	58	57	52
<b>SWL-OAF 1-3</b>	-	44	48	51	50	45
<b>SWL-OAF 1-4</b>	-	50	55	58	57	52
<b>SWL-OAF 1-5</b>	-	62	69	73	75	74

Hz	63	125	250	500	1000	2000
SWL-OAF 2-1	-	53	58	61	60	55
SWL-TEF G-1	-	59	66	70	73	72
SWL-TEF G-2	-	53	57	60	59	54

#### 4.7 EVAPORATIVE COOLING UNITS

Supply and install evaporative cooling units complying with the following performance and construction criteria.

Casing and fill:-

- fabricate casing from stainless steel or marine grade aluminium with thermoplastic or ABS plastic water reservoir
- fabricate pad frames from thermoplastic, stainless steel or marine grade aluminium providing adequate support to shredded "Aspen" timber or "Celdek"
- incorporate water pump of self priming type within plastic casing complete with stainless steel shaft and fully enclosed and waterproof electric motor
- supply water via thermoplastic ABS tubes and distributors
- design unit to ensure minimum saturation efficiency of 80%
- incorporate repeat cycle timer to operate a water basin solenoid operated dump valve, set to operate for 2 minutes for every 10 hours of water pump operation, and a 25mm diameter copper drain connection
- incorporate a weather protection cover to each unit
- where the pad frames extend beyond the water reservoir and the potential for water to drip onto the roof incorporate fibreglass drain trays drained to waste under the units
- incorporate a water disinfection unit to each unit
- incorporate a UPVC basket complete with broad spectrum microbicide briquettes suitable for control of Legionella bacteria.

Fan and motor:-

- double width, double inlet, forward curved type incorporating self aligning sealed ball type bearings
- constructed fan impeller from acrylic or polyester coated galvanised steel and scroll from fibreglass, plastic, stainless steel or aluminium
- totally enclosed fan cooled motor to IP54 (minimum), operating at a maximum speed of 24 r/s
- motor power capacity sufficient to supply 110% of design air capacity
- incorporate weatherproof isolating switch and unit control function switch panel.

Performance criteria:-

Designation	EVC G-1
High speed air quantity - L/s	2800
Low speed air quantity (approx) - L/s	1865

**Designation** **EVC G-1**

Estimated external resistance - Pa

Motor type - volts/phase 240/1

#### 4.8 FUME CUPBOARDS

Supply and install a variable exhaust air volume fume cupboard dual sash of the fully packaged type constructed by a specialist manufacturer complying with the following performance and construction criteria.

Comply in all respects with Australian Standard 2243.8 - Safety in laboratories - Fume cupboards and Australian/New Zealand Standard 3000 - Wiring rules.

Construction:-

- smooth internal surfaces with radiused corners
- incorporate removable internal baffles to uniformly distribute air through the cupboard cross section
- 1 piece base incorporating an integral sink
- cove base up walls a minimum of 100mm and incorporate a 20mm lip on the front opening
- incorporate two transparent sashes with external handles having a minimum clearance height of 650mm in the open position and 50mm in the closed position, where exposed to corrosive fumes all components are to be of a corrosion resistant material or finish
- arrange services on vertical fascia panels on both sides with access to all fittings and pipework from the front via a removable front moulding or removable fascia panels
- incorporate a fluorescent light fitting above a sealed accessible glass panel on both upper surfaces of the cupboard to provide an illuminance level at the work surface of 400 lux minimum
- construct panels from fire retardant, corrosion and high heat resistant glass reinforced plastic complying with Australian Standard 1530 - Methods for fire tests on building materials, components and structures
- incorporate "Corian", "ASHAH", "Trespar", "Labalam" or equal approved base and walls suitable for use with acids
- fabricate metal components from stainless steel type 316
- fabricate sashes and lighting panels from 6mm thick armourplate glass
- provide a locking mechanism to ensure only one door can be opened at a time
- provide a 50 x 50 x 2 RHS baked enamel finish support structure constructed to suit the weight of the fume cupboard.

Services:-

- incorporate water and gas outlets as scheduled, located on the inner surface of the fume cupboard
- construct hand wheels and bodies from non-ferrous metal epoxy powder coated finish, colours in accordance with DIN 12920
- incorporate GPO's as scheduled protected by residual current devices and fitted with illuminated indicators to show when power is available. GPO power to be supplied by a dedicated circuit.

## Features:-

- monitor air flow (in accordance with Australian Standard 1482 - Electrical equipment for explosive atmospheres - Protection by ventilation - Type of protection v)
- provide a lockable isolator to the exhaust fan
- operate the fan for 20 minutes after isolation
- extract air from the cupboard from both high and low levels, with a major part being taken from a low level register located just above the upper limit of the sump
- fix a warning label to the cupboard to:-
  - specify the spillage containment of the fume cupboard
  - specify the maximum quantity of flammable liquid which may be introduced into the cupboard at any one time, such quantity never to be in excess of 7.5 l/m<sup>2</sup> of banded base area
  - direct that in event of a liquid spill or fire, the emergency isolator be activated
  - prohibit the placement of any ignition source within the sump
- fix an identification label to the fume cupboard, exhaust fan and ductwork to:-
  - identify the fume cupboard number
  - model of the fume cupboard and manufacturer
- incorporate exhaust volume control system comprising infinite variable speed control of the exhaust fan, control the exhaust fan speed via electronic monitoring of the sash position and a 0-10 volt output signal

## Exhaust fan:-

- centrifugal, belt driven/direct, single width/single inlet, multivane type
- maximum fan outlet velocity of 7.5 m/s
- motor power sufficient to supply 110% of the design air quantity against the corresponding system pressure increase
- total enclosed fan cooled motor to IP54 (minimum), 415 V, 3 phase, 24 r/s maximum
- infinite variable speed drive
- provide a drain connection to the fan casing
- construct scrolls, wheels, inlet and discharge connections from polypropylene, shafts, keys and fittings from stainless steel type 316
- provide access to all parts of the fan for cleaning
- construct casing from PVC
- provide labelling to the fan to indicate any hazards to maintenance personnel.

## Controls:-

- provide fail safe control of the fume cupboard incorporating the following features:-
  - starting and prepurging the fume cupboard
  - implementation of a delay of one minute from establishment of adequate airflow before electrical and flammable gas services to the fume cupboard become available
  - visual indication of the availability of electrical and flammable gas services
  - shutting down of the fume cupboard on both sides of the double entry cabinet



- provision of 2 off local emergency isolator of the manual reset type for termination of electrical and gas supplies upon activation of the local emergency isolator power to fume cupboard GPO's and flammable gas services are to be isolated immediately. Visual indication of electrical and flammable gas service status shall change to show the services are unavailable
- initiate the post purge cycle upon operation of the off or manual emergency isolator
- provide an automatic emergency isolator, operate the automatic emergency isolator upon occurrence of any of the following events and isolate gas and GPO power supplies
  - low face velocity
  - mains power failure
  - operation of the fire detection device with the exhaust duct
  - low solution level or inadequate operation of the scrubber
- provide an audible alarm signal for 20 minutes or until manually acknowledged upon mains power failure
- provide pressure sensing on the discharge of the exhaust fan for indication of air flow.

Performance criteria:-

<b>Designation</b>	<b>FCEF 1-1</b>
Sash width - mm	1200
Exhaust quantity high speed - L/s	305
Estimated external static pressure - Pa	175

Services

Cold Water	Yes
Natural Gas	Yes
Emergency mechanically resettable	
Stop button switch	Yes
Sink	
300mm x 150mm x 200mm deep	Yes

Provide approved retro-fit fire stop collars to fume cupboard exhaust ductwork penetrations through fire rated enclosure.

#### **4.9 ROTARY VENTILATORS**

Supply and install "IVR Lowline Turbo Ventilators" Model LTV200 or equal approved natural rotary ventilators complying with the following performance and construction criteria.

Construction:-

- fabricate from galvanised steel
- corrugated roll formed vanes to prevent weather ingress
- incorporating self lubricating nylon bearings and sealed bearing housing
- locked on rotor mechanism and polyurethane collar to prevent loss and damage in high winds.

Performance Criteria:-

<b>Designation</b>	<b>RV 1</b>	<b>RV 1</b>	<b>RV 2</b>
Diameter - nominal (mm)	100	100	100
Relief air quality - L/s	50	50	50

#### **4.10 SAFETY STORAGE CABINETS**

Supply and install flammable liquids storage cupboards constructed by a specialist manufacturer complying with the following construction criteria:-

- comply in all respects with Australian Standard 2243 - Safety in laboratories - Storage of chemicals, Australian Standard 2982 - Laboratory Construction and Australian Standard 1940 - The storage and handling of flammable and combustible liquids
- incorporate 50mm diameter plugged socket connection at high or low level as appropriate to side of each cabinet for connection of 50mm diameter vent pipework
- incorporate vent pipework as follows:-
  - PVC for acids/chemical storage
  - galvanised steel for flammable liquid storage
- incorporate weatherproof cowl to each vent.

<b>Designation</b>	<b>SSC 1-1</b>	<b>SSC 1-2</b>	<b>SSC 1-3</b>
Chemical stored	Flammable liquid	Corrosive Storage	Oxidiser Storage
Capacity - litres	50	50	50
Size WxDxH (mm)	600 x 450 x 750	600 x 450 x 750	600 x 450 x 750

## **5 PIPING SYSTEMS**

### **5.1 GENERAL**

Construct and install all components of piping systems including pipework and supports in accordance with the requirements of this specification.

Provide all associated equipment such as supports necessary for the safe and efficient operation of the Mechanical Services and as necessary to allow effective maintenance of the plant and equipment.

The drawings are a schematic representation of the systems to be installed and as such do not purport to detail off-sets and bends required for the detailed co-ordination between trades and the as built structure.

Install pipework to achieve a neat and workmanlike appearance laid out with adequate provision for concrete shrinkage, expansion and contraction, grading, alignment and access for maintenance.

Arrange pipework to permit the removal of any item of equipment without cutting pipework and without breaking any structure.

Fabricate bends ensuring a smooth finish without any discernible flattening or corrugation and with a centre line radius of 1.5 times the diameter. Fabricate branches to form swept tees.

Fabricate reducers as concentric reducers on all vertical lines and eccentric reducers on horizontal lines and connections to plant and equipment with the "flat" arranged as appropriate to meet drainage and venting requirements.

Prior to the commencement of the installation, submit for approval evidence of the experience and qualifications of all welding personnel. Use certified welders and supervisors in accordance with Australian Standard 1796 - Certification of welders and welding supervisors.

## 5.2 SCHEDULE OF MATERIALS

Construct piping systems using the following materials:-

Piping System	Material	Design Conditions
Refrigeration	Copper	Maximum operating pressure 3100 kPa Operating temperature range - 20°C - 60°C.

Comply with the following material specifications:-

Copper piping (refrigeration) - Australian/New Zealand Standard 1571 - Copper - Seamless tubes for air conditioning and refrigeration having wall thickness of 1.2mm for pipe sizes of up to and including 50mm.

Supply pipework, new, free of rust, pitting and mill scale, deliver to site fully prime painted and with sealed ends to exclude dirt and water while stored.

## 5.3 SUPPORT AND EXPANSION SYSTEMS

Support and restrain all piping systems to ensure maintenance of alignment and prevention of undue stresses on the piping systems and building structure under all operating conditions.

Design the support and expansion systems including clamps and fittings to take account of the combined loads of the pipework, insulation and reactions due to thermal expansion/contraction and movement of the building structure.

Construct all supports and associated fittings from galvanised steel.

Install dimensionally stable insulating ferrules at the support points of insulated pipework. Incorporate integral aluminium foil/sheetmetal strips between the ferrules and supports to ensure continuity of thermal insulation vapour seal.

Space pipe supports, both vertical and horizontal, at intervals not exceeding the following:-

Nominal Pipe Size - mm	Support Intervals - mm
Up to and including 25	2000
32 to 100	3500

Provide supports adjacent all valves and equipment.

Clamp all pipework, using proprietary clamping systems such as "Binder Kwik-Smart" system or equal approved.

Ensure support systems do not compress pipework insulation.

Construct hanger rods from galvanised steel of diameter not less than 12mm for pipes less than 80mm diameter, 16mm for pipes, 100mm diameter.

Fix single pipe supports to the building structure with masonry anchors connected directly to hanger rods or clamped to structural steel members as applicable.

Fix multiple pipe supports from common channel sections such as “Binder Kwik-Smart” system or equal approved. Connected to the building structure with masonry anchors or clamped/welded to structural steel members.

Utilise hanger rods where maximum movement of pipe is less than 1/5 of the length of the rod. Incorporate spring/neoprene hangers where sufficient rod length cannot be provided to take up the movement.

Provide anchors as necessary to provide reactions for expansion devices, flexible connections and to prevent excessive forces being transmitted to equipment.

Comply in all respects with Australian Standard 1554 - Structural steel welding.

Obtain approval for the design of all support, anchor and expansion systems, for support locations and for loadings to be applied to the building structure, prior to the commencement of manufacture and installation of the systems.

#### **5.4 JOINTS AND FITTINGS - COPPER, REFRIGERATION SERVICES**

Expand, clean, degrease, thoroughly roughen with emery paper or steel wool and lap pipework, 20mm lap, with laps installed in the direction of flow. Utilise silver solder on copper/bronze connections. Purge pipework with dry nitrogen and silver braze with 15.0% silver alloy. Continue purging throughout the soldering process to prevent internal scaling deposits from forming.

Alternatively utilise flared compression fittings on pipe sizes up to and including 20mm.

#### **5.5 GRADIENTS AND DRAINS**

Provide drain facilities from all items of equipment such as drip trays to the nearest floor waste in not less than 25mm diameter pipework incorporating screwed unions to enable rodding out. Grade drain pipework at not less than 1:100.

Grade refrigeration suction and hot gas discharge lines in the direction of flow at not less than 1:250.

#### **5.6 TESTING OF PIPING**

Test all piping systems in accordance with the requirements of the appropriate Statutory Authorities, Australian Standards and the following.

Pressure test refrigeration systems to 3100 kPa on the high side and 700 kPa on the low side with a dry inert gas. Hold test for 6 hours with no measurable drop in pressure. Evacuate system to 25 Pa (0.2mm Hg) and hold for 6 hours without rising to above 55 Pa (0.4mm Hg) before charging with refrigerant.

Test drains by capping off lowest point, filling with liquid and visually checking all joints for leaks.

Fully re-make all joints found to be leaking and re-test the systems.

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## **6 AIR DISTRIBUTION SYSTEMS**

### **6.1 GENERAL**

Construct and install all components of air distribution systems including ductwork, dampers and air diffusion equipment in accordance with the requirements of this specification.

Construct and install the air distribution systems including ductwork and acoustic insulation in accordance with the Australian Standard 1668.2 - The use of mechanical ventilation and air conditioning in buildings - Mechanical ventilation for acceptable indoor air quality and all applicable statutory requirements.

The drawings are a schematic representation of the various systems to be installed and as such do not purport to detail off-sets and transitions required for the detailed co-ordination between trades and the as built structure.

Duct dimensions nominated on the drawings are in millimetres and are the clear air passage dimensions with the first dimensions indicating the side of ductwork in view on the particular plan or elevation.

Construct ductwork ensuring smooth airflow without obstruction, stiffen ducts and dampers to eliminate all start-up, shut-down or operating noise due to panel movement or vibration.

## 6.2 SCHEDULE OF CONSTRUCTION AND INSTALLATION STANDARDS

Construct and install ductwork in accordance with Australian Standard 4254 - Ductwork for air handling systems in buildings or the Sheet Metal and Air Conditioning Contractors National Associations Inc. - HVAC Duct Constructions Standards Metal and Flexible - First Edition 1985 and the following.

Fabricate ductwork from galvanised sheet steel to Australian Standard 1397 - Steel sheet and strip - Hot dipped zinc coated or aluminium/zinc coated.

Fabricate fume cupboard exhaust ductwork from UPVC stormwater pipe with pipe joints incorporating thermal fillet welds, scrape all joints prior to welding.

Seal water-tight all joints and grade ducting exposed to the weather or carrying noxious fumes or moisture including evaporative cooling, toilet exhaust, kitchen exhaust and laboratory exhaust ductwork with silicon sealant compound "GE Silgaze N" (unpainted surfaces), "GE 5090 Silicone II" (painted surfaces) or equal approved applied to the metal prior to constructing the joint.

Provide drain points to all low points in the kitchen and laboratory exhaust ductwork.

Construct ductwork utilising material thickness and reinforcement schedules in accordance with the SMACNA 2" wg (500 Pa) standard and the following minimum material thickness, transverse joint reinforcement and intermediate reinforcement schedule. Utilise "Pittsburg Lock" at all longitudinal corner seams.

Duct Longest Side (mm)	Material Thickness (mm)	Transverse Joint Reinforcement (mm)	Intermediate Reinforcement (mm)
0-450	0.6	Drive cleat all round at 1500 centres	Duct beaded or cross broken
451-600	0.6	PF or reinforced drive cleat at 1500 centres	Duct beaded or cross broken
601-1000	0.8	PF at 1500 centres	Duct beaded or cross broken.

PF denotes proprietary flanging system such as MEZ or TDF.

Seal UPVC fume cupboard ductwork joints with thermal welding including infill fillets. Comply in all respects with Australian Standard 2032 - Code of Practice for Installations of UPVC Pipe Systems.

Construct kitchen exhaust ductwork from not less than 1.2mm thick material.

## 6.3 CIRCULAR FLEXIBLE DUCTWORK

Fabricate ductwork from helically wound spring steel wire bonded to multiple layers of aluminium foil and polyester film, acoustically insulated and provided with air-tight aluminium laminate sheathing. Comply with Australian Standard 4254 - Ductwork for air handling systems in buildings and Australian Standard 1668 - Mechanical Ventilation and Air Conditioning Code.

Provide the following minimum acoustic insertion loss capability (based on a 3000mm length of 250mm diameter ductwork):-

Frequency/Hz	63	125	250	500	1000	2000
Insertion Loss	4	6	15	25	28	33

Incorporate insulation having the minimum thermal properties of R1.0.

Limit flexible duct length to single lengths of 3000. Incorporate sheetmetal circular ductwork to limit flexible duct lengths.

Form bends with a centre line radius of not less than 1.5 times the diameter of the ducts.

Replace deformed or damaged bends of ductwork.

Construct fittings including reducers, T-pieces, Y-pieces and change-over boxes from galvanised sheet steel thermally insulated.

Construct joints between duct pieces, and at connections to fittings, from short galvanised steel spigots incorporating spring tabs.

Seal joints and connections as follows:-

- tape inner sheath to duct fitting
- mechanically fix with "Jubilee" worm drive hose clip or similar proprietary banding system
- tape outer sheath to duct fitting.

Utilise "Venture Tape 1599B" or equal approved.

Support ductwork with rot and fire proof webbing (minimum 150 wide band) at all changes in direction and at not more than 2000mm intervals. Ensure ductwork is supported clear of ceilings.

Incorporate rigid UPVC webbing or galvanised sheet steel semi-circular sections at each support point to distribute loads.

#### **6.4 SUPPORTS, REINFORCEMENT AND BRACING**

Construct and install supports, reinforcement and bracing in accordance with the Sheet Metal and Air Conditioning Contractors National Associations Inc - HVAC Duct Construction Standards - Metal and Flexible -First Edition 1985 and the following.

Fabricate brackets, bracing, hanger rods and all bolts from zinc coated or hot dipped galvanised steel.

Utilise "Prestick" to the full width of all flange joints including proprietary flanges.

Unless approval is obtained to support air diffusion equipment and associated cushion head boxes/plenums from the ceilings/ceiling suspension system, support all that equipment from the building structure above.

#### **6.5 SUPPORTS, UPVC DUCTWORK SYSTEMS**

Support and restrain all ductwork systems to ensure maintenance of alignment and prevention of undue stresses on the ductwork systems and building structure under all operating conditions.

Design the support systems including clamps and fittings to take account of the combined loads of the ductwork, fittings, and reactions due to thermal expansion/contraction and movement of the building structure.

Construct all supports and associated fittings from galvanised steel. Isolate dissimilar metals with PVC tape.

Space ductwork supports, both vertical and horizontal, at intervals not exceeding the following:-

Nominal Ductwork Size - mm	Support Intervals - mm
125 and 150	2100
200	2400
250 and over	2500

### 6.6 DUCT MOVEMENT AND VIBRATION

Install ductwork to allow movement due to expansion and/or contraction without placing stress on either the ducts or building structure.

Provide flexible connections and vibration isolators as required to ensure vibration and/or noise is not transmitted to the building elements.

### 6.7 FLEXIBLE CONNECTIONS

Provide flexible connections at all fans, air conditioning units, energy recovery ventilators and air conditioning internal units.

Construct flexible connections from:-

- neoprene glass coated fabric having a density of not less than 1 kg/m<sup>2</sup> for normal applications at less than 90°C.

Provide weatherproof covers constructed from galvanised sheet steel to all exposed flexible connections.

Ensure flexible connections are completely air tight and a minimum of 100mm wide at duct connections to all fans and items of air handling equipment.

Align associated ductwork, fans and equipment prior to installing the flexible connections.

### 6.8 LEAK TESTING

Carry out leak testing comprising hand feel and audio checking of all joints.

Seal all leaks with "3M EC.800" or approved equivalent.

### 6.9 BALANCING DAMPERS

Provide volume control dampers as necessary for the correct and proper balancing of the air distribution systems.

Butterfly dampers - duct take-offs:-

- construct dampers from zinc coated steel or spun aluminium
- minimum casing thickness 0.8mm
- minimum blade thickness 0.6mm
- fix to trunk ductwork with pop rivets and seal with silicon sealant compound "3M EC 800".

Opposed blade dampers (galvanised steel construction) - ducts:-

- construct dampers from zinc coated steel with frames minimum 2.5mm x 150mm x 25mm channel sections and blades minimum 1.6mm thick with 12mm wide edge breaks to prevent flexing, twisting and distortion of the blades

- limit unsupported blade length to 1200mm
- fabricate blade spindles from 12mm diameter grade 316 stainless steel incorporating freely rotating brass, teflon or "oilite" bearings mounted on the damper frame
- utilise single blade dampers, with damper blades not more than 225mm wide and incorporating edge strips to the tips, in ducts over 350mm deep
- controls dampers by the use of galvanised steel quadrants, control levels and a locking device. Construct linkages from zinc coated steel incorporating position indication.

#### 6.10 SCHEDULE OF ACOUSTIC LINING

Supply and install acoustic lining as detailed on the drawings and in accordance with the following schedule:-

System Component	Acoustic Lining Requirements
Ductwork	Ductwork detailed as cross hatched on the drawings, 25mm thick insulation with perforated aluminium foil facing. Ductwork detailed as double cross hatched on the drawings, 50mm thick insulation with perforated aluminium foil facing.
Cushion heads	25mm thick insulation to top and side with perforated aluminium foil facing or 25mm thick bonded polyester "TBL 3225 - Black Welty" to top and sides.
Flexible ductwork	25mm acoustic type.

#### 6.11 ACOUSTIC LINING MATERIALS AND INSTALLATION

Manufacture acoustic lining from materials complying with Australian Standard 1530 - Part 3 - Test for Early Hazard Properties of Materials and having test results of Ignitability Index 0, Spread of Flame Index 0, Heat Evolved Index 0 and Smoke Developed Index not greater than 3.

Manufacture acoustic lining from mineral wool, fibreglass or bonded polyester wadding rigid batts having a density of not less than 30 kg/m<sup>3</sup> and a thermal conductivity of not more than 0.04 W/m<sup>2</sup>K at a mean temperature of 24°C.

Face lining with perforated aluminium foil laminate sheet similar to "Sisalation 450" or 0.6mm thick perforated zinc anneal sheet as scheduled and having a free area of approximately 10%. Utilise impervious lining to acoustic fill - "Melinex" or equal approved - in kitchen exhaust applications.

Fasten lining to sheet metal ducts with weld pins and speed clips located at not more than 75mm from the edges of the ducts and spaced at not more than 400mm centres.

Provide sheet metal nosings to end pieces.

Incorporate either galvanised sheet steel angles to all corner pieces or cut back insulation to expose the full depth of the foil laminate, roll under, glue, butt adjoining insulation prepared in the same manner, seal butt joint with silicon.

Lap, adhere and tape joints in the aluminium foil laminate sheets. Pop rivet joints in zinc anneal sheets.





## 7 THERMAL INSULATION

### 7.1 GENERAL

Supply and install thermal insulation to pipework, ductwork and equipment in accordance with the requirements of the specification.

Install the insulation using only skilled tradesmen, experienced and competent in this type of work.

Clean all surfaces thoroughly of scale, rust, grease, oil and dirt prior to the application of the insulation. Complete all pressure and leak testing prior to the application of the insulation. Maintain close contact between insulation and applied surfaces. Ensure insulation is continuous, with all joints firmly butted together, cold tracking eliminated and the system is vapour sealed.

Test all insulation systems, including coatings, facings, vapour barriers and adhesives in accordance with Australian Standard 1530 - Methods for fire tests on building materials, components and structures.

Manufacture insulation systems from materials having test results of - Ignitability Index 0, Spread of Flame Index 0, Heat Evolved Index 0 and Smoke Developed Index not greater than 3.

Utilise blown insulation products manufactured only with the use of gases with an Ozone Depletion Potential (ODP) of zero. Utilise only glues and sealants of the low Volatile Organic Compound (VOC) type with emission limits after 30 days not exceeding:-

- Multipurpose adhesives                      70g
- Sealants    250g.

### 7.2 SCHEDULE OF INSULATION

Supply and install thermal insulation to all ductwork, pipework and equipment in accordance with the following schedule.

Insulate within the factory of manufacture all equipment in accordance with the Plant and Equipment Section of the Specification and the following schedule.

Equipment, System	Thermal Insulation Requirements
Refrigeration pipework	All pipework insulated.
Air conditioning ductwork	All ductwork not acoustically insulated, to be thermally insulated.

### 7.3 PIPING SYSTEMS INSULATION

Provide piping system insulation systems as follows:-

- 18mm thick flexible closed cell, chemical blown PVC nitrate rubber sponge type material "Armaflex" manufacture or equal approved having a thermal conductivity of not greater than 0.04 W/mK at a mean temperature of 25°C
- where internal to the building utilise "FR/Armaflex" or equal approved comply with Australian Standard 1530 - Methods for fire tests on building materials, components and structures - Spread of Flame Index 0, Smoke Developed Index 3
- utilise only products manufactured using blowing gas with an Ozone Depletion Potential (ODP) of zero
- prior to the application of the insulation thoroughly clean free of scale, rust, grease and dirt all piping surfaces
- apply the insulation without longitudinal slitting, glue all joints with a waterproof adhesive and tape all joints and ends.

Insulate all sections of the piping systems.

#### 7.4 AIR DISTRIBUTION SYSTEMS INSULATION

Provide thermal insulation to all ductwork, comprising flexible mineral wool, fibreglass or "Tontine" bonded polyester wadding, factory faced with aluminium foil laminate having a thermal conductivity of not greater than 0.042 W/mK at a mean temperature of 20°C.

Minimum insulation performance and thickness :-

- within ceiling spaces/return air plenums R1.0/25mm

Apply the insulation to form an effective thermal and vapour barrier over the whole surface of the ductwork including flanges, stiffeners and support angles with all insulation joints butted together and with the aluminium foil overlapping at least 50mm and fully adhered with a non flammable adhesive.

Fix the insulation to the ducts with speed clips and pins at a maximum of 450mm centres. On ducts having a maximum duct dimension greater than 450mm provide fixing bands complete with corner angles at each joint and at 600mm centres maximum.

## 8 ELECTRICAL

### 8.1 GENERAL

Supply and install all electrical wiring systems, switchgear and controlgear assemblies (SCA) and ancillary equipment associated with the Mechanical Services systems.

Install the electrical services system using only skilled, Class 'A' electricians, experienced and competent in the type of work.

Purchase and supply packaged equipment complete with control cubicles containing motor starters, fuses, associated switchgear and safety controls.

Confirm the electrical loads of all equipment prior to the purchase of submains cables by the Electrical Services Contractor. Pay all costs associated with delays, re-work, making good, additional work and any other associated costs involved due to alterations, resulting delays, or deficiencies in the co-ordination of these works or provision of information.

### 8.2 SCHEDULE OF ELECTRICAL WORKS

Supply and install the complete electrical installation as required for the satisfactory operation, control, maintenance and safety of the Mechanical Services systems.

Include the following items and equipment:-

- Mechanical Services switchgear and controlgear assembly MSSB G-1 located in the ground floor north western plantroom
- Mechanical Services switchgear and controlgear assembly MSSB 1-1 located in the first floor north western plantroom
- Mechanical Services switchgear and controlgear assembly MSSB 1-2 located in the first floor south eastern plantroom
- Mechanical Services switchgear and controlgear assembly MSSB 1-3 located in the first floor south western plantroom
- terminals for the connection of the submains provided by the Electrical Services Contractor
- motor starters, switchgear and controls, complete with all necessary accessories for all electrically operated equipment

- all final power subcircuits between the switchgear and controlgear assemblies (SCA) and the various plant components and between isolating switches provided by the Electrical Contractor, including connections to SCA and equipment
- all control wiring and connections within and between the SCA, and to thermostats, control and solenoid valves, damper motors, airflow and pressure switches, packaged units and the like.

### 8.3 INSTALLATION STANDARDS

Comply with the requirements of the Supply Authority and with the current Australian Standards. In particular comply with the requirements of Australian/New Zealand Standard 3000 - Wiring rules, Australian Standard 2430 - Classification of hazardous areas and Australian Standard 3008 - Electrical installations - Selection of cables.

Earth the entire installation. Provide a separate earthing conductor to each outgoing circuit originating at the earth bar in the associated SCA.

### 8.4 WIRING SYSTEMS

Adequately rate cables for their duty with due allowance made for voltage drop, method of fixing, derating factors for numbers of cables enclosed and types of enclosures.

Rate cables on a voltage drop from the ETSA Utilities point of supply to each item of equipment not exceeding 5% of the supply voltage for power cabling and not exceeding 10% of the nominal voltage for control cables operating at extra low voltage.

Colour code the whole wiring installation. Number all terminals and each control wire. Cross reference numbers to the wiring diagrams.

Terminate cables using lugs or terminal clips.

Install cables such that circulating eddy currents and inductive currents are minimised. Slot cable entry holes to equipment where cables are rated at 300 amps or above. Group cables in 3 phase formation.

Maintain adequate spacing between cables to allow heat dissipation. Apply derating to cables installed in groups as required by Australian Standard 3008.1 - Electrical installations - Selection of cables - Cables for alternating voltages up to and including 0.6/1 kV.

Install cables using the loopin loopout system of wiring. Use only continuous conductors between terminal points. Where cable route length exceeds maximum manufactured cable length, join cables using the manufacturers recommended procedure.

Loop cables twice prior to terminating to equipment mounted on vibration isolation mounts. Rigidly fix the cable to the solid structure and to motor terminal box such that straining or movement of the cable gland under all conditions is entirely eliminated. Provide a single loop to all other cable terminations except SCA where looping is not required.

Provide cables of the following types:-

Power cables, PVC insulated:-

- PVC and PVC/PVC cables of minimum V75, 0.6/1 kV insulated stranded copper conductor in accordance with Australian Standard 3147 - Approval and test specification - Electric cables - Thermoplastic insulated - For working voltages up to and including 0.6/1 kV.

Control cables, field signalling, up to 110 V ac, 150 V dc:-

- stranded copper conductor, minimum 0.5mm<sup>2</sup>, V105, 110 V ac, 150 V dc, PVC insulated pairs or triples, V90 PVC sheathed with aluminium polyester tape screen, tinned copper drain wire and rip cord
- maximum capacitance core to core 200 pF, core to screen 300 pF. Utilise lower capacitance cable where dictated by operating parameters for proper system performance
- earth screens at the send end only
- terminate by exposure of not more than 50mm of insulated conductor. Maintain twist to connection point and insulate screen and drain wire from inadvertent earth or conductor contact by heatshrink sleeving
- "Olex Dekoron" or equal approved.

Control cables, field signalling, 240 V ac:-

- stranded copper conductor, minimum 0.5mm<sup>2</sup>, minimum V75, 0.6/1 kV PVC insulated and sheathed with insulated earth conductor
- up to and including 4 core, standard PVC/PVC circular power cable construction, orange sheath
- 5 core and above, circular multicore control cable, orange sheath, white cores with black lettering and numbering, green/yellow earth. "Olex BFCP" or equal approved
- where used in conjunction with variable speed drives, utilise twisted construction minimum 85% braided copper screen cable earthed at the drive end.

Control cables, field actuators:-

- stranded copper conductor, minimum 0.5mm<sup>2</sup>, minimum V75, 0.6/1 kV PVC insulated and sheathed with insulated earth conductor
- standard PVC/PVC circular power cable construction, orange sheath.

Supply and install cables, and cable enclosures or supports as follows:-

Within plantrooms and service shafts:-

- single insulated PVC cables enclosed in heavy duty rigid non-metallic conduit or cable troughs where multiple cable runs are required
- cabling to large motors, as an alternative, can be run in PVC/PVC cables on cable tray
- utilise flexible PVC conduits and terminators of approved manufacture at connections to motors and controls, limit conduit length to 1000 maximum.

External to plantrooms:-

- PVC/PVC cables supported on cable trays or as open wiring supported in accordance with Australian/New Zealand Standard 3000 - Wiring rules and classified as Cables likely to be disturbed may be installed
- provide catenary wires to support cables clear of ceiling tiles.

Install conduits, cable troughs and cable trays in accordance with Australian/New Zealand Standard 3000 - Wiring rules.

Manufacture conduits in accordance with Australian/New Zealand Standard 2053 - Conduits and fittings for electrical installations.

Manufacture cable trays from galvanised sheet steel of 1.0mm thick for trays up to 300mm wide, and 1.6mm for trays over 300mm wide. Provide a folded edge not less than 19mm deep and radiused. Perforate the sheet steel in "Admiralty" pattern. Utilise approved fittings for bends, tees, crosses and the like.

Install and support trays to ensure a neat workmanlike finish and ensure sufficient space is maintained around cable trays for air circulation.

Install cables parallel with and neatly saddled to the trays and allow 30% spare space for future cable installation.

Provide cable tray covers as necessary to prevent mechanical damage to the cables.

### **8.5 SWITCHGEAR AND CONTROLGEAR ASSEMBLIES (SCA)**

Comply in all respects with Australian Standard 3439.1 - Low voltage switchgear and controlgear assemblies - Type tested and partially type tested assemblies and Australian Standard 1939 - Degrees of protection provided by enclosures for electrical equipment (IP Code).

Incorporate all necessary starting arrangements, facilities and accessories.

Construct the supply section main busbars within the SCA up to and including the outgoing functional units to be capable of withstanding a minimum fault level of 15 kA for 0.01 seconds or, as scheduled, whichever is the greater with a peak factor of 2.0. Submit for approval, a type test certificate for the proposed busbar design to substantiate the fault rating and incorporate a compliance plate on the SCA.

Construct SCA using non visible structural members and commercial quality drawn SPC1 bright mild steel, machine bent and folded providing surfaces smooth and free from warps, twists and other distortions. Provide an internal framework to adequately stiffen the SCA such that all equipment is adequately supported and stresses imposed during transportation and installation are withstood.

Construct panels of the following minimum thickness material:-

<b>Diagonal Dimension</b>	<b>Thickness</b>
<600mm	1.6mm
600mm - 900mm	2.0mm (1.6mm with framing or bracing folding)
>900mm	2.5mm (2.0mm with framing or bracing folding)

Fit chrome plated, lockable handles to all doors. Key alike to CL001 keys.

Provide hinged fascia panels above the doors for the mounting of switches, meters and pilot lights.

Provide lift off panels complete with chromed handles and locating pins or wedges.

Adequately ventilate the SCA by natural means such that the maximum temperature inside the cubicles does not exceed the limits set out in Table 7.3 of Australian Standard 3439.1 - Low voltage switchgear and controlgear assemblies - Type tested and partially type tested assemblies. Provide filter media to air intake louvres.

Fill and grind smooth all visible welds, remove all scale, rust and grease and paint.

Provide, within the SCA, a minimum of 15% spare space for possible future circuits over and above any specified provisions. Include spare space provisions for all SCA sections including fuse ways, contact and relay panel space and fascia panel.

Panel mount, front connect and front wire all contactors, motor starters, fuses relays and timers fixed to drilled and tapped steel mounting panels with zinc plated steel bolts and shake proof washers.

Provide cable entry provisions via removable gland plates or pre-punched conduit knockouts.

Run wiring within wiring channels with all wiring neatly run and clipped. Number the terminal blocks and each end of all control cabling.

Provide numbered terminal strips to which all control cabling entering and leaving the SCA are to be connected.

Run field power wiring for equipment such as motors and heaters direct into the control equipment via cabling ducts.

Connect all control actives to the red phase.

Manufacture and install SCA equipment to comply with the following:-

Main busbars:-

- construct of high conductivity hard drawn copper with continuous installed current ratings suitable for and compatible with mounting or assembly arrangements and connected switchgear frame ratings
- configure to match incoming conductors, with uniform phase rotation
- submit complete busbar calculations with shop drawings for approval prior to construction
- pre-drill busbars and supports for incoming and outgoing supplies, future switchgear and CT's
- provide readily removable busbar sections for CT mounting
- construct main interconnections and tee-offs in excess of 100A rating using busbar
- machine bend and form all busbars at radii appropriate to busbar dimensions. Do not mark or stress. Draw file or belt sand matching faces smooth before jointing. Use high tensile steel bolts with washers, torque tensioned to the manufacturer's recommendations for all busbar joints. Other approved proprietary busbar connection systems may be offered for switchboards up to fault rating 15 kA for 0.01 sec
- use only pencils, crayons or dye when marking out. Scribing is not permitted
- colour busbars in Form 2 and Form 3 assemblies on each busbar section in each compartment by means of phase colour coded insulated heat shrink sleeving
- insulate busbars for miniature circuit breaker distribution sections with phase coloured thermoplastic insulation
- install connections for moulded case and miniature circuit breakers so that either a triple pole or 3 single pole circuit breakers can be mounted side by side
- construct supports to be rigid and made of an approved insulating material, with secondary insulation through each support for uninsulated busbars to prevent direct tracking paths between phases and earth.

Neutral and earth busbars:-

- provide adjacent neutral and earth bars for the full length of SCA in excess of 900mm in length, extended into cable zones
- fit miniature circuit breaker distribution sections with screw terminal type neutral and earth bars mounted adjacent. Provide connecting devices with tunnel connectors of 4.8mm diameter with provision for lug or stud connectors for all cables 10mm<sup>2</sup> or greater.

Switchgear and controlgear:-

- provide equipment with rated capacities defined as the nett values after application of deratings relative to the enclosure, situation and service conditions of the SCA and equipment.

Moulded case circuit breakers (MCCB's):-

- comply with Australian Standard 2184 - Low voltage switchgear and controlgear - Moulded case circuit breakers for rated voltages up to and including 600 V ac and 250 V dc
- for rating less than 400 A, fit with instantaneous and inverse overcurrent trip, minimum fault rating to match the host SCA and positive "ON", "OFF" status indication
- for rating 400 A or greater, fit with temperature insensitive solid state trip with externally adjustable short and long time delay operating in 3 phases, front accessible facilities for "In Service" secondary injection testing and calibration, "push-to-trip" button for mechanical verification, minimum fault rating and removable line and load covers to match SCA fault rating and positive "ON", "OFF" status identification
- fit auxiliary contacts for status monitoring functions.

Miniature air circuit breakers (MACB):-

- comply with Australian Standard 3111 - Approval and test specification 0 Miniature overcurrent circuit breakers and fit with instantaneous and inverse time overcurrent trip, positive "ON", "OFF" status identification, minimum fault rating of 6 kA, higher fault current rated circuit breakers where fault level exceeds circuit breaker capacity and circuit breaker cascading only where detailed.

Residual current devices (RCD's):-

- comply with Australian Standard 3190 - Approval and test specification - Residual current devices (current operated earth leakage devices).

Fuse combination units:-

- comply with Australian Standard 3947.3 - Low voltage switchgear and controlgear - Switches, disconnectors, switch disconnectors and fuse combination units
- flush mounting, double break, horizontal withdrawable cartridge type with individual enclosures and ionised gas barriers
- "ON", "OFF" position indicators operated by the contact mechanism or linkage
- dustproof, interlocked doors preventing door opening whilst energised and switch closure while door is open
- spring driven quick make/quick break contacts
- load break/fault make to minimum 50 kA at 440 volts and HRC fuse links and terminals fully shrouded to prevent accidental contact whilst SCA is energised
- auxiliary contacts for status monitoring functions
- fit auxiliary contacts for status monitoring functions.

Fuses:-

- comply with Australian Standard 2005.10 - Low voltage fuses - Fuses with enclosed fuse links - General requirements
- of silver eutectic type of "GEC", "Federal", "Brush" or equal approved manufacture



- provide 3 spare fuses of each type utilised, installed on a fully labelled clip-in rack, within each switchboard.

**Transducers:-**

- case mounted with flame retardant glass fitted polymer cover and flame retardant polycarbonate case
- DIN rail mounting with removable terminal covers to externally accessible screw terminals
- class 0.2 accuracy with 300% continuous overload capability at 25°C and 4 kV isolation between all inputs and outputs for 1 minute
- complete with integral terminal identification, rating details and wiring diagram
- current, true RMS, 3 phase, 4-20 mA output
- voltage, true RMS, 3 phase, line to neutral voltage, 4-20 mA output
- phase angle, 3 phase, 3 wire unbalanced for high voltage, 3 phase 4 wire unbalanced type for medium/low voltage, 4-20 mA output
- provide all necessary auxiliary power supplies
- GEC Alstom Istat 300 or approved equal.

**Contactors and motor starters:-**

- to Australian Standard 1029 - Low voltage contactors and Australian Standard 1202 - AC motor starters (up to and including 1000 V) - class 0.3 duty, utilisation category AC3. Use moulded encapsulated coils and arrange for replacement of coils and contacts without the need for special tools. Minimum life 1,000,000 no load operating cycles.

**Auxiliary and overload contacts:-**

- fit all contacts and starters with a minimum of 2 each normally open and normally closed auxiliary contacts. Fit no voltage release and delayed, thermally compensated electronic over current relays with manual reset to Australian Standard 1023 - Low voltage switchgear and controlgear - Protection of electric motors (1 per phase)
- utilise electric type thermal overload relays of "Sprecher and Schuh CT3" manufacture of equal approved for motors up to 50 kW
- utilise electronic type thermal overload relays of "Sprecher and Schuh CEF1" manufacture or equal approved for motors 50 kW and greater
- provide embedded thermistor protection to all motors rated 11 kW and above
- where required to operate in smoke control mode provide bypass contactors to shunt overload protection initiated by fire alarm signal
- overcurrent relays and under voltage releases are not required where the equipment is controlled by a variable frequency speed controller complying with this Specification.

**Rotary switches:-**

- cam operated, to Australian Standard 3947.5.1 - Low voltage switchgear and controlgear - Control circuit devices and switching elements - Electromechanical control circuit devices for voltages up to 650 V ac and 250 V dc type tested for a minimum of 1,000,000 operations including derating if required.

## Indicator lights:-

- coloured to Australian Standard 3947.5.1 - Low voltage switchgear and controlgear - Control circuit devices and switching elements - Electromechanical control circuit devices for voltages up to 650 V ac and 250 V dc. Fit lights of the backlit designation type, capable of dissipating continuous rated power and visible through a 180° viewing angle. Fit neon lamps. Provide a lamp test button
- "Sprecher and Schuh" manufacture DT L3 or equal approved.

## Alarm circuit:-

- connect each alarm/fault function to an individual fault indicator. In addition, provide one only common fault/alarm signal changeover 16 A contact to each SCA.

## Current transformers:-

- to Australian Standard 1675 - Current transformers - Measurement and protection
- protection, 5 Amp secondary, Class P, composite error 2.5, rated accuracy limit factor 20
- instrument, 5 Amp secondary, accuracy Class 1.0
- suitably rated for connected burden
- use separate protection and instrument current transformers.

## ELV control circuit transformers:-

- to Australian/New Zealand Standard 3108 - Approval and test specification - Particular requirements for isolating transformers and safety isolating transformers, 240/24 volt ac double wound and sized for the connected load. Provide separate fused control supply.

## Control relays:-

- to Australian Standard 1029 - Low voltage contactors and Australian Standard 3947.5.1 - Low voltage switchgear and controlgear - Control circuit devices and switching elements - Electromechanical control circuit devices for voltages up to 650 V ac and 250 V dc, plug in interchangeable, rail mounting, translucent cover, front connected with retaining clips. Provide a spare relay of each type plugged into a dummy socket on each SCA
- fitted with not less than 4 field selectable self wiping contacts
- fitted with field adjustable electronic timing mechanism where required.

## Under voltage and phase failure relays:-

- combination adjustable function relay with 1 only 16A changeover contact as follows:-
 

under frequency	-	45-50 Hz
over frequency	-	50-55 Hz
under voltage	-	pickup 350-450 V ac, dropout 70-90% of pickup
over voltage	-	pickup 300-600 V ac
reset	-	automatic reset (0-5 min adjustable)

## Terminals:-

- "Sprecher and Schuh" or equivalent screwed tunnel type, rail mounted.

**8.6 SCHEDULE OF SCA**

Incorporate the following equipment and comply with the design criteria as scheduled below:-

MSSB G-1:-

- Prospective short circuit current <6 kA
- Form of segregation Form 1
- Arcing fault containment Not required
- Thermal design conditions Maximum SCA internal temperature not to exceed 75°C. Switchroom is naturally ventilated and located internally
- Service conditions To clause 6.1 of Australian Standard 3439.1 - Low voltage switchgear and controlgear assemblies - Type tested and partially type tested assemblies
- Special service condition Insect and vermin proof
- Diversity factor for load circuits To clause 4.7 of Australian Standard 3439.1 - Low voltage switchgear and controlgear assemblies - Type tested and partially type tested assemblies
- Degree of protection IP43
- Equipment served:
 

Item	Nominal Rating Amps/Phase/Voltage	Starting
ACC 4a	33.4/3/415	Inverter
ACC 4b	19.5/3/415	Inverter
ACU G-4	0.8/1/240	DOL
ACU G-5	0.8/1/240	DOL
ACU G-6	0.8/1/240	DOL
ACU G-7	0.8/1/240	DOL
ACU G-13	0.4/1/240	DOL
ACU G-14	0.4/1/240	DOL
ACU 2-1	0.3/1/240	DOL
EVC G-1	7.3/1/240	DOL
OAF G-1	0.3/1/240	DOL
OAF G-2	0.3/1/240	DOL
OAF G-3	0.3/1/240	DOL
OAF G-4	0.26/1/240	DOL
OAF G-5	0.26/1/240	DOL
OAF G-6	0.22/1/240	DOL
OAF G-7	0.22/1/240	DOL
OAF 2-1	0.37/1/240	DOL
TEF G-1	0.72/1/240	DOL
TEF G-2	0.26/1/240	DOL
- Submains connected 4 x 1c 70mm<sup>2</sup> Cu/x90
- Submains protection 125A fault current limiting circuit breaker
- Supply voltage drop 2.5% maximum from ETSA Utilities supply point to MSSB
- SCA equipment under voltage and phase failure relay, run indicator lights.

## MSSB 1-1:-

- Prospective short circuit current <6 kA
- Form of segregation Form 1
- Arcing fault containment Not required
- Thermal design conditions Maximum SCA internal temperature not to exceed 75°C. Switchroom is naturally ventilated and located internally
- Service conditions To clause 6.1 of Australian Standard 3439.1 - Low voltage switchgear and controlgear assemblies - Type tested and partially type tested assemblies
- Special service condition Insect and vermin proof
- Diversity factor for load circuits To clause 4.7 of Australian Standard 3439.1 - Low voltage switchgear and controlgear assemblies - Type tested and partially type tested assemblies
- Degree of protection IP43
- Equipment served:
 

Item	Nominal Rating Amps/Phase/Voltage	Starting
ACC 1b	23.3/3/415	Inverter
ACC 2b	33.4/3/415	Inverter
ACC 2c	19.5/3/415	Inverter
ACU G-10	0.8/1/240	DOL
ACU 1-10	0.5/1/240	DOL
ACU 1-11	0.5/1/240	DOL
ACU 1-12	0.6/1/240	DOL
ACU 1-13	0.6/1/240	DOL
ACU 1-14	0.6/1/240	DOL
ACU 1-15	0.6/1/240	DOL
ACU 1-16	0.4/1/240	DOL
ACU 1-17	0.4/1/240	DOL
ACU 1-18	0.6/1/240	DOL
ACU 1-19	0.8/1/240	DOL
ACU 1-20	0.8/1/240	DOL
ACU 1-21	0.8/1/240	DOL
ERV 1-6	6/1/240	DOL
ERV 1-7	6/1/240	DOL
ERV 1-8	6/1/240	DOL
ERV 1-9	6/1/240	DOL
ERV 1-10	6/1/240	DOL
OAF G-8	0.03/1/240	DOL
OAF 1-3	0.03/1/240	DOL
OAF 1-4	0.26/1/240	DOL
- Submains connected 4 x 1c 70mm<sup>2</sup> Cu/x90
- Submains protection 125A fault current limiting circuit breaker
- Supply voltage drop 6.7V maximum from ETSA Utilities supply point to MSSB
- SCA equipment under voltage and phase failure relay, run indicator lights.

MSSB 1-2:-

- Prospective short circuit current <6 kA
- Form of segregation Form 1
- Arcing fault containment Not required
- Thermal design conditions Maximum SCA internal temperature not to exceed 75°C. Switchroom is naturally ventilated and located internally
- Service conditions To clause 6.1 of Australian Standard 3439.1 - Low voltage switchgear and controlgear assemblies - Type tested and partially type tested assemblies
- Special service condition Insect and vermin proof
- Diversity factor for load circuits To clause 4.7 of Australian Standard 3439.1 - Low voltage switchgear and controlgear assemblies - Type tested and partially type tested assemblies
- Degree of protection IP43
- Equipment served:
 

Item	Nominal Rating Amps/Phase/Voltage	Starting
ACC G-13	19.75/1/415	Inverter
ACC 1a	22.8/3/415	Inverter
ACC 2b	33.4/3/415	Inverter
ACU G-8	0.6/1/240	DOL
ACU G-9	0.6/1/240	DOL
ACU G-11	0.6/1/240	DOL
ACU G-12	0.6/1/240	DOL
ACU 1-22	0.6/1/240	DOL
ACU 1-23	0.6/1/240	DOL
ACU 1-24	0.6/1/240	DOL
ERV G-1	6/1/240	DOL
ERV G-2	6/1/240	DOL
ERV 1-11	6/1/240	DOL
ERV 1-12	6/1/240	DOL
ERV 1-13	6/1/240	DOL
- Submains connected 4 x 1c 35mm<sup>2</sup> Cu/x90
- Submains protection 125A fault current limiting circuit breaker
- Supply voltage drop 6.3V maximum from ETSA Utilities supply point to MSSB
- SCA equipment under voltage and phase failure relay, run indicator lights.

## MSSB 1-3:-

- Prospective short circuit current <6 kA
- Form of segregation Form 1
- Arcing fault containment Not required
- Thermal design conditions Maximum SCA internal temperature not to exceed 75°C. Switchroom is naturally ventilated and located internally
- Service conditions To clause 6.1 of Australian Standard 3439.1 - Low voltage switchgear and controlgear assemblies - Type tested and partially type tested assemblies
- Special service condition Insect and vermin proof
- Diversity factor for load circuits To clause 4.7 of Australian Standard 3439.1 - Low voltage switchgear and controlgear assemblies - Type tested and partially type tested assemblies
- Degree of protection IP43
- Equipment served:
 

Item	Nominal Rating Amps/Phase/Voltage	Starting
ACC 3a	33.4/3/415	Inverter
ACC 3b	19.5/3/415	Inverter
ACU 1-1	0.6/1/240	DOL
ACU 1-2	0.6/1/240	DOL
ACU 1-3	0.6/1/240	DOL
ACU 1-4	0.4/1/240	DOL
ACU 1-5	0.4/1/240	DOL
ACU 1-6	0.6/1/240	DOL
ACU 1-7	0.3/1/240	DOL
ACU 1-8	0.3/1/240	DOL
ACU 1-9	0.3/1/240	DOL
ACU 1-25	0.3/1/240	DOL
ERV 1-1	6/1/240	DOL
ERV 1-2	6/1/240	DOL
ERV 1-3	6/1/240	DOL
ERV 1-4	6/1/240	DOL
ERV 1-5	6/1/240	DOL
OAF 1-1	0.03/1/240	DOL
OAF 1-2	0.26/1/240	DOL
OAF 1-5	1.3/1/240	DOL
- Submains connected 4 x 1c 35mm<sup>2</sup> Cu/x90
- Submains protection 125A fault current limiting circuit breaker
- Supply voltage drop 2.1V maximum from ETSA Utilities supply point to MSSB
- SCA equipment under voltage and phase failure relay, run indicator lights.

## 8.7 SCHEDULE OF POWER SUPPLIES

Equipment	Estimated Load Amps per Phase	Volts	No. off Phase	Isolator Rating - Amps
KEF G-1	4.3	415	3	20
FCEF 1	7	415	3	20

Connect DDC unit to single GPO and telephone line provided by electrical services contractor adjacent to unit.

Wire branch selector box to its corresponding indoor unit.

## 9 CONTROLS

### 9.1 GENERAL

Provide control systems as necessary for the safe, correct and efficient operation of the plant. Include all necessary equipment such as motors, valves, relays, thermostats and interlocks to provide the complete operating systems.

Incorporate control strategies and hardware, such as spring returns on dampers, to ensure the systems fail to the safe, fire mode condition.

Incorporate control equipment and control strategies to provide for automatic, staged re-start of all equipment on re-establishment of power supplies after power failure and after manual re-setting of fire shut down controls.

Use hardware of approved manufacture, proven performance and reliability and of the same type and manufacture throughout the project.

Do not incorporate brand names on equipment exposed to view in occupied areas.

Indicative controls set point, differential and time delay criteria are included. Adjust and set all criteria during plant commissioning to ensure optimum plant performance.

Utilise electronic controls throughout the project.

### 9.2 SCHEDULE OF CONTROLS SYSTEMS

Provide manual and automatic control systems for the following equipment and systems:-

- air conditioning units - air cooled
- evaporative cooling system
- outdoor air fans
- toilet exhaust systems
- heat recovery ventilation systems
- fume cupboard
- kitchen exhaust fan.

### 9.3 CONTROLS HARDWARE

Control panels:-

- construct control panels from satin finish stainless steel

- flush mounted incorporating key switches ("Kraus Naimer" with "Lockwood 201 series" 6 pin cylinder master keyed)
- indicator lights ("NHP square series")
- timers (to match key switches) as scheduled
- engrave the panel with each control function
- do not incorporate brand or Contractor's names
- incorporate auto-off switches, green normal running indicator lights and red safety control failure indicator lights as scheduled
- timer unit (bypass control).

Indicator lamps:-

- circular, colour coded of "Sprecher and Schuh" manufacture model DTL3 or equal approved.

## 9.4 DIRECT DIGITAL CONTROL SYSTEM (DDC)

### 9.4.1 GENERAL

Supply and install Direct Digital Control System (DDC) including all specified control functions for all air conditioning and ventilation systems. Locate DDC controller at position indicated on the drawings, subject to architect approval.

### 9.4.2 CONTROL UNITS

Supply and install compatible control units comprising transceivers, microprocessor boards, memory boards, software, firmware, clock calendar, and connected to the system LAN. Provide a minimum of 160 hour battery back-up for each control unit memory software and internal clock.

- ability to control, monitor and/or address a minimum of 64 points comprising analogue inputs and outputs, digital inputs and outputs and pulsed inputs and outputs
- ability to enable/disable any or all automatic control outputs
- ability to place each input/output point into test mode to allow testing of the control algorithms without disruption to the field devices and the controlled/monitored environment.
- perform general management and test functions such as setting the time and date.

### 9.4.3 CONTROLLERS

#### General

Controller components: EEPROM's, EPROM's, RAM, real time clock, battery backup device, data communications facilities and power supplies.

Provide modular controllers to allow installation of any combination of analogue inputs, analogue outputs, digital inputs or digital outputs. Alternatively, provide universal I/O terminals which are software configured.

Controllers shall include serial socket or similar to enable a laptop computer to interrogate the controller. Controller shall also have integrated display and keypad and the facility to lockout keypad override functions via manufacturers security key.

Store programs loaded on controllers so they are retained during power failures of up to 160 hours. Systems utilising batteries shall automatically re-charge when mains power is available and the system shall prompt the operator to replace the batteries when required.



Provide controller power supply surge protection.

Real time clock accuracy: =5 seconds per annum, with resolution to 100 milliseconds.

Controllers shall include automatic re-boot facilities and self diagnostics.

#### **Controller Accuracy**

Input analogue to digital conversion and output digital to analog conversion: =13 bit.  
Valve and damper actuator signals: True analogue, eg. 4-20mA, 0-10V. Pulse width modulation not acceptable.

#### **9.4.4 SOFTWARE**

##### **Logical Operations**

Incorporate PLC blocks including the following logical functions;  
AND/ANDNOT, OR/OR NOT, AND B, OR B, OUT/OUT NOT, COS, SET/RESET

##### **Programmable Operations**

Twelve module of programmable control including the following:

- PID controller.
- ON/OFF controller.
- Heating/cooling PID control.
- Heating/cooling ON/OFF control.
- Average calculation.
- Minimum/maximum selection.
- Psychrometric calculation.
- Line segment function (16 segment or 4x4 segment).
- Input selector.
- Calculator (Linear or Polynomial equation).
- Timer functions.
- Totalisation (Event, integration, run time).
- Comparator.
- Sequencer.
- Simple calculator.

##### **Calibration**

Provide facility for individual sensor calibration.

##### **Start and Stop Schedules**

Provide equipment start and stop schedules resident on the controller serving each item of equipment, and a facility to download amendments to the schedule from the controller via an on board lap top connection or via LCD interface.

##### **Power Failure Alarm Suppression and Plant Restart**

If loss of power occurs at a controller, suppress consequential alarms and upon restoration of power, restart the plant in an orderly sequence and reactivate alarms

##### **Backup Facility**

It shall be possible to down-load and up-load all application software between controllers and lap top computers for storage on hard disk and back-up to tape or disk.

## Mechanical Services Systems:-

- provide full control and status monitoring of all Mechanical Services plant and equipment installed via the DDC
- provide alarm monitoring of common fault alarms from the air conditioning plant and equipment via the DDC
- provide time switching, after hours timer termination control and status monitoring of all Mechanical Services equipment installed.

**9.5 CONTROL FUNCTIONS AND SEQUENCE OF OPERATION**

Incorporate the following mandatory items and control functions as the minimum functional requirements.

Air conditioning units - cassette type (ACU G-1 to ACU G-11, ACU G-13, ACU 1-1 to ACU 1-25 and ACU 2-1):-

- upon receipt of a demand signal via wall mounted push button the unit should be enabled to run for an adjustable period via the DDC system for a period between 1 to 10 hours, initially set for 2 hours. Depressing the push button a second time during operation shall stop the system and reset the timer
- Interlock operation with motion sensor voltage free contact in general teaching spaces to deactivate units when room is unoccupied within general teaching spaces
- temperature controls and software strategy via the DDC to maintain the area conditions within the range of 20°C to 27°C (adjustable)
- incorporate common run and fault status on the DDC system
- system shall time schedule operation via the DDC for 365 days and calendar including holiday and daylight saving scheduling.

Air conditioning units - cassette type (ACU G-12):-

- provide manufacturers standard control panel incorporating thermostat/sensor, temperature set point adjustment, fan speed and on/off controls.

Evaporative cooling systems (EVC G-1):-

- incorporate stainless steel control panels within the kitchen to control the respective evaporative cooling units with the following functions:-

CP 1	controlling EVC 1 evaporative cooling unit supply fan pump green run	high/low/off switch on/off switch indicator light
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- interlock the water dump cycle to operate on a timed scheduled basis on the unit operation
- interlock the water disinfection units to operate whenever the pumps are operating
- provide time switched daily operation of the pumps and associated water disinfection units from the DDC controller.

Heat recovery ventilation units (ERV G-1 to ERV G-2 and ERV 1-1 to 1-13):-

- interlock to operate when any corresponding air conditioning unit is operating via the DDC controller.

<b>Energy recovery ventilator unit</b>	<b>Associated air conditioning units</b>
ERV G-1	ACU G-8,G-9
ERV G-2	ACU G-11,G-12
ERV 1-1	ACU 1-1
ERV 1-2	ACU 1-2
ERV 1-3	ACU 1-3
ERV 1-4	ACU 1-4,1-5
ERV 1-5	ACU 1-6
ERV 1-6	ACU 1-10,1-11
ERV 1-7	ACU 1-12,1-13
ERV 1-8	ACU 1-14,1-15
ERV 1-9	ACU 1-16,1-17
ERV 1-10	ACU 1-18
ERV 1-11	ACU 1-23
ERV 1-12	ACU 1-22
ERV 1-13	ACU 1-24

- control the air conditioning units outside air bypass dampers by the DDC system to enable motorised dampers to close to 50% when the exhaust air temperature is below 20°C when in heating mode. Dampers to fully open when exhaust air temperature rises above 20°C.

Outside air fans (OAF G-1 to OAF G-7 inclusive and OAF 1-1 to OAF 1-4 inclusive):-

- interlock to operate whenever any of the associated air conditioning units are operating

<b>Outdoor air fan</b>	<b>Associated air conditioning units</b>
OAF G-1	ACU G-1
OAF G-2	ACU G-3
OAF G-3	ACU G-14
OAF G-4	ACU G-4
OAF G-5	ACU G-5
OAF G-6	ACU G-6
OAF G-7	ACU G-7
OAF 1-1	ACU 1-7, 1-9
OAF 1-2	ACU 1-8
OAF 1-3	ACU 1-19, 1-21
OAF 1-4	ACU 1-20
OAF 2-1	ACU 2-1

Toilet exhaust system (TEF G-1, TEF G-2):-

- interlock to operate with the lights and incorporating a run-on timer (wiring and controls by the Electrical Services Contractor).

Kitchen exhaust system (KEF-1):-

- demand operation of the kitchen exhaust fan from the stainless steel control panel located in the kitchen incorporating the following functions:-

CP 2     controlling KEF-1  
            fan high speed  
            fan low speed  
            fan run green indicator light  
            light switch for canopy lights.

Fume cupboards and exhaust fan (FCEF 1-1):-

- provide manufacturers proprietary standard control system
- interlock make up air supply fan OAF 1-5 to operate when FCEF 1-1 is operating. Modulate damper to supply air to room that requires make up air, controlled by cabinet sash position accordingly.

## 10 GENERATED NOISE AND VIBRATION CONTROL

### 10.1 GENERAL

Select and install all plant, equipment, piping and ducting systems to ensure quiet and vibration free operation in compliance with the specified noise and vibration level criteria.

Replace and modify all systems causing undue noise or vibration exceeding the specified criteria.

### 10.2 SCHEDULE OF GENERATED NOISE AND VIBRATION CONTROL SYSTEMS

Accurately balance, both statically and dynamically all rotary machinery. Comply with the requirements of Australian Standard 1359.51 - Rotating electrical machines - General requirements - Noise level limits, Australian Standard 1359.114 - Rotating electrical machines - General requirements - Vibration measurements and limits and Australian Standard 2625 - Rotating and reciprocating machinery - Mechanical vibration.

Provide flexible connections to all rotary machinery and equipment containing rotary machinery including flexible connections between ductwork and fans, and flexible conduits and coiled cables (MIMS) to motors and other operating devices subject to vibration.

Provide acoustic lining to ductwork as scheduled and acoustic seals to pipe duct and conduit penetrations through plantrooms and acoustic barriers.

Select plant and equipment with operating noise ratings and rotational speeds less than the specified requirements.

Select air diffusion equipment with noise ratings at all operating conditions to ensure the specified requirements are met.

Install vibration isolation mounts and hangers as scheduled.

Equipment and Systems	Vibration Isolation Mounts and Hangers	Minimum Isolation Efficiency %	Static Deflection mm	Mounting Base
Fume cupboard exhaust fan	Spring mounts	95	50	N/A
Air conditioning units - ceiling mounted	Neoprene pads	80	2	N/A
Axial flow fans - suspended	Spring hangers with neoprene mounts - Type A	95	50	N/A
Pipework within plantrooms	Rubber inserts between pipes and clamps	80	2	N/A

Equipment and Systems	Vibration Isolation Mounts and Hangers	Minimum Isolation Efficiency %	Static Deflection mm	Mounting Base
Fume cupboard exhaust fan	Spring mounts	95	50	N/A
Air conditioning condensing units floor mounted	Spring mountings with neoprene mounts - Type A	95	25	N/A
Evaporative cooling units	Neoprene double deflection mounts	90	10	N/A

### 10.3 VIBRATION ISOLATION MOUNTS

Provide vibration isolation mounts selected to comply with the scheduled isolation efficiency and static deflection requirements. Calculate total static deflection from the scheduled static deflectors plus the floor deflection.

Incorporate restraining devices to prevent excessive movement of plant, equipment and piping systems.

Additionally, incorporate restraining devices, to all plant, equipment and piping systems, complying with the requirements of Australian Standard 1170.4 - SAA Loading Code - Earthquake loads.

Construct all brackets, housings, base plates, restraining devices and supports from galvanised steel and rubber/neoprene components from oil resistant materials.

Install all mounts in accordance with the manufacturer's recommendations.

Spring mounts - type A:-

- seismic-mount type, "Mason Type SLR, SSLR, SSLFH", "Embelton Type CM/EM/XM" or equal approved
- selected and positioned to provide uniform deflection for all springs and with a surge frequency less than 30% of the predominant frequency
- mean coil diameter to compressed length ratio equal to not less than 0.8
- incorporate levelling screws and locknuts, and holding down bolts incorporate ribbed neoprene pads.

Neoprene pads:-

- ribbed type, "Mason Type Super W, Waffle Pads", "Embelton EPDM Waffle" or equal approved to internal areas
- cross ribbed type, incorporating non-skid faces, pure polychloroprene material, "Embelton, Shearflex (Red) Neoprene Pad Mounting" or equal approved to roof mounted plant
- limit loading to 400 kPa.

Hangers - type A:-

- incorporate spring and double deflecting neoprene cups in series, "Mason Type 30N", "Embelton Type RSH S/D" or equal approved
- selected and positioned to provide uniform deflection for all springs.

Neoprene mounts:-

- double deflection type, "Mason Type ND", "Embelton Type NDR" or equal approved
- limit loading to 90% of the manufacturer's recommended loading.

Rubber pipe inserts:-

- "Binder Kwik-Smart 1300 series" system or equal approved.

## 11 PAINTING IDENTIFICATION AND LABELLING

### 11.1 GENERAL

Utilise capable and skilled tradesmen for all painting. Ensure the areas in which the painting is to be carried out are cleaned and free from dust. Protect all work from the weather.

Use only best quality paints, fillers, temporary surface dressings and all other painting materials delivered to site in the original manufacturer's sealed and labelled containers.

Select sealers, primers, undercoats and finishing paints as specified by the manufacturer as appropriate for the particular application.

Utilise only low VOC paints for all painted surfaces. VOC emission limits after 30 days shall not exceed 100g/L for flat coatings and 150g/L for non flat coatings.

No material substitution is permitted without prior approval.

Apply the painting on correctly prepared surfaces strictly in accordance with the manufacturer's recommendations and provide a high standard of finish having an even colour and smooth surface without imperfections or blemishes.

Make good all damage to surfaces with motor body filler prior to painting.

Take all measures to ensure that all surrounding and adjacent areas on the site are suitably protected whilst painting is in progress and pay all costs incurred in making good where damage or marking occurs.

On completion of the painting thoroughly clean the installation and surrounding building surfaces of all paint marks, grease, oil and dirt. Polish all equipment identification plates and normally bright metal parts.

Protect all finished painted surfaces.

Paint, with an anticorrosive primer before despatch to site, factory assembled, non galvanised steel components to provide adequate protection against dampness and weather during transport and storage.

Provide black and yellow diagonal stripe danger notation to all motor drives and edges of ductwork, pipework and equipment installed at low level or likely to be hazardous.

Provide all warning signs as required by the Statutory Authorities.

### 11.2 SCHEDULE OF PAINTING AND FINISHES

Paint, identify and label the plant, equipment, air distribution and piping systems including associated fittings, machine bases, supports and insulation.

Paint the following:-

- air diffusion equipment.

### 11.3 PLANT AND EQUIPMENT

Supply plant and equipment factory finished to a high standard. Touch up minor damage to paintwork on site.

Totally repaint factory equipment where damage to finishes is extensive.

Where plant and equipment is not factory painted, paint with 1 coat of zinc chromate or similar metal primer and 2 coats of full gloss enamel.

Paint galvanised steel surfaces with 1 coat of an etching primer and 2 coats of full gloss enamel after cleaning the surfaces of all oil and protective coatings.

### 11.4 PIPING SYSTEMS

Paint identification bands on the pipework, in colours in accordance with Australian Standard 1345 - Identification of the contents of pipes, conduits and ducts and identification lettering to approval.

Provide bands and lettering at all pipe connections to equipment, pipe junctions and at approximately 7500mm intervals. Provide arrows indicating direction of flow adjacent the identification bands.

Use the following identification:-

Service	Code
Domestic cold water	DCW
Drains	D
Refrigeration suction	RS
Refrigeration hot gas	RHG
Refrigeration liquid	RL

### 11.5 AIR DISTRIBUTION SYSTEMS

Paint galvanised steel ductwork including hangers, supports and fittings with 1 coat of an etching primer and 2 coats of full gloss enamel after cleaning the surfaces of all oil and protective coatings.

Paint with 1 coat of matt black paint the internal surface of air diffusion equipment and dampers, ductwork and cushion head exposed to view through the face of the air diffusion equipment. Powdercoat or finish with colour anodising all air diffusion equipment as scheduled to the following specifications.

Polyester powder coating system to comprise zinc chromate coat and 50 micron high durability polyester powder coat all to comply with Australian Standard 3715 - Metal finishing - Thermoset powder coatings for architectural applications. Ensure all edges are fully coated.

Ensure anodising is in accordance with Australian Standard 1231 - Aluminium and aluminium alloys - Anodised coatings for architectural applications to a polished smooth gloss finish to approval.

Apply anodising by an approved method with production batches tested to ensure uniform specification as follows:-

- all components to be pre-cut and anodised prior to assembly
- anodised coating thickness - anodic coating Grade 4 of minimum average thickness of 24 micrometres
- coating weight - anodic film weight to be less than 2.45 mg/100mm<sup>2</sup> for each 10 um of film thickness

- anodising colour - colour to Architects selection having a uniform smooth gloss finish to approval
- efficiently seal all anodised coatings and test for sealing efficiency by resistance to staining.

### 11.6 IDENTIFICATION AND LABELLING

Provide engraved labels to all instruments, gauges, indicators, control equipment with white lettering on black background. Attach labels using screw fixings. For indoor use, use durable, plastic, multilayer laminate labels. For outdoor use, use brass labels.

Label, using experienced signwriters, all items of equipment with lettering not less than 50mm.

Label all submain protective switchgear with the protection setting and outgoing submain cable size.

Provide colour coded IPA studs, glued in place, to all isolating switches and power outlets.

Utilise red markers to signify the location of equipment requiring maintenance in accordance with the Maintenance and Testing of Safety Installations Log Book.

Submit details and samples of labels proposed prior to the installation and obtain approval from the relevant authorities.

### 11.7 SCHEDULE OF COLOURS

Paint systems and equipment to colours as scheduled. Colour codes relate to Australian Standard 2700 - Colour Standards for general purposes.

<b>System, Equipment</b>	<b>Colour Scheme</b>
Air distribution systems	Air diffusion equipment colour to approval.

## 12 TESTING AND COMMISSIONING

### 12.1 GENERAL

Test, balance and commission the Mechanical Services systems.

Carry out the works using competent personnel trained and holding appropriate qualifications for this type of work. Provide all necessary equipment and instrumentation.

Pre-plan, schedule and co-ordinate the works with the other trades to ensure they are carried out in a safe and efficient manner with the minimum of inconvenience to all concerned.

Provide a minimum of 3 days notification of tests.

Carry out all tests required by Statutory Authorities including the local Health Authorities and Electricity Supply Authorities to prove the systems operate to their satisfaction and in accordance with the appropriate Codes and Regulations.

Conduct all inspection and test plans, testing, commissioning and training in accordance with ASHRAE Guideline 1 - The HVAC Commissioning Process.

Commissioning plan to include all interfacing requirements with the following subsystems:-

- air control systems
- energy recovery ventilators
- fume cupboards
- controls systems



- indoor air quality systems
- compliance with codes and standards
- witness testing requirements.

Provide quarterly commissioning tuning reviews of the Mechanical Services systems for the 52 week defects liability period including a final recommissioning at the end of the period.

### **12.2 INSPECTION AND TEST PLANS**

Prepare inspection and test plans for all plant, equipment and systems.

Incorporate the following details with each plan:-

- testing methodology
- test instruments/test rig
- comprehensive test log sheets
- authorities test requirements
- approval certificates.

Submit the inspection and test plans for approval 4 weeks prior to the commencement of any testing and/or commissioning. An independent commissioning agent will be appointed by the Mechanical Consulting Engineers. Prepare inspection and test plans in consultation with and to the approval of the commissioning agent.

### **12.3 PRE-COMMISSIONING PROCEDURES**

Carry out the following works prior to the commencement of the commissioning of the systems:-

- leak test piping systems
- pressure and leak test air distribution systems
- clean out plantrooms and operate all air handling systems with temporary filter media
- submit for approval, manufacturer's test certificates, performance curves and tables for all plant, equipment and electrical components.
- submit for approval, certification of motor/pump alignment
- submit for approval, instrumentation calibration certificates, commissioning and test log sheets.

### **12.4 COMMISSIONING PROCEDURES**

Carry out all commissioning and testing necessary to ensure the systems operate in a stable, safe, automatic and integrated manner providing optimum efficiency under all load conditions. Include the following commissioning and testing.

Plant and equipment:-

- check the operation of the plant and equipment including, noise and vibration levels, operating temperatures, pressures and flows
- check and prove all operating and safety controls
- check and prove performance characteristics at full and part load.

Refrigeration systems:-

- charge systems
- check operation of all relief devices, flow activated controls and vents

- check and prove operation of expansion devices
- monitor moisture indicators and check and record all operating and safety pressure settings.

Air distribution systems:-

- check and prove all pressure and flow activated controls
- balance the systems such that air flows at all points in the system are within -0% and +10% of the specified flow rates. Adjust air flows such that pressure drops through dampers, at or near air diffusion equipment, are the minimum possible and the minimum possible fan speed is used by the minimum use of dampers in the highest resistance run of ducting
- simulate the system resistance of the operating condition of 50% loaded filters by installing temporary media/blanking plates. Adjust the system air quantity to -0% and +5% of the specified flow by adjusting the fan drive
- adjust supply air outlets to ensure direction and throw of air is adequate for the application, free from draughts and uniform over the face
- measure air diffusion terminal velocities
- subsequent to occupation provide fine tuning of the air balance based on temperature measurements within the space
- commission fume cupboard in accordance with Australian Standard 2243 Part Appendix E, F and G.

Electrical systems:-

- progressively and finally test the complete installation to ensure it is mechanically and electrically safe and operates correctly under normal, emergency and fault conditions
- check all terminations, clamps and fixings
- check phase identifications match throughout the installation
- check for excessive heating at all joints.

Automatic controls, gauges and instruments:-

- adjust and activate the controls system. Prove the operation of all operating safety and emergency controls, for each item of equipment, each system, and the installation as a whole
- provide hand instrumentation as necessary to supplement the permanent gauges and instruments to check and log all operating conditions including ammeter readings for all motors, megger tests of all electrical equipment, voltage tests, compressor suction and discharge superheat temperatures, air pressure drops through filter banks, coils, speeds of fans and motors, ambient and internal dry and wet bulb temperatures in all system components.

Noise and vibration:-

- take noise level measurements with details of sound pressure levels in each octave band mid frequency from 125 Hz to 4000 Hz inclusive in all strategic locations
- where excessive vibration is evident measure the vibration levels.

## 12.5 INSTRUMENTATION

Provide all instruments and apparatus necessary to carry out the commissioning and performance testing.

Calibrate all test instruments at an approved NATA certified laboratory prior to carrying out the tests.

**12.6 PERFORMANCE TESTS**

Carry out performance tests on the complete Mechanical Services system on both design cooling and design heating days over a period of 8 hours each day or longer as required to prove system performance and the system operating sequences.

During the tests log internal and ambient temperatures, internal loads (people, lights, equipment) outside air quantities, chilled and heating water flow rates and temperature differences, and current draw and overload settings of each electrical drive.

**12.7 BUILDING TUNING**

Attend site at minimum quarterly intervals post handover for a minimum 12 month period in order to monitor and adjust the control operation of the installations in order to optimise their energy efficiency. Fully re-commission all installations after 12 months.

**12.8 COMMISSIONING AND PERFORMANCE DATA**

Submit for approval typed copies of all data recorded during precommissioning, commissioning and testing of the installation together with all necessary inspection certificates from local authorities within 7 days of completing the works.

Submit for approval typed copies of all data relative to the performance tests within 7 days prior to review of the completed tests.

Submit for approval 3 typed copies of all test sheets and certificates.

**12.9 POST CONTRACT DRAWINGS**

Submit for approval, 7 days prior to Completion, copies of the construction drawings modified to reflect all field changes. Prepare the drawings utilising computer aided drafting, DWG CAD format - Autocad Version 2004 (or later). Notate the drawings to highlight the position of all items requiring maintenance and pertinent to the functioning of the system such as valves, dampers, bleeds, vents, timing devices and fuses.

Submit for approval 3 copies of the drawings inserted in plastic envelopes and bound in the installation manual. Also provide 1 copy of the CAD drawing computer files in CD-ROM format in each manual.

**12.10 INSTALLATION MANUAL**

Submit for approval 3 copies of Installation Manuals prior to Completion.

Bind the manual in a white vinyl hard back A4 folder with clear plastic sleeves and typed cover inserts.

Format the inserts to the cover and spine sleeves as follows. Include the title Project Name and Mechanical Services vertically on the spine.

SPINE	FRONT COVER
ST ALOYSIUS COLLEGE - GYMNASIUM AND CLASSROOMS FITOUT MECHANICAL SERVICES	ST ALOYSIUS COLLEGE - GYMNASIUM AND CLASSROOMS FITOUT  MECHANICAL SERVICES INSTALLATION MANUAL  CONSULTING ENGINEER: BESTEC  MECHANICAL SERVICES CONTRACTOR: CONTRACTOR'S NAME

Include the following contents and format the manual as follows.

Fly Sheet:-

- include names and addresses of all members of the project consulting team, Construction Manager and services Contractors.

Section 1 - index:-

- include sections and sub-sections with dividers between
- include list of drawings.

Section 2 - system description:-

- include general description of the system and its componentry
- include manufacturer's literature for all equipment
- include schedule of capacities for all equipment

Section 3 - installation maintenance and operating instructions:-

- include detailed maintenance log sheets for each item of equipment
- include manufacturer's installation, maintenance and operating instructions for each item of equipment.

Section 4 - plant operating instructions:-

- include a complete description and correct sequence of all actions necessary for the starting up, operation and shutting down of the plant.

Section 5 - performance test results:-

- include commissioning data and performance test results
- include a commissioning report which confirms that commissioning of each system is in accordance with the design documents and the design intent, and lists any outstanding commissioning required and seasonal/quarterly commissioning tests to be conducted

- include separate section headings for the 4 quarterly commissioning tuning reviews and the 12 month re-commissioning activities.
- Include a copy of Principals handover and training records.

Section 6 - compliance certification:-

- include authorities test certificates, electrical certificates of compliance, EMC Certificates of compliance for all products installed and authorities registration certificates.

Section 7 - CD-ROM:-

- include CD-ROM in plastic sleeve.

Section 8 - installation drawings:-

- include the post contract drawings.

### **12.11 MAINTENANCE AND TESTING OF SAFETY INSTALLATIONS LOG BOOK INSERTS**

Compile and submit for approval, the following inserts for the Maintenance and Testing of Safety Installations Log Book prior to Practical Completion.

Include the following contents and format the inserts as follows.

Section 5 - air handling systems:-

- include a schedule of inspections and maintenance required in accordance with the Building Code of Australia and Australian Standard 1851 - Maintenance of fire protection equipment.

Include maintenance log sheets and defect report sheets within the Maintenance and Testing of Safety Installations log book.

Incorporate all requirements including full details of the Mechanical Services Fire Safety Provisions.

### **12.12 HANDING OVER AND PRINCIPALS INSTRUCTION**

Complete the testing balancing and commissioning of all systems, provide all commissioning and performance data and provide the installation manuals including post contract drawings prior to handing over the installation.

Completion will not be granted until the above requirements have been met.

Provide the services of the Commissioning Engineer to instruct the Principals Representative in all details of the plant operation.

Include the following training topics:-

- design intent
- review of controls set-up, programming, alarms and troubleshooting
- the installation manuals including the electronic version
- building plant operation including start-up, normal operation, after hours operation, shut-down
- interface with other services systems
- optimising energy efficiency
- occupational health and safety issues
- maintenance requirements
- occupant satisfaction feedback

Provide a record of the Principals handover and training including attendance, time and date of training. Include the training records in the installation manual.

Prepare a brief outline of the proposed training format for approval 4 weeks prior to practical completion.

## **13 MAINTENANCE AND SERVICING**

### **13.1 GENERAL**

Maintain and service the installation for a period of 52 weeks from the date of Completion.

Carry out all maintenance, servicing and test procedures in accordance with the current requirements of the Development Act, Regulations Under the Development Act, Building Code of Australia and the Australian Standards.

Maintain the installation on a monthly basis and provide emergency service on a 24 hour call out basis.

### **13.2 SCHEDULE OF MAINTENANCE AND SERVICING REQUIREMENTS**

Carry out maintenance and servicing to ensure the safe, reliable and efficient operation and long life of the plant, equipment and systems.

Maintain the plant and equipment in accordance with the manufacturer's recommendations and the following:-

Plant and equipment - monthly:-

- check and lubricate all bearings
- check and adjust all belt drives, pulleys, couplings, guards, pump glands and shaft seals
- check and clean (washable media only) filters.

evaporative cooling systems - monthly Legionella control:-

- carry out all works required by Australian Standard 3666 - Air handling and water systems of buildings - Microbial control
- isolate the equipment, drain down and clean out
- refill with clean water, add approved disinfectant and circulate
- drain down disinfectant
- thoroughly clean all surfaces (including roof decking) and components (including strainers)
- refill and check aerobic bacteria count.

Piping systems - monthly:-

- inspect for and rectify corrosion
- check and rectify damage to insulation
- check valve settings and control valve actuation
- check operation of relief devices and refrigerant expansion devices
- check that drains and overflows are clear.

Air distribution systems - monthly:-

- check for air leakage in flexible duct connections, access panels, inspection holes and adjust and repair as necessary
- check damper settings and motorised damper operation.

Electrical systems - monthly:-

- check operation of circuit breakers, interlocks, and indicator lights
- check thermal overload settings
- check electric motors for excessive noise and excessive temperature
- check timer setting.

Controls systems - monthly:-

- check and test the operation of all safety controls and systems
- check operation and settings of all controls, and adjust settings as necessary.

Noise and vibration control - monthly:-

- check antivibration mountings and adjust as necessary
- check and tighten all holding down bolts, clamps and brackets
- check equipment for excessive noise.

Provide all consumables necessary for the proper maintenance and servicing, including grease, oil, refrigerant, refrigeration filter/driers, oil filters and chemicals.

Replace all components worn during the maintenance period including belt drives, glands, fuses and globes.

### **13.3 DOCUMENTATION OF MAINTENANCE AND SERVICING**

At the completion of each maintenance visit, provide a detailed check list of the items serviced. Include readings for all gauges and equipment including pressure drops across filters, thermal overload and timer settings, control set points, operating flows and pressures, refrigerant and oil analyses.

Complete the relevant sections of the Maintenance and Testing of Safety Installations Log Book.

Complete the maintenance log book and arrange to have countersigned by the Proprietor.

Maintain and update all essential data (including wiring diagrams and drawings) necessary to maintain the systems.

Forward, within 7 days of completing the maintenance and servicing, a report on the plant condition and the completed check lists, to the approving authority.

Retention monies (or bank guarantees) will not be released until 12 correctly dated and completed reports have been received at the appropriate times and approved. Should these 12 maintenance and services visits not be completed within the Maintenance and Defects Liability period, then that period, including all equipment warranties will be extended until the maintenance and servicing requirements have been met.

**13.4 RECTIFICATION OF DEFECTS**

Rectify promptly all defects.

Retention monies (or Bank Guarantees) will not be released until all defects have been rectified.

**14 ASSOCIATED WORKS****14.1 GENERAL**

Carry out all building works, civil works and structural works required for access, storage, construction, installation, operation and maintenance of the installation with the exception of the items of work described in this section of the specification as being carried out by the Construction Manager and other Sub Contractors.

**14.2 SCHEDULE OF SITE PROVISIONS**

Site provisions provided by the Construction Manager are scheduled in the contract preliminaries. Provide any additional provisions necessary for the satisfactory completion of the works.

**14.3 SCHEDULE OF ASSOCIATED WORKS**

Associated works provided by the Construction Manager are scheduled below. Provide any additional associated works necessary for the completion of the works.

Work by Superstructure Sub Contractor:-

- 2 off 1300mm x 550mm wall penetrations for air intake louvres, ground floor
- 2 off 400mm x 300mm wall penetrations for ductwork, ground floor

Work by Ceiling and Dry Wall Sub Contractor:-

- 8 off 200mm diameter wall penetrations for circular ductwork, ground floor
- 15 off 450mm diameter wall penetrations for circular ductwork, first floor
- 3 off 600mm x 400mm wall penetrations for ductwork, third floor
- 1 off 1200mm x 600mm x 13000mm long fire rated riser for exhaust ductwork, first floor
- 2 off 950mm x 950mm ceiling penetrations for air conditioning units, ground floor

Work by Metal Work Sub Contractor (external weatherproof louvres including bird mesh behind):-

- Full length, 460mm deep weatherproof louvres to first floor activity area

Work by Hydraulic Services Sub Contractor:-

- 7 off 150mm x 150mm tundishes to plantrooms

**14.4 SCHEDULE OF TERMINATION POINTS**

Termination points of services provided by other Sub Contractors are scheduled below. Provide all works necessary to connect to and complete the installations from these termination points.

Work by Electrical Services Sub Contractor:-

- provision and termination of submains, 4 x 1c 70mm<sup>2</sup> Cu/x90, at the Mechanical Services switchboard MSSB G-1
- provision and termination of submains, 4 x 1c 70mm<sup>2</sup> Cu/x90, at the Mechanical Services switchboard MSSB 1-1
- provision and termination of submains, 4 x 1c 35mm<sup>2</sup> Cu/x90, at the Mechanical Services switchboard MSSB 1-2



- provision and termination of submains, 4 x 1c 35mm<sup>2</sup> Cu/x90, at the Mechanical Services switchboard MSSB 1-3
- provision of 2 off 415V, 3 phase, 20 Amp, weather proof switched isolators on the roof adjacent exhaust fans, FCEF -1 and KEF -1
- provision of voltage free contact at teaching space lighting control movement sensors for extension of wiring to air conditioning for shutdown.

Work by Hydraulic Services Sub Contractor:-

- provision of cold water connection to evaporative cooling unit in ground floor plantroom.

#### **14.5 PENETRATIONS**

The Construction Manager will provide penetrations as scheduled above.

Major penetrations will be in the form of block-outs. Minor penetrations will be formed by the placement of sleeves. Provide and place the sleeves in position.

Holes in roofs will be formed and include upstands provided by the Roofing/Roof Plumbing Sub Contractor.

#### **14.6 ENCLOSURES**

The Construction Manager will construct plant and duct enclosures as scheduled and as shown on the drawings.

Where noted on the drawings the duct and plant enclosures will be fire rated. Refer to the Architectural Drawings for the method of fire rating.

The Construction Manager will supply and install access doors to all plantrooms and building services ducts. Where the plantrooms and ducts are subject to suction or pressurisation the doors will be fitted with gaskets to the top, bottom and sides. A 4 sided duty metal frame will be provided to ensure correct compression of the seals.

**ST ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TENDER FORM**

Company .....

Address .....

..... Telephone.....

Hereby tender in accordance with the:-

- Conditions of Tendering
- General Conditions of Contract
- Specification No. 52894A/1 and Drawing No.'s 52894A M-01 to M-07 inclusive
- Addenda No.'s.....

To carry out the complete works for the Fixed Lump Sum, including Goods and Services Tax of:-

- Prime Cost and Provisional Sums           \$ .....
  - Fixed Lump Sum Tender                       \$ .....
  - Goods and Services Tax                       \$ .....
- \_\_\_\_\_
- Total Fixed Lump Sum Tender               \$ .....
- \_\_\_\_\_

Company ..... Signature of Tenderer .....

Date.....

**ST ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TENDER FORM**

**Sub-Contractors Schedule:-**

Air Distribution Systems .....

Thermal Insulation.....

Electrical.....

Controls.....

Painting .....

Testing and Commissioning.....

Maintenance and Servicing.....

Other .....

**Personnel Schedule:-**

Contracts Engineer .....

Foreman.....

Commissioning Technician.....

Draftsperson.....

**Cost Analysis Schedule:-**

General Requirements \$.....

Plant and Equipment

Air conditioning units - multi system type	\$ .....
Air conditioning units - cassette type	\$ .....
Filters, panel type - air	\$ .....
Fans - roof mounted	\$ .....
Fans - mixed flow in-line	\$ .....
Sound attenuators	\$ .....
Fume cupboards	\$ .....
Energy Recovery Ventilator Units	\$ .....
Rotary ventilators	\$ .....

\$.....

Signature of Tenderer .....

Date.....

**ST ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TENDER FORM**

Air Distribution Systems

Ductwork \$ .....

Dampers \$ .....

Conditioner casings/plenums \$ .....

Air diffusion equipment \$ .....

Kitchen exhaust canopies \$ .....

\$.....

Thermal Insulation

\$.....

Electrical

Cabling systems \$ .....

Switchboards \$ .....

\$.....

Controls

\$.....

Noise and Vibration Control

Vibration isolation \$ .....

\$.....

Painting, Identification and Labelling

\$.....

Testing and Commissioning

\$.....

Maintenance and Servicing

\$.....

Goods and Services Tax

\$.....

Total Fixed Lump Sum Tender

\$.....

Signature of Tenderer .....

Date.....

**ST ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TENDER FORM**

**Nominated Costs:-**

Included in the tender sum above are the following costs:-

Power, fuel and water consumed during commissioning. \$.....

**Unit Rate Schedule:-**

Unit rates applicable to the Contract including all labour materials, oncosts, loading, allowances, overhead recovery and profits.

**Unit Rate Schedule - Air Distribution Systems:-**

Unit rates including the supply, installation and insulation (as applicable) of ductwork per metre run.

<u>Material</u> Duct size mm	Plain Straight Lengths	Thermally Insulated Straight Lengths	Acoustically Insulated 25mm Straight Lengths	Acoustically Insulated 50mm Straight Lengths
200 x 250	\$ .....	\$ .....	\$ .....	\$ .....
350 x 250	\$ .....	\$ .....	\$ .....	\$ .....
400 x 300	\$ .....	\$ .....	\$ .....	\$ .....
600 x 400	\$ .....	\$ .....	\$ .....	\$ .....

<u>Material</u> Duct size mm	Plain - Radius Bend	Thermally Insulated 25mm - Radius Bend	Acoustically Insulated 25mm - Radius Bend	Acoustically Insulated 50mm - Radius Bend
450 x 200	\$ .....	\$ .....	\$ .....	\$ .....
450 x 400	\$ .....	\$ .....	\$ .....	\$ .....
600 x 400	\$ .....	\$ .....	\$ .....	\$ .....

Signature of Tenderer .....

Date.....

**ST ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TENDER FORM**

<u>Material</u> Duct size mm	Plain - Transition	Thermally Insulated 25mm - Transition	Acoustically Insulated 25mm - Transition	Acoustically Insulated 50mm - Transition
450 x 400 to 450 x 200	\$ .....	\$ .....	\$ .....	\$ .....
450 x 400 to 350 x 200	\$ .....	\$ .....	\$ .....	\$ .....
600 x 400 to 400 x 400	\$ .....	\$ .....	\$ .....	\$ .....

<u>Material</u> Duct size mm	Flexible - Insulated
200	\$ .....
250	\$ .....
300	\$ .....
350	\$ .....
400	\$ .....
450	\$ .....
500	\$ .....

<u>Material</u> Duct size mm	Kitchen Exhaust Straight Lengths	Kitchen Exhaust Radius Bend
1500 x 225	\$ .....	\$ .....

Supply and installation of a 600mm x 600mm face/450mm x 450mm neck louvre face diffuser complete with cushion head, 3000mm of 450mm diameter flexible ductwork, 90° branch take-off and butterfly damper:-

\$ .....

Signature of Tenderer .....

Date.....

**ST ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TENDER FORM**

**Labour and Mark-up Rate Schedule:-**

Labour rates applicable to the contract including all oncosts, loading, allowances, overhead recovery and profits.

	Hourly Rate		
	Normal Time	Time & Half	Double Time
Pipe fitter - site	\$ .....	\$ .....	\$ .....
Sheetmetal worker - factory	\$ .....	\$ .....	\$ .....
Sheetmetal worker - site	\$ .....	\$ .....	\$ .....
Electrician - site	\$ .....	\$ .....	\$ .....
Foreman - site	\$ .....	\$ .....	\$ .....
Commissioning Technician - site	\$ .....	\$ .....	\$ .....
Contracts Engineer - site	\$ .....	\$ .....	\$ .....
Draftsperson - factory	\$ .....	\$ .....	\$ .....
Maintenance Technician - site	\$ .....	\$ .....	\$ .....
Mark-up to be applied on the cost to purchase materials			..... %
Mark-up to be applied on the Sub-Contractors			..... %
<b>Site Hours:-</b>			
Nominate the number of site hours included in the tender submission			.....hours

Signature of Tenderer .....

Date.....





**ST ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TECHNICAL DATA SCHEDULE**

Company .....

Address .....

..... Telephone.....

We hereby provide full and accurate details of the plant and equipment to be installed. All plant and equipment is in accordance with the Specification No. 52894A/1.

Company ..... Signature of Tenderer .....

Date.....

**SAINT ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TECHNICAL DATA SCHEDULE**

**Air Conditioning Units - Multi System Type:-**

<b>Designation</b>	<b>ACU G-1</b>	<b>ACU G-2</b>	<b>ACU G-3</b>	<b>ACU G-4</b>
Manufacturer	.....	.....	.....	.....
Model no.	.....	.....	.....	.....
Total sensible cooling capacity - kW	.....	.....	.....	.....
Total cooling capacity - kW	.....	.....	.....	.....
Total heating capacity - kW	.....	.....	.....	.....
Supply air quantity - L/s	.....	.....	.....	.....
Outside air quantity - L/s	.....	.....	.....	.....
Supply air fan motor drive type	.....	.....	.....	.....
Cooling stage	.....	.....	.....	.....
Condenser fan type	.....	.....	.....	.....
Condenser fan motor drive type	.....	.....	.....	.....
Configuration/system type	.....	.....	.....	.....

<b>Designation</b>	<b>ACU G-5</b>	<b>ACU G-6</b>	<b>ACU G-7</b>	<b>ACU G-8</b>
Manufacturer	.....	.....	.....	.....
Model no.	.....	.....	.....	.....
Total sensible cooling capacity - kW	.....	.....	.....	.....
Total cooling capacity - kW	.....	.....	.....	.....
Total heating capacity - kW	.....	.....	.....	.....
Supply air quantity - L/s	.....	.....	.....	.....
Outside air quantity - L/s	.....	.....	.....	.....
Supply air fan motor drive type	.....	.....	.....	.....
Cooling stage	.....	.....	.....	.....
Condenser fan type	.....	.....	.....	.....
Condenser fan motor drive type	.....	.....	.....	.....
Configuration/system type	.....	.....	.....	.....

Signature of Tenderer .....

Date .....

**SAINT ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TECHNICAL DATA SCHEDULE**

<b>Designation</b>	<b>ACU G-9</b>	<b>ACU G-10</b>	<b>ACU G-11</b>	<b>ACU G-13</b>
Manufacturer	.....	.....	.....	.....
Model no.	.....	.....	.....	.....
Total sensible cooling capacity - kW	.....	.....	.....	.....
Total cooling capacity - kW	.....	.....	.....	.....
Total heating capacity - kW	.....	.....	.....	.....
Supply air quantity - L/s	.....	.....	.....	.....
Outside air quantity - L/s	.....	.....	.....	.....
Supply air fan motor drive type	.....	.....	.....	.....
Cooling stage	.....	.....	.....	.....
Condenser fan type	.....	.....	.....	.....
Condenser fan motor drive type	.....	.....	.....	.....
Configuration/system type	.....	.....	.....	.....

<b>Designation</b>	<b>ACU 1-1</b>	<b>ACU 1-2</b>	<b>ACU 1-3</b>	<b>ACU 1-4</b>
Manufacturer	.....	.....	.....	.....
Model no.	.....	.....	.....	.....
Total sensible cooling capacity - kW	.....	.....	.....	.....
Total cooling capacity - kW	.....	.....	.....	.....
Total heating capacity - kW	.....	.....	.....	.....
Supply air quantity - L/s	.....	.....	.....	.....
Outside air quantity - L/s	.....	.....	.....	.....
Supply air fan motor drive type	.....	.....	.....	.....
Cooling stage	.....	.....	.....	.....
Condenser fan type	.....	.....	.....	.....
Condenser fan motor drive type	.....	.....	.....	.....
Configuration/system type	.....	.....	.....	.....

Signature of Tenderer .....

Date .....

**SAINT ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TECHNICAL DATA SCHEDULE**

<b>Designation</b>	<b>ACU 1-5</b>	<b>ACU 1-6</b>	<b>ACU 1-7</b>	<b>ACU 1-8</b>
Manufacturer	.....	.....	.....	.....
Model no.	.....	.....	.....	.....
Total sensible cooling capacity - kW	.....	.....	.....	.....
Total cooling capacity - kW	.....	.....	.....	.....
Total heating capacity - kW	.....	.....	.....	.....
Supply air quantity - L/s	.....	.....	.....	.....
Outside air quantity - L/s	.....	.....	.....	.....
Supply air fan motor drive type	.....	.....	.....	.....
Cooling stage	.....	.....	.....	.....
Condenser fan type	.....	.....	.....	.....
Condenser fan motor drive type	.....	.....	.....	.....
Configuration/system type	.....	.....	.....	.....

<b>Designation</b>	<b>ACU 1-9</b>	<b>ACU 1-10</b>	<b>ACU 1-11</b>	<b>ACU 1-12</b>
Manufacturer	.....	.....	.....	.....
Model no.	.....	.....	.....	.....
Total sensible cooling capacity - kW	.....	.....	.....	.....
Total cooling capacity - kW	.....	.....	.....	.....
Total heating capacity - kW	.....	.....	.....	.....
Supply air quantity - L/s	.....	.....	.....	.....
Outside air quantity - L/s	.....	.....	.....	.....
Supply air fan motor drive type	.....	.....	.....	.....
Cooling stage	.....	.....	.....	.....
Condenser fan type	.....	.....	.....	.....
Condenser fan motor drive type	.....	.....	.....	.....
Configuration/system type	.....	.....	.....	.....

Signature of Tenderer .....

Date .....

**SAINT ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TECHNICAL DATA SCHEDULE**

<b>Designation</b>	<b>ACU 1-13</b>	<b>ACU 1-14</b>	<b>ACU 1-15</b>	<b>ACU 1-16</b>
Manufacturer	.....	.....	.....	.....
Model no.	.....	.....	.....	.....
Total sensible cooling capacity - kW	.....	.....	.....	.....
Total cooling capacity - kW	.....	.....	.....	.....
Total heating capacity - kW	.....	.....	.....	.....
Supply air quantity - L/s	.....	.....	.....	.....
Outside air quantity - L/s	.....	.....	.....	.....
Supply air fan motor drive type	.....	.....	.....	.....
Cooling stage	.....	.....	.....	.....
Condenser fan type	.....	.....	.....	.....
Condenser fan motor drive type	.....	.....	.....	.....
Configuration/system type	.....	.....	.....	.....

<b>Designation</b>	<b>ACU 1-17</b>	<b>ACU 1-18</b>	<b>ACU 1-19</b>	<b>ACU 1-20</b>
Manufacturer	.....	.....	.....	.....
Model no.	.....	.....	.....	.....
Total sensible cooling capacity - kW	.....	.....	.....	.....
Total cooling capacity - kW	.....	.....	.....	.....
Total heating capacity - kW	.....	.....	.....	.....
Supply air quantity - L/s	.....	.....	.....	.....
Outside air quantity - L/s	.....	.....	.....	.....
Supply air fan motor drive type	.....	.....	.....	.....
Cooling stage	.....	.....	.....	.....
Condenser fan type	.....	.....	.....	.....
Condenser fan motor drive type	.....	.....	.....	.....
Configuration/system type	.....	.....	.....	.....

Signature of Tenderer .....

Date .....

**SAINT ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TECHNICAL DATA SCHEDULE**

<b>Designation</b>	<b>ACU 1-21</b>	<b>ACU 1-22</b>	<b>ACU 1-23</b>	<b>ACU 1-24</b>
Manufacturer	.....	.....	.....	.....
Model no.	.....	.....	.....	.....
Total sensible cooling capacity - kW	.....	.....	.....	.....
Total cooling capacity - kW	.....	.....	.....	.....
Total heating capacity - kW	.....	.....	.....	.....
Supply air quantity - L/s	.....	.....	.....	.....
Outside air quantity - L/s	.....	.....	.....	.....
Supply air fan motor drive type	.....	.....	.....	.....
Cooling stage	.....	.....	.....	.....
Condenser fan type	.....	.....	.....	.....
Condenser fan motor drive type	.....	.....	.....	.....
Configuration/system type	.....	.....	.....	.....

<b>Designation</b>	<b>ACU 1-25</b>	<b>ACU 2-1</b>
Manufacturer	.....	.....
Model no.	.....	.....
Total sensible cooling capacity - kW	.....	.....
Total cooling capacity - kW	.....	.....
Total heating capacity - kW	.....	.....
Supply air quantity - L/s	.....	.....
Outside air quantity - L/s	.....	.....
Supply air fan motor drive type	.....	.....
Cooling stage	.....	.....
Condenser fan type	.....	.....
Condenser fan motor drive type	.....	.....
Configuration/system type	.....	.....

Signature of Tenderer .....

Date .....

**SAINT ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TECHNICAL DATA SCHEDULE**

**Air Conditioning Units - Cassette Type:-**

<b>Designation</b>	<b>ACU G-13</b>
Manufacturer	.....
Model	.....
Total sensible cooling capacity - kW	.....
Supply air quantity - L/s	.....
Full load amps per phase - Amps	.....

**Energy Recovery Ventilator Units:-**

<b>Designation</b>	<b>ERV G-1</b>	<b>ERV G-2</b>	<b>ERV 1-1</b>	<b>ERV 1-2</b>
Air off conditions - db°C/wb°C	.....	.....	.....	.....
Outside/supply air quantity - L/s	.....	.....	.....	.....
Exhaust air quantity - L/s	.....	.....	.....	.....
Estimated external static resistance - Pa	.....	.....	.....	.....
Minimum supply air fan motor power - kW	.....	.....	.....	.....

<b>Designation</b>	<b>ERV 1-3</b>	<b>ERV 1-4</b>	<b>ERV 1-5</b>	<b>ERV 1-6</b>
Air off conditions - db°C/wb°C	.....	.....	.....	.....
Outside/supply air quantity - L/s	.....	.....	.....	.....
Exhaust air quantity - L/s	.....	.....	.....	.....
Estimated external static resistance - Pa	.....	.....	.....	.....
Minimum supply air fan motor power - kW	.....	.....	.....	.....

Signature of Tenderer .....

Date .....

**SAINT ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TECHNICAL DATA SCHEDULE**

<b>Designation</b>	<b>ERV 1-7</b>	<b>ERV 1-8</b>	<b>ERV 1-9</b>	<b>ERV 1-10</b>
Air off conditions - db°C/wb°C	.....	.....	.....	.....
Outside/supply air quantity - L/s	.....	.....	.....	.....
Exhaust air quantity - L/s	.....	.....	.....	.....
Estimated external static resistance - Pa	.....	.....	.....	.....
Minimum supply air fan motor power - kW	.....	.....	.....	.....

<b>Designation</b>	<b>ERV 1-11</b>	<b>ERV 1-12</b>	<b>ERV 1-13</b>
Air off conditions - db°C/wb°C	.....	.....	.....
Outside/supply air quantity - L/s	.....	.....	.....
Exhaust air quantity - L/s	.....	.....	.....
Estimated external static resistance - Pa	.....	.....	.....
Minimum supply air fan motor power - kW	.....	.....	.....

**Fans - Roof Mounted:-**

<b>Designation</b>	<b>KEF -1</b>
Manufacturer	.....
Model no.	.....
Capacity - L/s	.....
Fan speed - r/s	.....
Outlet velocity - m/s	.....
Diameter - mm	.....
Motor power - kW	.....
Cowl material	.....
Acoustic performance - dB re 1 pW	
63 Hz	.....
125 Hz	.....
250 Hz	.....

Signature of Tenderer .....

Date .....



**SAINT ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TECHNICAL DATA SCHEDULE**

**Designation** **KEF -1**

500 Hz .....

1000 Hz .....

2000 Hz .....

**Fans - Mixed Flow In-line:-**

**Designation** **OAF G-1** **OAF G-2** **OAF G-3** **OAF G-4**

Manufacturer .....

Model .....

Capacity - L/s .....

Fan speed - r/s .....

Outlet velocity - m/s .....

Motor type - V/phase .....

Acoustic performance - dB re 1 pW

63 Hz .....

125 Hz .....

250 Hz .....

500 Hz .....

1000 Hz .....

2000 Hz .....

**Designation** **OAF G-5** **OAF G-6** **OAF G-7** **OAF G-8**

Manufacturer .....

Model .....

Capacity - L/s .....

Fan speed - r/s .....

Outlet velocity - m/s .....

Motor type - V/phase .....

Acoustic performance - dB re 1 pW

63 Hz .....

Signature of Tenderer .....

Date .....

**SAINT ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TECHNICAL DATA SCHEDULE**

<b>Designation</b>	<b>OAF G-5</b>	<b>OAF G-6</b>	<b>OAF G-7</b>	<b>OAF G-8</b>
125 Hz	.....	.....	.....	.....
250 Hz	.....	.....	.....	.....
500 Hz	.....	.....	.....	.....
1000 Hz	.....	.....	.....	.....
2000 Hz	.....	.....	.....	.....

<b>Designation</b>	<b>OAF 1-1</b>	<b>OAF 1-2</b>	<b>OAF 1-3</b>	<b>OAF 1-4</b>
Manufacturer	.....	.....	.....	.....
Model	.....	.....	.....	.....
Capacity - L/s	.....	.....	.....	.....
Fan speed - r/s	.....	.....	.....	.....
Outlet velocity - m/s	.....	.....	.....	.....
Motor type - V/phase	.....	.....	.....	.....
Acoustic performance - dB re 1 pW				
63 Hz	.....	.....	.....	.....
125 Hz	.....	.....	.....	.....
250 Hz	.....	.....	.....	.....
500 Hz	.....	.....	.....	.....
1000 Hz	.....	.....	.....	.....
2000 Hz	.....	.....	.....	.....

<b>Designation</b>	<b>OAF 1-5</b>	<b>OAF 2-1</b>	<b>TEF G-1</b>	<b>TEF G-2</b>
Manufacturer	.....	.....	.....	.....
Model	.....	.....	.....	.....
Capacity - L/s	.....	.....	.....	.....
Fan speed - r/s	.....	.....	.....	.....
Outlet velocity - m/s	.....	.....	.....	.....
Motor type - V/phase	.....	.....	.....	.....

Signature of Tenderer .....

Date .....

**SAINT ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TECHNICAL DATA SCHEDULE**

<b>Designation</b>	<b>OAF 1-5</b>	<b>OAF 2-1</b>	<b>TEF G-1</b>	<b>TEF G-2</b>
Acoustic performance - dB re 1 pW				
63 Hz	.....	.....	.....	.....
125 Hz	.....	.....	.....	.....
250 Hz	.....	.....	.....	.....
500 Hz	.....	.....	.....	.....
1000 Hz	.....	.....	.....	.....
2000 Hz	.....	.....	.....	.....

**Evaporative Cooling Units:-**

<b>Designation</b>	<b>EVC G-1</b>
Manufacturer	.....
Model	.....
High speed air quantity - L/s	.....
Low speed air quantity - L/s	.....
Motor power - kW	.....
Motor type - V/phase	.....
Casing material	.....
Fin material	.....

**Sound Attenuators:-**

<b>Designation</b>	<b>SA 1-1</b>	<b>SA 1-2</b>
Manufacturer	.....	.....
Model	.....	.....
Static pressure loss - Pa	.....	.....
Static insertion loss - dB re 1 pW		
63 Hz	.....	.....
125 Hz	.....	.....
250 Hz	.....	.....
500 Hz	.....	.....

Signature of Tenderer .....

Date .....

**SAINT ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TECHNICAL DATA SCHEDULE**

<b>Designation</b>	<b>SA 1-1</b>	<b>SA 1-2</b>
1000 Hz	.....	.....
2000 Hz	.....	.....

**Rotary ventilators:-**

<b>Designation</b>	<b>RV-1</b>	<b>RV-2</b>	<b>RV-3</b>
Manufacturer	.....	.....	.....
Model	.....	.....	.....

**Safety Storage Cabinets:-**

<b>Designation</b>	<b>SSC 1-1</b>	<b>SSC 1-2</b>	<b>SSC 1-3</b>
Manufacturer	.....	.....	.....
Model	.....	.....	.....

**Air Distribution Systems:-**

Flexible ductwork

Manufacturer.....  
Model .....

Modulating dampers

Manufacturer.....  
Model .....

Air diffusion equipment

Manufacturer.....  
Louvre face model .....

Exhaust air model .....

Eggcrate model.....

**Electrical:-**

Switchgear and controlgear assemblies, manufacturer.....

**DDC Controls:-**

Controls manufacturer .....

Signature of Tenderer .....

Date.....

**SAINT ALOYSIUS COLLEGE  
GYMNASIUM AND CLASSROOMS FITOUT  
MECHANICAL SERVICES  
TECHNICAL DATA SCHEDULE**

**Generated Noise and Vibration Control:-**

Manufacturer .....

Springmounts type A, model .....

Neoprene pads, model .....

Hangers type A, model .....

Signature of Tenderer .....

Date .....