

0701 MECHANICAL SYSTEMS**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide the mechanical services, as documented.

1.2 DESIGN**Design for durability and maintainability**

Design for durability: Develop the design so the systems achieve the documented performance, reliability, service life, energy efficiency and safety requirements, and are easily maintainable.

Access for maintenance: Develop the design so the systems conform to **ACCESS FOR MAINTENANCE** in the *0171 General requirements* worksection.

Outdoor design conditions

Requirement: As documented.

Indoor design conditions

Requirement: As documented.

1.3 STANDARDS**General**

Mechanical ventilation and air conditioning: To AS/NZS 1668.1 and AS 1668.2.

Microbial control: To AS/NZS 3666.1, AS/NZS 3666.2 and the recommendations of SAA/SNZ HB 32.

Refrigeration systems: To AS/NZS 1677.2 and the recommendations of SAA HB 40.1 and SAA HB 40.2.

Flammable refrigerants: To the recommendations of AIRAH Flammable Refrigerants - Safety Guide.

Plumbing, drainage and water supply: To AS/NZS 3500.0, AS/NZS 3500.1, AS/NZS 3500.2, AS/NZS 3500.3 and AS/NZS 3500.4 and the PCA.

1.4 INTERPRETATION**Definitions**

General: For the purposes of this worksection the definitions given in the *0171 General requirements* worksection apply.

1.5 CONTRACT DOCUMENTS**General**

Requirement: Conform to the *0171 General requirements* worksection.

1.6 SUBMISSIONS**General**

Requirement: Conform to the *0171 General requirements* worksection.

Certification

Certification: Submit certification that the plant and equipment submitted meets the requirements and capacities of the contract documents except for departures that are identified in the submission.

Electrical loading information for mechanical services

General: Submit electrical loading information for all equipment before completion of the main switchboard shop drawings.

Loading and connection: Submit the information for items not supplied from the services switchboards.

Starting characteristics: Submit details for motors with reduced current starting. Make sure starting characteristics are within the characteristics of the respective submain protection devices.

Switchboards: Submit the following information for each building services switchboard:

- Board location and designation.
- For each submain connected to the board, submit the following for each item connected to it:

- . Submain designation.
- . Item designation and name.
- . Power rating in kW.
- . Number of phases.
- . Full load amps per phase.
- . Power factor.
- . Total amps on each phase for respective submain.

Environmentally sustainable design**Mechanical services shop drawings**

Requirement: Submit the following detail drawings at minimum 1:100 scale or larger, showing:

- Fire and smoke dampers including dimensional tolerances.
- Floor wastes.
- Ductwork, plinths, pipework and equipment layouts and sections. Show the location of fire-resisting building elements.
- Diffuser, grille, terminal and chilled beam reference numbers corresponding to design values and commissioning test results.
- Each item of equipment with its identifying name or code and key performance data.
- Riser layouts and sections.
- Plant room layouts and sections.
- Locations of automatic control sensors, motors and valves.
- Acoustic details.
- Conditioner construction details.
- Seismic restraint details.
- Provisions for access for maintenance and removal of components to *0171 General requirements* clause **ACCESS FOR MAINTENANCE**.
- Lifting provisions for heavy items.
- Piping and other schematic drawings including numbering of each valve to correspond to the valve tag notation. For refrigerant piping include slope of horizontal runs, oil traps, double risers and valving.
- Submission drawings required by authorities.
- Connections to other services.
- Switchboard details.
- Wiring diagrams.

Operations and maintenance manuals

Requirement: Conform to the *0171 General requirements* worksection.

Technical data

General: Documented fan pressures and pump heads are based on provisional equipment selections and estimated pressure drops.

Equipment: Before ordering equipment, calculate the respective system pressure losses based on the equipment offered and layouts shown on the shop drawings and submit the proposed selections.

Submissions: Submit technical data for all items of plant and equipment.

Data to be submitted: Include at least the following information in technical submissions:

- Assumptions.
- Calculations.
- Model name, designation and number.
- Capacity of all system elements.
- Country of origin and manufacture.
- Materials used in the construction.
- Size, including required clearances for installation.
- Certification of conformance to the applicable code or standard.

- Technical data schedules corresponding to the equipment schedules in the contract documents. If there is a discrepancy between the two, substantiate the change.
- Manufacturers' technical literature.
- Type-test reports.

1.7 INSPECTION

Notice

Inspection: Give notice so inspection may be made of the following:

- 1st Fix
- 2nd Fix
- Practical Completion (including commissioning witnessing)

2 EXECUTION ---

2.1 SUPPORT OF PLANT AND EQUIPMENT

Support of ground level plant and equipment

Ground level:

- If the ground slope is 15° or more, or the area of the plant and equipment is extensive, obtain the advice of a professional engineer for the documentation of a suitable slab or platform.
- In all other cases, provide proprietary plastic or concrete supports installed with falls that achieve a raised, impervious and water shedding bearing surface.

Balustrades: If balustrades or screening are required, obtain the advice of a registered architect.

2.2 SEISMIC RESTRAINT OF NON-STRUCTURAL COMPONENTS

Provisions

General: Install all components, other than service items exempted in AS 1170.4, to resist seismic loads determined in conformance with AS 1170.4. Securely fix all plant and equipment to the building structure. Do not rely on gravity and/or friction to resist seismic forces.

Anti-vibration mounts: Use horizontally restrained type.

Components: Do not use components that will be damaged by earthquake conditions. Protect systems against the adverse effects of components such as mercury switches that, although not damaged by earthquake, may malfunction.

3 SCOPE OF WORKS ---

Outline Description: The works include but are not necessarily limited to the works referred to in the outline description given below.

Items not included in the specification but shown on the drawings or visa versa shall be included in the Contract. The documents herewith, comprising performance based specification and conceptual based drawings have been prepared to obtain tenders from mechanical services contractors. To that end the documents have been prepared to provide the mechanical services concept and intent of the systems design only.

The mechanical services documents are to be read in conjunction with all architectural, structural and other services documents. All allowances to incorporate interface and co-ordinate with the above shall be included by the contractor. No variations due to poor co-ordination with all the above documents will be accepted.

New Systems

- Provide new Variable Refrigerant Flow (VRF) heat recovery system consisting of structural platform or roof skid mounted condensing unit, multiple indoor fan coil units, interconnecting refrigeration pipework, ductwork, dampers, cowls, outlets and grilles, outside air kits, vibration isolation, condensate drains with pumps (if required) and pipework, electrical wiring and controls. Note: All individual units shall have independent wall mounted controller in their corresponding area served as well as independent push button run on time switches. Provide a centralised controller for master control of all units. Provide and allow to connect to the following indoor fan coil units to a single outdoor condenser:

. Ducted Units

- Provide and install a roof mounted ventilation fan to the top of the lift shaft. Include and coordinate the associated electrical and lift shaft penetration requirements. Provide temperature sensor for fan control all associated supports, ductwork, grilles, backdraught damper, electrical including wiring and controls. Confirm and coordinate all mounting requirements of mechanical equipment (temp sensor, fan penetration etc) with lift manufacturer for suitable locations.
- Provide new car park exhaust air systems consisting of inline duct mounted exhaust fan, VSDs, ductwork, attenuators, fire dampers, high level exhaust grilles, CO & NOx sensors, carpark jet fans, weatherproof air louvres, control and electrical wiring. The systems shall be installed to AS1668.2 – 2012 and all relevant standards and regulations.
- Provide new toilet exhaust systems consisting of inline duct mounted or wall mounted exhaust fans, motion detectors, exhaust ductwork, grilles, electrical wiring and controls.
- Provide new general exhaust systems consisting of ceiling mounted exhaust fan, exhaust ductwork, grilles, electrical wiring and controls.
- Allow for the, trimming of ceilings, required wall/roof penetrations and upstands (metal upstands required) for outside air systems nominated, and all associated builders works etc for the installation of all new mechanical equipment, pipework, electrical cabling etc. Ensure all new wall/roof penetrations are appropriately sealed.

General

- Electrical wiring and controls.
- Mechanical contractor is to provide final connections from individual isolators provided adjacent mechanical equipment by electrical contractor. NOTE: Individual electrical isolators are required for all indoor units on VRF air conditioning systems as well as isolators at the outdoor VRF condensers.
- Equipment concrete plinths and intermediate structural supports or skid frames for the supporting of mechanical equipment.
- Equipment, ductwork and pipework hangers and supports.
- Catenary wire hangers and cabling supports for electric and control wiring.
- Supporting structures in ceiling voids for plant and equipment.
- Provision of painting and corrosion protection to support steelwork etc.
- Equipment, ductwork and pipework hangers and supports. Including seismic bracing to comply with AS1170.4
- Allow for the painting of outlets, grilles and all mechanical items exposed to view. Confirmation of final requirements and colours to be advised by the architect.
- Pipework and ductwork insulation to NCC minimum R-Value requirements.
- Condensate drainage to the nearest tundish or gully trap provided, including drip trays and all pipework. Allow to drain condensate from all indoor fan coil units and outdoor air cooled condensers. Where condensate drains cannot be connected to sewer, provide soakage pit. Works to be carried in accordance to EPA Schedule 3 – Class 2 pollutants [Clause 11 Environment Protections (Water Quality) Policy 2015].
- All exposed refrigeration pipework and wiring to be covered in weatherproof colourbond capping. Where located in a trafficable area: ensure capping is appropriate in construction to withstand crushing and provide appropriate trip hazard warning signage or hazard prevention coverings to ensure installation is safe to the satisfaction of the Principal. Paint in a colour to match adjacent surface colour, confirm final colour with architect.
- Supply of door air relief grilles.
- Anti-vibration mounts to equipment.
- Flexible connections to equipment.
- Sealing of all ductwork, pipework, electrical and control wiring etc. passing through all full height walls, acoustic separation sensitive areas, using approved acoustic insulated solid duct transfers and sealants to ensure that the acoustic rating of each room is not compromised.
- Ceiling access panels (include micro traffolyte labels to all access panels or T-Bar ceiling tile required for access to indicate location of associated equipment services items concealed in ceiling space above). Nominate unit designation on label eg “FCU-01 Access”.
- Roof penetrations, upstands and weatherproof overflashing. Provide trimmers between purlins as required.

- Trenching, backfilling and compaction as required for the above services.
- Condensate pumps (where required) and condensate pipework to tundishes provided.
- Vandal cages for external equipment (ie outdoor units, etc) with accessible and lockable doors.
- Trenching, backfilling and compaction for soakage pits and condensate pipe to soakage pits.
- Hoisting of all equipment.
- Coordination of installation with other trades.
- Craneage as required for the installation of new equipment.
- Removal of ceiling tiles, T-Bar, etc for the installation of equipment, ductwork, pipework, grilles and wiring. Make good to ceilings after installation.
- Cutting holes in ceilings and bulkheads for the installation of diffusers and grilles. Make good to ceilings and bulkheads after installation.
- Allow to cut and chase brick and block walls for refrigerant pipework, condensate pipework, electrical and control wiring.
- Associated building works such as penetrations, openings, chasing, trenching, making good, manufacturer's access requirements unless detailed elsewhere in documents to be provided by other trades.
- Provide protective drop sheets to walls and floor as required to protect finished surfaces.
- Vacuum clean floors after sections of installation are complete.
- Remove all redundant equipment, rubbish, etc from site.
- Remove all cuttings, swarf and rubbish from roof and gutters.
- Selection of individual equipment items to meet the minimum capacities specified herein.
- Detailed design and construction of all items to meet the design intent requirements of the specification and drawings.
- Confirmation of all electrical characteristics and requirements for mechanical equipment with the electrical services contractor.
- Confirmation of all hydraulics, fire protection requirements with the relevant contractors.
- Calculations of static pressure (resistance) associated with all fan systems, air distribution ductwork systems etc for review and signoff.
- Shop drawings.
- As-Installed drawings
- Operating and Maintenance Manuals.
- Testing and Commissioning of all systems.
- Equipment warranty, maintenance and servicing of the above systems for 12 months from the date of practical completion.
- Other works as shown on the drawings or in the specification.

3.1 DOCUMENTS ISSUED

The arrangements and details shown on the drawings are indicative only. Allow to check all dimensions and building details prior to commencement of any work. To that end the documents have been prepared to provide the mechanical services concept and intent of the systems design only and are not considered as built documents. The requirement of the mechanical contractor is to provide for a fully automatic durable and trouble free system of mechanical services, including matters of minor design not specifically included in this document.

Drawings: The following drawings form an integral part of this specification:-

Description:

B8014/M01 Mechanical Services HVAC Basement, Ground & First Floor Layout

B8014/M02 Mechanical Services HVAC Second & Third Floor & Roof Layout

B8014/M03 Mechanical Services HVAC Details Sheet

3.2 ASSOCIATED WORK

Include items scheduled below and all items necessary for successful and economical operation and to meet the intent of the Contract Documents for a fully automatic durable and trouble free system of

mechanical services shall be provided, including matters of minor design not specifically included in this document.

The Builder shall be deemed to have inspected the site, made allowances for all difficulties of access, installation, staging, testing, commissioning, procurement, noise and vibration control etc and shall utilise their own experience and expertise determine detailed design and installation allowances to achieve the objectives of the Contract Documents and allowed for the following:-

- Openings in ceiling, walls and bulkheads for registers, grilles.
- Ceiling access panels where shown on drawings.
- Pipe risers where shown on drawings.
- Roof penetrations and upstands where shown on drawings. Metal upstands required.
- Concrete plinths and roof structural supports for mounting of VRF and split condensing units
- Installation of door air relief and weatherproof grilles.
- Electrical supply to mechanical plant.
- Tundishes for drains from mechanical plant.

4 DESIGN AND COORDINATION INFORMATION

4.1 ERRORS AND OMISSIONS

It is the mechanical contractor's responsibility to comply with the intent of the design herein, any errors or omissions found within the specification and drawings (or any Irregularities between the specification and drawings) which could change the design intent and subsequently the cost shall be reported to the residing engineer for his attention and if necessary an addendum will be issued during the tender period.

Any errors or omissions not identified will be deemed to have been included and allowed for in the tender offer.

4.2 DESIGN BASIS

Mechanical Services systems have been designed on the following parameters.

- Indoor room temperatures:
 - . Maximum 24°C DB/50% RH
 - . Minimum 20°C DB
- Maximum outdoor air temperature 38°C DB/21°C WB.
- Minimum outdoor air temperature 0°C.
- Maximum extreme ambient outdoor air temperature at which condenser plant will keep running 50°C DB.
- Minimum extreme ambient outdoor air temperature at which condenser plant will keep running 0°C DB.
- Outdoor air 10-12 l/s per person.
- Summer solar loads to AIRAH data.

SA Power Networks Main Supply System

Equipment shall be designed for operation on the SA Power Networks electrical supply system rated at 415V, 3 phase, 4 core (3phase + neutral), 50Hz and/or 240V, 1 phase, 50 Hz.

Noise Emissions

Noise emissions shall comply with data stated in "Noise and Vibration" section.

Note specifically the need to select plant and equipment to meet specified noise levels in the occupied areas and at the site boundary.

Vibration Transmission

Vibration transmission characteristics shall comply with data stated in "Noise and Vibration" section.

4.3 EQUIPMENT, WEIGHTS, SIZES AND POWER REQUIREMENTS

Equipment ratings, weights, sizes and power requirements have been transmitted to architectural, structural, and electrical engineering designers during the design phase of the project for inclusion in design and estimating processes.

Confirm all weights, sizes and electrical loads (both starting and running loads) of relevant equipment proposed to be installed on the site and brands nominated in the Tender documents with relevant other trades prior to committing to final cable sizes and equipment selections. Coordinate with relevant trades to ensure proper provisions and interface arrangements have been made, and include all due allowances for such coordination and perform without charge any minor adjustments.

4.4 SPACING OF PLANT AND EQUIPMENT

Drawings show the design intent and indicate the location of the equipment.

Ensure that plant and equipment items are readily accessible for operation and maintenance and that sufficient space is provided to comply with the manufacturer's recommendations for overhaul, maintenance or repair and to the approval of the architect.

Determine the extent of work of other trades operating in the areas concerned and coordinate the layout of plant and equipment to be installed under this Contract, with that to be installed by the other Builders.

4.5 COORDINATION WITH OTHER TRADES

Determine the extent of their work and coordinate the layout of plant and equipment to be installed under this section of the specification with that to be installed by the other trades to ensure there are no interface problems before installation commences.

4.6 QUALIFICATIONS AND EXPERIENCE

The tenderer is deemed to have sufficient experience and expertise in Contracts of this nature and to have submitted a full and complete tender offer and to have allowed in his tender price for all contingencies and minor works and the resolution of all discrepancies and inclusion of all materials necessary to fulfil the intent of this Contract as described in the associated drawings and specifications. Variation Orders will not be issued for other than changes to the Scope of Works or Scheduled Capacities as initiated by the Architect.

4.7 LICENSED PERSONNEL

Work shall be carried out by qualified and licensed tradesman with suitably capable apprentices or assistants in respect of:-

- Air conditioning installations
- Electrical wiring - Commercial and Industrial installations
- Air conditioning controls - Commercial and Industrial installations

4.8 NATIONAL CONSTRUCTION CODE (NCC)

Unless otherwise specified, the entire installation including the supply of equipment and materials shall be in accordance to the current NCC and all clauses within associated to these works. Particularly section "J".

The NCC applicable to the works shall be the edition last published prior to the closing date for tenders unless otherwise specified.

4.9 AUSTRALIAN STANDARDS

Unless otherwise specified, materials and workmanship shall be in accordance with the relevant standard of the Standard Association of Australia

A standard applicable to the works shall be the edition last published prior to the closing date for tenders unless otherwise specified or as referenced by the NCC.

Overseas standards and other standard documents named in the specification shall be applicable in the same manner as Australian Standards to relevant materials and workmanship.

4.10 SEISMIC RESTRAINT OF NON-STRUCTURAL COMPONENTS

General: Arrange all components, other than service items exempted in AS 1170.4 clause 5.1.4, to resist seismic loads determined in accordance with AS 1170.4 and the DPTI Guide Note G172 "Seismic Restraint of Engineering Services". Securely fix all plant and equipment to the building structure. Do not rely on gravity and/or friction to resist seismic forces.

Anti-vibration mounts: Use horizontally restrained type.

Components: Do not use components that will be damaged by earthquake conditions. Protect systems against the adverse effects of components such as mercury switches that, although not damaged by earthquake, may malfunction.

Provide details of supports for approval.

4.11 GUARANTEES

Guarantee that the complete system within specified termination points shall safely, reliably, and efficiently provide the specified full load design capacity and performance, including all start up, shutdown and control functions and intermediate ratings as required, throughout the full 12 month Defects Liability period following the date of issue of the Certificate of Practical Completion.

4.12 SPECIFICATION AND TENDER DRAWINGS

Ensure all personnel to be engaged on the project have been briefed and have a full understanding of the technical and physical requirements of the system described in this specification and accompanying drawings, all appropriate codes, regulations and standards, manufacturers data, requirements of regulatory and statutory authorities, and instructions issued by the Architect.

Prior to commencement of fabrication or installation, ensure all current drawings are obtained and the dimensions of relevant site works have been checked.

Before commencing work verify the exact positions of all outlets, diffusers and equipment, cable runs, plant positions, etc.

Drawings must not be used for architectural or structural work, but shall be read in conjunction with architectural, structural and all other relevant drawings.

The services should be read as diagrammatic only and show the principle of design and do not include details of sets and bends required for the coordination between the structure and other trades. Due allowance shall be made in the tender price for all sets and bends.

Deviation from the design principles will not be permitted without written approval.

4.13 SHOP DRAWINGS AND DETAILED DESIGN

Secon Tender (Construction) drawings may be made available for the preparation of Shop Drawings. These drawing shall be used as a guide only and all building architecture, structural and services dimensions and clearances etc shall be checked and confirmed to ensure all ductwork and equipment fit and service requirements are obtained. A direct copy of the Secon Tender (Construction) Drawings is not acceptable.

Shop Drawings and Detailed Design shall be prepared and reviewed prior to ordering any equipment or commencing work on site. Any items that the Architect may require shall be provided to shop drawing or detailed design standard within seven calendar days of request.

Ensure the builder has coordinated all services and provides a signed off copy prior to submitting shop drawings for review. Any costs arising from clashes with other services will remain with the sub-contractor.

Engineering CAD drawings will not be made available for the basis of the contractor's construction drawings.

CAD: Drawings shall be prepared using CAD drafting format – AutoCAD Version 14 or later.

Drawings shall be to a scale of not less than 1:50 and larger as required and shall be on B1 sheets.

Submit PDF copies of drawings and engineering calculations allowing 10 working days to be examined and returned.

Shop Drawings shall include the following:-

- Spatial coordination with other trades and services including location of tundishes, drains, MSSB, electrical isolators, penetrations, supports, grilles, etc.
- Equipment location and supports.
- Ductwork and pipework locations and construction.
- Wall, ceiling and roof penetrations.
- Electrical wiring and controls diagrams.
- Plant servicing requirements.

Shop drawings shall be of sufficient detail and content to describe exactly how the item will be manufactured, installed and operated.

Detailed Design shall include the following:-

- Site measurement.
- Detailed selection of equipment.
- Design coordination with other trades and services including advice of electrical loads, weights, control signals, etc.
- Design seismic mounts and restraints in accordance with AS 1170.4.
- Coordination of existing and new works.
- Engineering Calculations: Prior to ordering equipment, submit engineering calculations based on shop drawing layouts and actual equipment selections of:-
 - . Duct and pipework resistances and selection curves for pumps and fans and control valves with proposed operating point shown on curve.
 - . Noise ratings demonstrating compliance of selected equipment and system detail design with specified noise ratings.
- Detailed design of all items to allow fabrication to proceed.
- Detailed design of all items to allow installation to proceed.

Shop Drawings and Detailed Design Review

Shop drawings and detailed design will be reviewed for the following:-

- That shop drawings and detailed design items as required by the Contract have been carried out.
- That submitted items demonstrate an acceptable quality of work.
- That submitted documents demonstrate general compliance of selected equipment and detailed design and shop drawings with the intent of documented requirements.

Shop drawing and detail design review is to verify that work has been carried out to sufficient quality and content. The outcome is the granting of permission for the Builder to use the documents for the purpose of the Contract provided they are assessed to be of sufficient quality and content.

If errors or discrepancies are identified by the design team during the review process, they will be marked up for the information of the Builder. The review is not an approval process and does not include active checking of Builder calculations or drawings for errors or discrepancies, or Builder compliance with Contract Documents or Contract Instructions. The Builder remains responsible at all times for the content, accuracy, scope of work, and technical sufficiency of the submitted documents.

Where drawings are determined to be of sufficient quality and content for their purpose, they will be stamped "Proceed as Drawn". Where minor errors and discrepancies are identified which have little consequence to quality, content or purpose of the drawing, they will be stamped "Proceed as Drawn Subject to Comments". Where errors, discrepancies or omissions are identified which are assessed to cause the quality or content of the drawing to be unsuitable for its purpose, the drawing will be stamped "Resubmit Drawing Prior to Proceeding".

Where drawings or calculations are returned for amendment, allow for amendments to be carried out and re-submitted in sufficient time to prevent delays to the completion of the work.

All required shop drawings shall be prepared with all equipment, service lines, ductwork, cable runs and the like fully coordinated with those of all other trades and building elements. This requires locations and routes of the other engineering services (plumbing, fire, electrical etc) to be shown on the shop drawings to ensure there are no clashes prior to installation. Shop drawings shall incorporate sectional views (vertical) through ceiling and duct cavities to indicate the order of installation, and offsets required, for a fully coordinated installation.

Shop drawings may be submitted on a floor-by-floor basis but, in any case in adequate time to allow for examination by the Superintendent prior to commencement of ordering and fabrication.

4.14 SHOP DRAWINGS

Secon Tender (Construction) drawings may be made available for the preparation of Shop Drawings. These drawing shall be used as a guide only and all building architecture, structural and services dimensions and clearances etc shall be checked and confirmed to ensure all ductwork and equipment fit and service requirements are obtained. A direct copy of the Secon Tender (Construction) Drawings is not acceptable.

Shop Drawings shall be prepared and reviewed prior to ordering any equipment or commencing work on site. Any items that the Architect may require shall be provided to shop drawing standard within seven calendar days of request.

CAD: Drawings shall be prepared using CAD drafting format – AutoCAD Version 14 or later. Drawings shall be to a scale of not less than 1:50 and larger as required and shall be on B1 sheets. Submit PDF copies of drawings and engineering calculations allowing 10 working days to be examined and returned.

Shop Drawings shall include the following:-

- Spatial coordination with other trades and services including location of tundishes, drains, electrical isolators, penetrations, supports, grilles, etc.
- Equipment location and supports.
- Ductwork and pipework locations and construction.
- Wall, ceiling and roof penetrations.
- Electrical wiring and controls.

Shop drawings shall be of sufficient detail and content to describe exactly how the item will be manufactured, installed and operated and shall include the following:-

- Site measurement.
- Design coordination with other trades and services including advice of electrical loads, weights, control signals, etc.
- Coordination of existing and new works.
- Details to allow fabrication to proceed.
- Details to allow installation to proceed.

Shop Drawings Review

Shop drawings will be reviewed for the following:-

- That shop drawings as required by the Contract have been carried out.
- That submitted items demonstrate an acceptable quality of work.

Shop drawing review is to verify that work has been carried out to sufficient quality and content. The outcome is the granting of permission to use the documents for the purpose of the Contract provided they are assessed to be of sufficient quality and content.

If errors or discrepancies are identified by the design team during the review process, they will be marked up and returned for correction. The review is not an approval process and does not include active checking of drawings for errors or discrepancies, or compliance with Contract Documents or Contract Instructions.

The Builder remains responsible at all times for the content, accuracy, scope of work, and technical sufficiency of the submitted documents.

Where drawings are determined to be of sufficient quality and content for their purpose, they will be stamped "Proceed as Drawn". Where minor errors and discrepancies are identified which have little consequence to quality, content or purpose of the drawing, they will be stamped "Proceed as Drawn Subject to Comments". Where errors, discrepancies or omissions are identified which are assessed to cause the quality or content of the drawing to be unsuitable for its purpose, the drawing will be stamped "Resubmit Drawing Prior to Proceeding".

Where drawings are returned for amendment, allow for amendments to be carried out and re-submitted in sufficient time to prevent delays to the completion of the work.

All required shop drawings shall be prepared with all equipment, service lines, ductwork, cable runs and the like fully coordinated with those of all other trades and building elements. This requires locations and routes of the other engineering services (plumbing, fire, electrical etc) to be shown on the shop drawings to ensure there are no clashes prior to installation. Shop drawings shall incorporate sectional views (vertical) through ceiling and duct cavities to indicate the order of installation, and offsets required, for a fully coordinated installation.

Shop drawings may be submitted on a floor-by-floor basis but, in any case in adequate time to allow for examination by the Superintendent prior to commencement of ordering and fabrication.

4.15 AS INSTALLED DRAWINGS

Tender drawings may be made available for the preparation of As Installed Drawings. These drawing shall have Secon Consulting Engineers name removed from the title block and shall be upgraded to as installed. A direct copy is not acceptable for an As Installed Drawing.

Make AutoCAD V14 or later drawings of 'work as executed' of all work. Show accurately the installed positions of all pipes, valves, ducts, motors, controls, access points, electrical connections, access hatches etc.

'As-Installed' drawings will be reviewed for quality and content in a similar manner as for shop drawings review. Where drawings are determined to be of sufficient quality and content for their purpose, they will be forwarded to the Proprietor for acceptance. Where errors, discrepancies or omissions are identified, they will be returned for correction.

Where drawings or calculations are returned for amendment, allow for amendments to be carried out and re-submitted in sufficient time to prevent delays to the completion of the work or awarding of Practical Completion.

The review of installed drawings is not intended to be a checking process, and the Builder remains responsible at all times for the content, accuracy and scope of submitted documents.

4.16 SAMPLES

Submit samples of all items as requested by the Architect for approval, including the following:-

- Diffusers, Registers and Grilles
- Air Conditioning Control Panels
- Temperature Sensor
- Return Air Grille

Samples may, after approval by the Architect, be installed on the project provided they are suitably identified and their location is recorded and agreed to by the Architect.

For certain items where requested the first installed of each type may be accepted by the Architect as a sample.

Samples submitted during the Tender stage to determine style and appearance are not regarded as samples in relation to the Quality System, and will require to be resubmitted and approved by the Architect during the Contract.

4.17 AUTHORITIES, NOTICE OF ALTERATIONS AND CERTIFICATES

Carry Out Work: Carry out the work to the requirements of all relevant authorities.

Make Application: Make formal application for supply or submit notice of alteration for each installation, pay all charges, obtain a Certificate on completion of the work and present to the Architect prior to Practical Completion. Include a copy of all such items in the Maintenance Manual.

4.18 AUTHORITIES AND APPROVALS

Authorities: The public and other authorities whose requirements shall apply to the work in this Section in accordance with the General Conditions and the ordinances, regulations, by-laws and the like specifying those requirements, shall include the following:-

- SA Water Corporation
- Local Council
- SA Health Commission
- Department for Administrative and Information Services – The Office of the Technical Regulator
- Safe Work SA
- Insurance Council of Australia
- National Construction Code (NCC)
- South Australian Metropolitan Fire Service (SAMFS)
- SA Power Networks
- Any other Authorities having jurisdiction over the Works

Lodgement: Complete and lodge all necessary forms (including technical sections) for the submission of applications and approvals to the relevant authorities.

Approvals: Authority approvals including Certificates of Compliance and Certificates of Occupation shall be surrendered before the Certificate or Notice of Practical Completion is issued.

Authorities Mark: Pipes, fittings, accessories and the like used shall bear approval marks where and as required by the regulatory authority.

4.19 MAINTENANCE LIFTING

Where an item greater than 20 kg requires to be removed for maintenance or replacement, provide the following:-

- Suitable attachments on the item for connection of lifting equipment.
- Suitable attachments from the roof structure or roof slab, such as eye bolts or lifting beams, for the equipment to be removed and positioned over a fork lift, trolley or sled. Alternatively purpose built lifting frames. Show all proposed maintenance lifting arrangements on shop drawings and submit to the Architect for approval.

4.20 INSPECTIONS

48 hours written notice to the Architect of all items requiring inspection, including prior to the sealing of shafts and risers, and enclosure of services in ceilings, walls and trenches where they will not be accessible for later inspection.

4.21 EXTRANEOUS INTERFERENCE

Requirement: The electrical wiring and equipment shall operate without interference to radio, television, computer, communications or other systems within this or other local area installations.

4.22 OBVIOUS WORKS

Minor Parts: If neither the specification or drawings contain any mention of minor parts of work which in the opinion of the Architect is reasonable and obviously necessary for the satisfactory completion of the works, such parts shall be supplied and installed without extra charge.

4.23 EXISTING SERVICES

Requirement: Existing services must be maintained at all times. Before cutting into existing services confer with the Client Representative for suitable times to carry out the work and allow for temporary services required to carry out the above.

The existing equipment and ductwork layouts shown are diagrammatic only. Where units, diffusers and outlets are being relocated, due allowance shall be made for bends, sets, penetrations, etc, to enable services to be installed within the existing ceilings.

4.24 EXISTING BUILDING

Unknown: Existing ductwork, pipework, etc, in the existing ceiling spaces of the buildings is unknown. The information provided is for information only and must be checked and confirmed on site. Due allowance shall be made for bends, sets, penetrations, etc, to enable services to be installed within the existing ceilings without modifications to existing services.

Ensure the structural integrity is maintained, in particular the cutting of ceilings to accommodate air conditioning systems.

4.25 DEMOLITION

General: Liaise with all concerned parties to ensure continuity of power supplies where applicable.

Surveys: Carry out all necessary surveys of other services to eliminate risk of damage during demolition.

Make Safe: Make safe all existing electrical services prior to demolition.

Removal: Remove all demolished equipment and materials from the site.

4.26 STAGING WORKS

Coordinate the required installation of mechanical services with the Client and teaching requirements of the site.

4.27 FIRE INDICES

Comply with the Fire Indices nominated in the Building Code of Australia for the relevant Building Type and Classification.

5 MATERIALS AND WORKMANSHIP

5.1 MATERIALS

Provision of Materials: Supply everything necessary for the proper completion of the work and for the proper performance of the systems.

Manufacturer's Recommendations: Unless otherwise specified, use manufactured items in accordance with current published recommendations of the relevant manufacturer.

Quality of Materials: Unless otherwise specified, materials to be incorporated in the works shall be new.

Protection of Materials: Store and protect material so as to preserve their quality and fitness for the Works.

Uniformity: Uniformity of type and manufacture of fittings, equipment and accessories shall be maintained throughout the installation.

5.2 LABOUR

Provision of Labour: Provide all qualified labour necessary for the proper completion of the work.

5.3 WORKMANSHIP

Best Practice: Properly and neatly execute all work to a high standard and best practice. Untidy work whether exposed to view or concealed will not be accepted.

5.4 CORROSION PREVENTION

Dissimilar Metals: Do not install copper in contact with steel, zinc, or other materials likely to generate electrolytic, galvanic or corrosive action. Make junctions between dissimilar metals with special fittings manufactured in suitable compatible material.

5.5 ACCESSIBILITY

Maintenance Access: Install plant items so they are accessible to manufacturers recommendations for access for maintenance and servicing purposes, and comply with Occupational Health and Safety Regulations and Guidelines

Concealment: Where practical, conceal reticulated services so they are accessible within ducts or non-habitable enclosed spaces. Obtain prior approval for the location of exposed services and ensure witnessed tests are conducted before enclosing.

Enclosed Services: If services are to be enclosed so as to be not accessible after completion, obtain prior approval and record the actual locations on work as executed drawings, prior to enclosing.

Maintenance Access: Install plant items so they are accessible to manufacturers recommendations for access for maintenance and servicing purposes, and comply with Occupational Health and Safety Regulations and Guidelines.

Access Hatch Locations: The Tender drawing shows the general location of access hatches. Plan the location and layout of plant and services to minimise the number and impact of maintenance access hatches. Obtain prior approval for the location and size prior to installation.

Access Hatch Sizes: Unless noted otherwise, access hatches shall be 600 x 600 for full body access, and 300 x 300 for hands only access. Access hatches shall be KAPP Model PF (Press-Fit) or equal approved steel door and frame installed to manufacturers recommendations.

5.6 CLEANING

Pre-Cleaning: Before installation, clean services and equipment by a suitable method. Remove loose scale, burrs, fins and obstructions.

Capping Off: During construction, temporarily seal open ends of pipework and equipment to prevent the entry of foreign matter. Provide purpose-made covers of pressed steel or rigid plastic. Do not use wood plugs, rags, paper or the like. Open ended pipework found on site will not be accepted and will be required to be removed from site and replaced with new.

Cleaning Out: Remove loose scale, dirt and the like from the pipework by flushing with clear water at a velocity sufficient to remove foreign matter and until clear water discharges at outlets. Leave the system free from foreign matter on completion.

Cleaning of Plant, Equipment, Reticulated Services: On completion of the work, clean all items externally and internally and leave free of dust, dirt, overspray, finger marks, etc.

Storage: Store pipes on site in a suitable location above ground to avoid entry of debris to ensure the integrity of factory sealing up to the time of installation.

5.7 CHASES AND ENCASING

Approvals: Cut chases with a power saw unless otherwise approved. Do not chase reinforced concrete work without approval.

Expansion and Contraction: Services chased into masonry or encased in concrete shall not cross any movement joint, and shall be insulated with 10mm Ensolex so that expansion and contraction can take place without damage to the services or to the material or surface finish of the surrounding element.

Minimum Cover: Chased services shall have a minimum of 10mm mortar cover.

5.8 COVER PLATES

Requirement: Where pipework emerges from finished wall, floor or ceiling surfaces (other than surfaces within concealed spaces, plant rooms and the like) provide ornamental cover plates of matching colour where possible of non-ferrous metal or stainless steel, of nominal diameter 50mm greater than the diameter of the pipe (including any insulation), close-fitting and firmly fixed in place to the satisfaction of the Architect.

5.9 ROOF PENETRATIONS AND FLASHINGS

Pipework, Electrical and Control Cables

Penetrations through any roof shall be two section metal flashings. The roofing trade to provide the up stand with the over flashing by the mechanical trade.

Dektites are not permitted service penetrations

Material: Use same materials for the overflashing as the penetrating item.

Fixing: Securely fix overflashing.

Testing: After completion test flashings are leak free and that water is free flowing past the penetration to the satisfaction of the Architect.

Ductwork

Penetrations: Provide roof penetrations and upstands.

Flashings: Flash roof penetrations/upstands with weatherproof overflashing.

Material: Use same materials for the overflashing as the penetrating item.

Fixing: Securely fix overflashing.

Testing: After completion test flashings are leak free and that water is free flowing past the penetration to the satisfaction of the Architect.

Sealing Penetrations

Seal any penetration prior to capping.

5.10 WALL, BEAM, FLOOR AND CEILING PENETRATIONS

General

Requirement: If different from those shown on service drawings, obtain approval from the Architect before proceeding.

Formwork Sleeves: Fabricated from 0.6mm galvanised steel, 20mm larger all round than the service and shall extend 50mm beyond finished surface. Position and fix these prior to wall, beam or floor construction, and remove on completion.

Making Good: Make good all penetrations to maintain the fire and/or acoustic rating of structure penetrated.

Core Holes

Core Holes: Core holes through existing floors, slabs and walls. Prior to coring holes obtain approval for the location from the Structural Engineer. Seal penetration with approved fire rating material.

Fire Rated Wall Penetrations (Other than UPVC Pipes and Conduits)

Requirement: Penetrations through Fire/Smoke wall shall be sealed with an approved epoxy seal and filled with an approved fire rated material to FRL rating of penetrated structure. Use Fyreguard, Fyre-Seal-IBS, Fyre-Mortar, or Fyre-Pillows together with Fyre-Seal-Mastic

Fire Rated Floor Penetrations (Other than UPVC Pipes and Conduits)

Requirement: Seal the space between the services and the penetration with an approved epoxy seal and filled with an approved fire rated material. Use Fyreguard, Fyre-Seal-IBS, Fyre-Mortar, or Fyre-Pillows together with Fyre-Seal-Mastic

Fire Rated Wall and Floor Penetrations (UPVC Pipes and HDPE Pipes)

Requirement: Fire Prevention Collars to UPVC and HDPE pipes passing through floors and fire/smoke walls.

Approval: Fire Prevention Collars tested and approved to AS 1530.4 and AS 4072.1 with fire resistant rating equal to the floor or wall.

Installation: Floor Fire Prevention Collars cast into floor.

Manufacturer: "Hilti" or approved alternative.

Fire and Vapour Sealed Penetrations through Fire Rated Walls and Floors

Requirement: Use Fyreguard galvanised steel encased Fyre-Sleeves with pipework vapour seal lapped 50mm over each end of the steel sleeve.

Cable Penetration of Fire Rated Ceiling

Fyre-Spring: Use Fyreguard Fyre-Spring system.

Light and Power Switches in Fire Rated Walls

Fyre-Seal: Use Fyreguard Fyre-Seal-IBS strips to maintain fire integrity of wall.

6 NOISE AND VIBRATION

6.1 SCOPE

Undertake the detailed design and selections of all materials, equipment, installation and construction methods to meet specified noise and vibration suppression levels.

Carry out the following:-

- Rotating machinery shall be accurately, statically and dynamically balanced and shall be selected to comply with the noise level requirements.
- Fans, including their motors, shall be attached to sub-bases which shall be resiliently mounted on spring or rubber.
- Pumps, including their motors, shall be attached to sub-bases which shall be resiliently mounted on spring or rubber.
- Propeller and fan-motor assemblies shall be rubber mounted in their casings.
- Flexible duct connectors and conduits shall be installed between moving machinery and associated ductwork.
- Duct interiors, registers, grilles, etc., shall be free from raw edges of metal or screw ends projecting into the airstream, and shall be selected to achieve specified noise ratings.
- Equipment shall be selected within specified noise ratings and to achieve the required noise levels specified as follows.
- Fans shall have top speeds and outlet velocities not greater than selections specified elsewhere in this Specification. Flexible connections of an approved pattern shall be fitted on the fan duct connections.
- Flexible joints between air conditioning units and condensate drains.

6.2 NOISE LEVELS

Select and install mechanical plant and equipment, registers, grilles, diffusers, anti-vibration hangers, spring isolating mounts, neoprene pads, acoustic plant and duct insulation, acoustic baffles etc. to be not greater than the following noise levels:-

Air Conditioned Area: 40dbA

Plant noise at the site boundary: 40dbA

6.3 VIBRATION SUPPRESSION

Equipment shall operate within the specified vibration limits. Prevent the transmission of vibration from rotating or reciprocating equipment to other building elements by suitable means including, where appropriate, static and dynamic balancing, rubber or spring isolation mounting supports, inertia blocks, pipework vibration isolation and the like.

Set and adjust isolation mounting supports so that they give the required static deflections with adequate clearance for free movement.

The static deflection (mm) of isolation mounting supports shall be not less than the following:-

Motor Power

3.5 to 7.5 kW	Concrete Floor on Ground:	Suspended Span to 10m	Suspended Span over 10m
Equipment Speed (r/s):			
Up to 6	25	75	90
6 – 9	25	45	50
9 – 13	12	25	40
13 – 20	12	25	25
20 – 40	6	25	25
over 40	6	20	20

Motor power Over 7.5 kW	Concrete Floor on Ground:	Suspended Span to 10m	Suspended Span over 10m
Equipment Speed (r/s):			
up to 6	25	90	110
6 – 9	25	65	75
9 – 13	25	25	45
13 – 20	25	25	40
over 20	25	25	25

6.4 ANTI-VIBRATION HANGERS

Anti-vibration hangers shall be double deflection types with neoprene cups in series.

6.5 ACOUSTIC CEILING INSULATION

Provide a minimum 50mm acoustic insulation, 48kg/m³ within ceiling cavity for a foot print of 4m² below each item of mechanical equipment where acoustic treatment is required.

6.6 FANS – ACOUSTIC WRAP

Wrap fan casing with Vibralag or 5kg/m³ foam backed loaded vinyl where required in acoustically sensitive areas to achieve required noise levels.

6.7 NEOPRENE PADS AND WRAPPINGS

- 6mm Neoprene pads shall be used in conjunction with spring mounts and for all static deflection up to and including 9mm.
- 6mm neoprene wrappings shall be used in conjunction with all pipe hangers and shall be placed between the pipe and the pipe clamp to minimise sound transmission.
- Double thickness 6mm neoprene pads shall be used small condenser mounts (e.g. wall split and cassette units).

6.8 SPRING AND RUBBER MOUNTS

- Embelton "Type CM or EM" or equal approved seismic mounts shall be used under all larger condensing units.
- Embelton or equal approved spring isolation hangers used to support indoor sections of ducted air conditioning units and ceiling mounted fans, etc. Include seismic restraint gripple wiring to comply with AS1170.4.

6.9 PIPEWORK ISOLATION

All pipework shall be isolated from the building structure at all supports and penetrations, generally as described above and as detailed on drawings.

7 PAINTING, CORROSION PROTECTION AND IDENTIFICATION

7.1 SCOPE

Corrosion protection, painting and identification of all items to ensure the following:-

- Protection against moisture or corrosive agents which may be encountered during the service life of installed items.
- Painting to provide an attractive durable and cleanable surface to all mechanical equipment and covers in areas exposed to view, excluding plantrooms. Architect to advise final colour or finish required.
- Identification of all plant, controls and switches, valves, wires, terminals, controls, pipes, ducts, etc, with durable engraved traffolyte labels and painted markers.
- Ceiling access panels (include micro traffolyte labels to all access panels or T-Bar ceiling tile required for access to indicate location of associated equipment services items concealed in ceiling space above). Nominate unit designation on label eg "HRU-01 Access".
- Where non-ducted supply systems are utilised provide tamper/vandal proof signs indicating that windows must be opened in order to provide fresh air shall be mounted adjacent the unit controls.

7.2 EXCLUSIONS

The following surfaces shall not be painted:-

- Ductwork in roof spaces and plantrooms and areas not normally occupied.
- Conditioner casings in roof spaces and unoccupied areas.
- Fibreglass, PVC, stainless steel, chrome plated surfaces
- Pipework in roof spaces, riser ducts, plantrooms, etc, where not normally exposed to view.
- Bearings, motor rails, adjusting screws, valve bodies and actuators, etc.
- Flexible ductwork and pipework connectors.
- Proprietary equipment if supplied in manufacturers standard paint colours and finishes. Any damage to proprietary painted equipment during installation and construction shall be repaired at no cost to the Contract in an equivalent painting system and colour.

7.3 CORROSION PROTECTION

Equipment and the total installation shall be designed to prevent the accumulation of moisture. Sharp corners shall be radiused and crevices shall be sealed by continuous seal welds, or use of an approved filler.

Dissimilar metals shall be prevented from contact by a 3mm air gap or 1.5mm of PVC insulator. Bolts, rivets and clips shall have a corrosion resistance equal to the component to which they are attached and shall be of the same noble metal.

Surface Preparation

Surfaces shall be prepared as follows:-

- Black Steel
Shall be degreased and loose rust, scale and other matter removed by hand or power tool cleaning. The surface shall immediately be given one coat of zinc based primer.
- Galvanised Steel, Copper, Aluminium
Shall be degreased and coated with vinyl etch primer.
- Zinanneal
Shall be degreased and etch primed.
- Surfaces Subject to Oil Spillage
Shall be degreased and coated with oil resistant undercoat and finishing coat.

Metal Coatings

Repair steel surfaces damaged by welding, or rust, by the application of a cold phosphating (phosphoric acid) solution. Wash off residue after the reaction is complete.

Galvanised steel pipe supports, fabricated components, bolts, nuts, etc, installed in damp locations, in the ground, or exposed to the weather.

7.4 PAINTING PROCEDURES

Protect all adjacent surfaces from paint splatter and remove all spillage or spots so that adjacent finishes are in a clean and unmarked condition.

Use first quality lead free paints pre-mixed and delivered to site clearly labelled in the manufacturers sealed containers.

Thinning, mixing or adding of other colours or brands will not be accepted.

Paints for priming, undercoating, finishing and re-coating shall be compatible with each other and the surface conditions to be painted.

Primers shall be an approved zinc chromate or other metal work primer.

Steel surfaces shall be cleaned of oil and other manufacturing lubricants and etch primed prior to applying finishing coats. Galvanised surfaces are not required to be painted.

Damage to a manufacturers surface finish shall be restored to the original corrosion resistance of the finish. Epoxy coated surfaces shall be lightly abraded followed by an active solvent wipe and restoration of original coating thickness.

Weld spatter, slag, burrs and other surface irregularities shall be removed or repaired before surface protection is applied.

Submit details of paint materials and samples of surface preparation and paint finish to the Architect prior to proceeding. Surface preparation and paint finish samples may be the first installed items of each type.

7.5 PAINT COLOURS

Paint systems shall be full-gloss, solvent-borne paint appropriate to the pipework material and its location (interior, exterior or hot surface).

Paint colours shall be to AS 1345.

Submit colours to the Architect for approval prior to proceeding.

7.6 PLANT AND EQUIPMENT IDENTIFICATION

Provide the following identification systems:-

Equipment Nameplates: Engraved plates permanently fixed by mechanical means to factory-assembled items of equipment.

Lettering: Except for plant items shall be 5mm upper case engraved black lettering on a white background.

Lettering for plant items shall be 50mm high or appropriate smaller lettering if approved by the Architect.

7.7 PIPE IDENTIFICATION

Pipework shall be identified to AS 1345.

Identification shall be by means of the basic identification colours of AS 1345, applied to the pipework either as full-length painting, or as painting in bands at intervals to AS 1345 clause 6, or as securely attached pipeline markers to AS 1345 clause 6 and figs. 1 and 2.

Location of Bands or markers shall be to AS 1345 clause 6.2.

Bands of markers shall be provided in the following locations:-

- Pipework both insulated and non insulated in concealed spaces including risers, roof and ceiling spaces, and pipework exposed in habitable or occupied areas such as rooms and access or circulation areas, including pipework specified to be painted full-length in decorative or protective colours.
- Exposed pipework external to the building.

7.8 ELECTRICAL AND CONTROLS IDENTIFICATION

Every piece of equipment and plant control item, instrument or gauge, switchboard item including incoming and outgoing circuit wiring shall be clearly labelled using the full English language description.

For wiring this may be achieved via numbered labels referenced to an English language description on an adjacent permanently mounted drawing.

Labels shall consist of 5mm upper case black lettering on a white background of engraved laminated plastic.

Labels shall be permanently attached by screws and adhesive.

7.9 SAMPLES

Submit samples of all identification systems to the Architect for approval.

0721 PACKAGED AIR CONDITIONING**1 RESPONSIBILITIES****1.1 GENERAL**

Requirement: Provide packaged air conditioning plant, as documented.

Split systems: Supply indoor and outdoor condensing units of split systems designed and rated by the manufacturer to operate together.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0171 General requirements.
- 0701 Mechanical systems.
- 0734 Humidifiers.
- 0741 Ductwork.
- 0744 Ductwork insulation.

1.3 STANDARDS**General**

Refrigeration systems: To AS/NZS 1677.2 and the recommendations of SAA HB 40.1 and SAA HB 40.2.

Flammable refrigerants: To the recommendations of *AIRAH Flammable Refrigerants - Safety Guide*.

Microbial control: To AS/NZS 3666.1 and the recommendations of SAA/SNZ HB 32.

Ductwork and insulation: To AS 4254.2.

Air filter performance and construction: To AS 1324.1.

2 PLANT AND EQUIPMENT**2.1 SCOPE**

The capacities scheduled and other requirements specified are the minimum to be accepted. Ensure selected equipment meets the specified capacities at specified maximum ambient conditions. Install equipment in strict accordance with the manufacturer's recommendations unless otherwise specified or shown.

All equipment shall be manufactured to a recognized quality assurance standard.

2.2 VRF REFRIGERATION SYSTEMS

VRF air conditioning systems shall be of Mitsubishi manufacture heat recovery units or approved equal, capable of achieving the air conditioning capacities as scheduled and the arrangement as indicated on the drawings.

Each system shall be air cooled, split type multi-system air conditioner equipment consisting of outdoor units and multiple indoor units, each having capability to provide the independent cooling and heating for the requirements of the rooms.

Units are to be selected for 100% simultaneous capacity. Any diversity of systems will not be accepted.

Compressors shall be equipped with inverter controller, and capable of changing the rotational speed to match variations in cooling and heating demands.

The Outdoor condensing unit shall be suitable for connection of following indoor models.

- Ceiling Cassette type

Outdoor Condensing Unit

The refrigerant system piping shall be capable of extending up to 150m with 50m level difference without oil traps.

- The unit shall operate continuously at the ambient temperature of -5°C in cooling -15°C in heating (Operative Range: -20°C).
- Both indoor unit outdoor units shall be assembled, tested, and charged with refrigerant at the factory.
- The outdoor unit shall be a factory assembled unit housed in a sturdy weatherproof casing constructed from corrosion protected steel panels finished with a baked enamel.
- The outdoor units shall have a minimum 2 off scroll compressors and be capable of operating on failure of 1 of the compressors.
- The connectable range of indoor units shall be from 0.8 to 10HP.
- The noise level shall not be more than 54 dB(A) at normal operation measured horizontally 1m from and 1.5m above floor mounting level.
- The outdoor unit shall be modular in design and should be capable of side by side installation with top discharge as shown on the drawings.
- Include safe trays under outdoor unit and fan discharge ductwork as shown. Ensure the resistance of discharge ductwork does not exceed the capabilities of the outdoor fan.
- If required provide horizontal discharge cowls to condenser discharge fans, for connection to plantroom external louvres. Switch unit fans to high static mode.

Compressors

Compressors shall be of a hermetic scroll type and equipped with inverter control capable of changing speed in accordance with the cooling or heating load requirements.

Compressors shall have multi-step capacity control to meet load fluctuation and indoor unit individual control.

Branch Selector Control Boxes (BS)

Each separate system is to be provided with branch selector or control (BS) boxes in accordance with manufacturers requirements for simultaneous heating or cooling operation for any individual indoor unit (eg, one BS box per indoor unit for a three pipe heat recovery system, or multiple heat recovery BS boxes for a two pipe heat recovery system). Where required provide condensate drains from BS boxes.

Heat Exchanger

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fin coil.

The aluminium fins shall be protected with anti-corrosion surface treatment.

Safety Devices

The following safety devices shall be provided with each outdoor unit.

- High Pressure Switch
- Overload Relay
- Inverter Overload Protector
- Fusible Plugs.

Oil Recovery System

Each unit shall be equipped with an oil recovery system to ensure safe operation when long refrigerant pipe runs are required.

Indoor Units

- Ducted Units

Indoor unit shall be of the ceiling mounted duct type and fitted with electronic control valves which control refrigerant flow rate in response to load variations. The fan shall be of the dual suction multi blade type and statically and dynamically balanced to ensure low noise and vibration free operation.

Each unit shall be complete with direct expansion coil, centrifugal supply air fan, integral drip tray and condensates drain. Condensate shall be piped to an adjacent tundish drain provided by other trades.

Casings shall be of robust construction, heat and sound insulated. Casings shall be provided with removable gasketed access panels for servicing and maintenance. Panels shall be secured with set screws or self-tapping screws into anchor nuts or plates. Self-tapping screws direct into a panel will not be accepted.

Internal lining of the casing shall be non-combustible and shall conform with the requirements of AS 1668 for duct internal linings.

The evaporator fan shall be resiliently mounted and operate with a low tip speed to give quiet operation. The fan motor speed shall not exceed 25 r.p.s. Cooling coils shall be copper tube with aluminium fins. Face velocity shall not exceed 2.8 m/s.

Provide unit fire shutdown to all units with airflow greater or equal to 1000 l/s – coordinate and provide all requirements.

Provide suitable access for coil inspections as required by AS3666, provide standard operating procedure (SOP) for inclusion in operation and maintenance manuals. Ensure safe access is provided to provide the required servicing and inspection of units. Coordinate this requirement with builder.

Control

Computerized PID control shall be used to maintain room temperatures and each unit shall be equipped with a self-diagnostic facility. Refer to the controls section of the specification for further details.

Refrigerant

Type: Refrigerant shall be R410A.

2.3 UNITARY SPLIT SYSTEM AIR CONDITIONING UNITS (INVERTER TECHNOLOGY)

General

Provide Mitsubishi manufacture (or equal approved) individual split type heat pump air conditioning units, including indoor units complete with replaceable filters, outdoor section, interconnecting refrigeration piping, insulation sufficient to prevent condensation, and operating and safety controls.

Ducted Indoor Units

Indoor unit shall be of the ceiling mounted duct type and fitted with electronic control valves which control refrigerant flow rate in response to load variations. The fan shall be of the dual suction multi blade type and statically and dynamically balanced to ensure low noise and vibration free operation.

Each unit shall be complete with direct expansion coil, centrifugal supply air fan, integral drip tray and condensates drain. Condensate shall be piped to an adjacent tundish drain provided by other trades.

Casings shall be of robust construction, heat and sound insulated. Casings shall be provided with removable gasketed access panels for servicing and maintenance. Panels shall be secured with set screws or self tapping screws into anchor nuts or plates. Self tapping screws direct into a panel will not be accepted.

Internal lining of the casing shall be non-combustible and shall conform with the requirements of AS 1668 for duct internal linings.

The evaporator fan shall be resiliently mounted and operate with a low tip speed to give quiet operation. The fan motor speed shall not exceed 25 r.p.s. Cooling coils shall be copper tube with aluminium fins. Face velocity shall not exceed 2.8 m/s.

Provide unit fire shutdown to all units with airflow greater or equal to 1000 l/s – coordinate and provide all requirements.

Provide suitable access for coil inspections as required by AS3666, provide standard operating procedure (SOP) for inclusion in operation and maintenance manuals. Ensure safe access is provided to provide the required servicing and inspection of units. Coordinate this requirement with builder.

Controls

The units shall have standard wired controls not infra red.

Outdoor Units

Provide fully weatherproofed units suitable for outdoor operation, self contained with compressor, condenser and main electric controls.

Treatment

Outdoor unit coil shall be epoxy coated for extended life in salt laden air. The casing shall be constructed from highgate galvanised steel-polyester powder coated for all weather protection and all fasteners shall be stainless steel.

Outdoor Units Installation

Roof Mounted: Locate at roof level plant deck on approved anti-vibration mounts and uni-strut mounts separated from the roof sheeting via waffle pad. Refer to drawing details.

Ground Mounted: Mount on concrete slab. Provide anti-vibration mounts under unit.

Install refrigeration piping and electrical wiring neatly. Provide a galvanised steel cover over all exposed pipework from the outdoor unit to the wall.

Other: Provide ducted connection for unit discharge fan to connect to external building weatherproof louvre.

Install refrigeration piping and electrical wiring neatly. Provide a galvanised steel cover over all exposed pipework from the outdoor unit to the wall.

Clearance: Provide clearance around the units for condenser air flow and maintenance access.

Ensure air discharge does not interfere with other outdoor units. If this is unavoidable provide air deflection plates.

Condensate Drains

Provide 20mm ID minimum drains from indoor ceiling and ground mounted outdoor units and extend to nearest pump, gully, tundish or soakage pit (refer to drawings).

If outdoor sections do not have a drain connection, install a drip tray below outdoor section. Drain to nearest gully, tundish or soakage pit (refer to drawings).

Refrigerant

Type: Refrigerant shall be R410A.

2.4 CONDENSATE PUMP (SERVING INDIVIDUAL UNITS)

Install the drain water lift mechanism mounted in the ceiling space in an accessible location.

The unit shall be centrifugal type with an integral sump.

Model number "Maxi Blue" or equal approved, with a minimum capacity of 10 litres per hour with a head of 10 metres and shall come complete with a safety switch. The pump shall incorporate a check valve.

The pump shall be self priming and quiet in operation and shall be controlled automatically by change in temperature of air moving through the conditioner coil.

Mount the pump above the ceiling on a semi rigid anti vibration pad.

Mount the pump in a safe tray and the pump and safe tray in a 25 mm acoustic insulated box. The box shall be designed to allow easy removal and servicing of the pump.

The safety switch shall be wired to the system to turn the air conditioning unit off in the event that the condensate in the drain pan approaches the overflow level.

Provide all associated interconnecting pipework, electrical and control wiring.

0731 FANS

1 RESPONSIBILITIES**1.1 GENERAL**

Requirement: Provide fans, as documented.

1.2 DESIGN**Centrifugal fans**

Requirement: Select fans so the air flow can be increased $\geq 5\%$ above the rate documented in **Fan schedules** as follows:

1.3 FANS**General**

Use fans which have quiet operation and maximum static efficiency and which deliver the required air quantity against the resistance of the system as installed.

Balancing: Statically and dynamically balance rotating parts after assembly at the manufacturer's works.

Installation: Isolate fans from rigid ductwork with flexible connections and from the building structure with resilient mounts.

Each fan shall be provided with sealed for life bearings designed for a calculated life of 100,000 hours under the particular duty of the fan. Dust seals shall be provided for all bearings.

The overall sound power level of the fan shall not exceed the level nominated in the fan schedule.

All fans which discharge air from a conditioned space shall be provided with manual or motor driven back draught dampers to close when not in operation in accordance to section "J" of the BCA.

All fans shall be provided with variable speed adjustment unless otherwise stated.

Fans - Axial

Fans with blades of aerofoil section and non-overloading characteristics.

Blades manufactured from glass-reinforced plastic GRP.

Blades shall provide fully adjustable pitch.

Fan casing rolled and flanged from heavy gauge mild steel and shall be hot dip galvanised.

Squirrel cage induction motor.

Electrical connection: A terminal box external to the fan casing and wired to the fan motor.

Guards: Provide heavy galvanised steel guards to fans with exposed intake or discharge.

Fans - Axial Plate Mounted

Fan Type: Axial impellers of GRP with squirrel cage induction motor. Bearings - sealed for life, ball.

Impeller fully covered by removable guard.

Fan fixed to square plate. Plate manufactured from galvanised steel finished with polyester epoxy coating.

Noise levels: Select fans to lowest noise level possible.

Fans – Axial Mixed Flow

Provide direct drive fans with casings of moulded fibreglass or impact-resistant plastic

Blades manufactured from epoxy coated steel or reinforced injection moulded polypropylene.

Impellers to be of injection moulded plastic and of mixed flow design.

Electrical connection: A terminal box external to the fan casing and wired to the fan motor.

Mixed flow axial fans shall be of the type 'Fantech TD' series or equal and approved.

Fans - Centrifugal In Line

Provide direct-driven fans with casings of galvanised steel, moulded fibreglass or impact-resistant plastic.

Impellers: Backward curved centrifugal design.

Non Return Dampers: Install non return dampers in the system

Fans - Back Draught Dampers

All fans which discharge air from a conditioned space shall be provided with manual or motor driven back draught dampers to close when not in operation in accordance to section "J" of the NCC.

Fans - Variable Speed Controllers

Fans nominated in the schedule shall be fitted with a variable speed controller or an electronic variable speed drive as applicable to the fan being offered and shall be selected for single or three phase operation as required to match the fan motor kW rating.

The fans shall be selected to exhaust a constant air flow against the initial and final resistance of the system.

The fan speed shall be varied by manually operated variable speed control.

Step type controllers will not be accepted unless prior authorisation and approved has been granted by the consulting engineer.

Run-On Timers

Provide suitable fan run-on timers where nominated. Timers are to permit the supply of electricity to the fan motor so they can continue to operate for a predetermined time-limit. Provide Fantech "VZ" series timer, select suitable unit to provide required controls function.

Cowls - Outside Air Intakes and Exhaust

Roof mounted outdoor intakes or exhaust cowls shall be 'Fantech RV/MRV' series, or equal approved. Max pressure loss 8Pa.

They shall incorporate birdmesh guards and be constructed from UV stabilized plastic or fibreglass.

0732 AIR FILTERS**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide air filters, as documented.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0171 General requirements.
- 0701 Mechanical systems.

1.3 STANDARDS**Air filters**

Performance and construction: To AS 1324.1.

Microbial control: To AS/NZS 3666.1 as required by the BCA and the recommendations of SAA/SNZ HB 32.

1.4 AIR FILTERS**General**

Air filters shall be installed where shown on the drawings.

Each filter shall be sized capable of handling the scheduled air quantity at the maximum effective face velocity specified and its performance characteristics shall meet the requirements specified hereafter for the scheduled filter type.

Filters and components shall be readily available in Australia and shall be manufactured by Camfil Farr Pty Ltd, Email Ltd, Australian Air Filters Pty Ltd, or approved equal.

Filters shall comply with the requirements of AS 1324.1 and prototypes shall have been tested by a NATA registered laboratory in accordance to either AS1324, ASHRAE 52 and EN779 for all filters other than HEPA filters, test reports shall be made available upon request. HEPA filters shall be tested in accordance with either AS4260 or EN1822.

Filters shall be installed in accordance with manufacturer's recommendations complete with all accessories necessary for their proper performance.

Filter connections to adjoining equipment, panelling or support framing shall be sealed airtight to prevent any air by-passing the filter media.

Commissioning media shall be installed before start up of all air conditioning and ventilation systems and removed at the completion of acceptance testing. At the end of the defects liability period all filter media shall be replaced with clean new filter media, except for HEPA filters which shall be revalidated.

Adequate access shall be provided to each filter for inspection, maintenance and replacement.

Holding Frames

Provide permanent holding frames to mount the filter cells in a front or upstream service configuration. Holding frames to be fixed into the air handling systems and sealed to prevent air bypass. Provide stiffeners where necessary to prevent banks from flexing.

Filter banks shall consist of permanent holding frames in combinations of face sizes; 610 x 610 and 610 x 305 only, frames shall be manufactured from 1.5 mm thick galvanised steel with sealing gasket and suitably sized filter fasteners.

Disposable Pleated Panel Filter G4 95mm

Make: Camfil Farr. Model 30/30 or equal

Type: Filters shall be disposable 95 mm thick pleated media in a beverage board frame.

Efficiency: Filters to be Type 1 / Class A with a minimum performance rating of G4.

The initial resistance of the filter shall not exceed 68 Pa at a velocity of 2.5 m/s.

The filters bank shall be sized for a maximum face velocity of 1.8 m/s unless indicated otherwise.

Outside Air Fan Box and Filter G4 50mm

Make: Fantech FGR series box or similar.

Type: 50mm panel filter.

Efficiency: Filters to be Type 1 / Class A with a minimum performance rating of G4.

The initial resistance of the filter shall not exceed 68 Pa at a velocity of 2.5 m/s.

The filters shall be sized for a maximum face velocity of 1.8 m/s unless indicated otherwise.

0751 MECHANICAL PIPING**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide mechanical piping, as documented.

1.2 DESIGN**Design pressures**

Design pressures: To AS 4041 but not less than the maximum hydrostatic head at the location, given the pump shut off head for the maximum impeller size for the pump casing.

Piping system

Requirement: Provide piping systems complete with all necessary piping, valves, supports, guides, drains, vents, expansion compensation and all fittings necessary for their safe and efficient operation.

1.3 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0171 General requirements.
- 0701 Mechanical systems.
- 0753 Water treatment.
- 0771 Automatic controls.

1.4 STANDARD**General**

Standard: To AS 4041.

2 PIPEWORK**2.1 GENERAL**

Straight Lines: Run pipework services in straight lines parallel or square to building surfaces with minimum joints and neat supporting systems.

Changes of Direction: Use long radius elbows or bends where practicable in preference to short radius elbows. Do not use mitered fittings.

Arrangement: Arrange pipework runs adjacent to and horizontally parallel with each other and with walls, ceilings, beams and the like. Provide adequate spacing, of at least 25mm between pipes, 50mm between pipes and electrical cables.

Scope: Design, construction and site installation of rigid, corrosion resistant, quiet, flow adjustable and firmly supported pipework systems to the layout principles shown on drawings.

Labelling: Provide labelling to all pipework whether concealed or exposed to view to indicate system pipework.

2.2 SUPPORTS

Generally: Provide supports including hangers, saddles, bolted clips, sufficient to secure the pipework to adjacent surfaces, to restrain the internal forces of pressure piping's, and to support it at joints, at changes of direction, and at intervals suitable to the size and type of pipe, and as necessary to prevent sagging of pipework and vibration. Make provision for adjustment of gradient as required.

Proprietary Supports: Approved proprietary support systems shall be used.

Support all refrigerant pipework with proprietary support system that uses non crush type fittings.

Keep all refrigerant pipe work clear of plinths such that they do not lie where moisture will accumulate.

Support Material: The same material as the pipe, or galvanised or non-ferrous metals, with bonded PVC or fibreglass woven tape sleeves to separate dissimilar metals. Provide fixing of compatible material.

Additional Supports: Locate supports not more than 600mm either side of any change in direction, valve or piece of equipment.

2.3 FLEXIBILITY

Expansion and Contraction: Install the services with sufficient bends, expansion loops or expansion devices so that it can absorb its own expansion and contraction without developing excessive stresses in the pipework itself, in connected equipment, or in the supporting structure.

Vibration Isolation: Provide flexible connection between pipework and any equipment where vibration may be transmitted to the pipework.

2.4 JOINTS

Generally: Keep the number of joints and junctions to a minimum. Use joints applicable to the materials used. Flexible PVC conduits are not acceptable. Use demountable joints where permanent joints are impractical and at connections to all equipment and components.

Joints: Fit joints tightly, seal and make leak proof, with no internal projections, burrs or obstructions.

Permanent Joints: Provide welded or brazed joints where practicable, otherwise compression or screwed joints.

2.5 CONDENSATE AND DRAIN PIPEWORK

Discharge pipework where shown on the drawings.

Internal pipework shall be PVC Class 6 pressure pipe. Run in straight lines with minimum 1:200 fall, and adequately supported against sagging.

External pipework shall be Copper Type B. Run in straight lines with minimum 1:200 fall, and adequately supported against sagging. Paint external copper pipework.

Trap: Provide transparent, kink resistant hose or a other clear, removable joint at the unit. Secure each end with hose clamps (cable ties are not permitted). Provide means to clean and remove the trap. Do not use silicone sealant to secure and water proof connections. Provide transparent, kink resistant hose or a other clear, removable joint at the unit. Provide means to clean and remove the trap.

2.6 REFRIGERATION PIPEWORK

Refrigeration pipework, valves and fittings between evaporating and condensing units. Pipework shall be sized and fitted with oil traps, fittings and gauges in accordance with the unit manufacturers' recommendations and to ensure oil return to the compressor and maintain compressor lubrication.

Material: Copper seamless tubes - up to 50dia AS 1432, Type B
- 50dia and above 1.6mm thickness

Refrigerant liquid line pipework and all suction pipework shall be insulated.

Fittings: Shall be de-zincification resistant.

Permanent Joints: Make 15% silver brazed slip joints. Either use a capillary fitting or expand one tube over the other leaving a minimum of clearance and an effective overlap not less than 12mm.

Brazing: To AS 1167 Clause 3.7. Use a minimum of heat and avoid damage to pipe and fittings. Use dry nitrogen to purge air from pipes before brazing. During brazing, maintain a flow of dry nitrogen through pipes to prevent oxidation.

Brazing alloy: To AS 1167 Part 1.

- Brazing copper to copper: Alloy B4 to Table 2

Pulled Bends: To AS 1135 Clause 3.4.3.

2.7 VRF REFRIGERANT PIPEWORK

Requirement: Supply, install, test and commission all interconnecting pipework between the condensing unit and the fan coil units. Use refrigerant quality seamless copper tube with brazed connections and the appropriate headers and joints. Utilise longest possible lengths of copper pipe to minimise joints on site and appropriate refrigeration tools must be used to avoid the use of elbows.

During brazing, pass dry nitrogen through the pipework. The gas used for the brazing process must be dry nitrogen (oxygen, carbon dioxide and freon gases are not acceptable).

Isolating Valves

VRF Heat Pump type systems shall have lever action ball type or equally approved isolating valves installed on the liquid & gas pipe at every junction leading to an indoor unit/s.

In addition an approved Schroder valve with O ring sealed cap is to be fitted on liquid & gas pipe between each ball valve isolator leading to the indoor unit for future serviceability. Each Schroder valve should be installed adjacent to each ball valve.

VRF Heat Recovery type systems shall have lever action ball type or equally approved isolating valves installed on the high & low pressure pipe leading into each BS box from the condensing unit/s.

In addition an approved Schroder valve with O ring sealed cap is to be fitted on liquid & gas pipe between each port leading to the indoor unit for future serviceability. Each Schroder valve should be installed adjacent to the BS box.

Joint Orientation

Install refrigeration pipe joints and headers in an appropriate orientation to enable correct distribution of refrigerant.

Pressure Testing

Immediately after installation of pipework and prior to sealing of insulation joints and start up of equipment, vacuum dehydrate the pipework; pressure test to 2,800kPa; hold for a minimum of 24 hours, check for leaks and repair if necessary. Following this, vacuum dehydrate the pipework to (-755mmHg) and hold for one to four hours depending on the pipe length.

Refrigerant Charge

Additional refrigerant charge weight must be calculated to the actual length of the refrigerant pipework. The refrigerant charging process must be carried out with an appropriate charging station and under supervision.

2.8 INSULATION

Insulate all pipework with slip on closed cell elastomeric pipe insulation to meet current NCC insulation R-value requirements. Insulate all proprietary joints with split case preformed insulation sections. Protect insulation when exposed to the atmosphere with colourbond capping to the superintendent's approval. Glue all insulation (after pressure and leak testing) to provide a complete seal to prevent any condensation. Submit insulation material R-value datasheets to the engineer for review and signoff.

2.9 REFRIGERANT COMPARTMENT LEAKAGE CALCULATIONS

The specialist contractor / installer shall secure safety against refrigeration leakage according to statutory and local regulations.

Provide detailed calculations for assessment for each system showing compliance that all systems meet the maximum critical concentration of refrigerant of 0.3kg/m³ of conditioned space per compartment (subject to ISO5149).

2.10 COLD WATER PIPEWORK

Pipework: Copper Type B.

3 VALVES, FITTINGS AND GAUGES

Valves, connectors, fittings, filter dryers, oil traps, water traps and seals all as required by equipment manufacturers for refrigerant and condensate pipework to air conditioning units.

Dryer

The dryer shall be of the flanged angle type with replaceable cores and shall be installed in a valved bypass in the liquid line.

The dryer shall have a flow capacity of 60% circuit capacity, a maximum resistance to flow of 14kPa and a capacity based on ARI 710-58 rating of 24°C or 1 gram per tonne of refrigeration capacity.

Sight Glass

Moisture indicating sight glasses shall be provided and they shall be installed in positions where easily viewed.

0741 DUCTWORK

1 RESPONSIBILITIES

1.1 GENERAL

Requirement: Provide ductwork, as documented.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- 0171 General requirements.
- 0701 Mechanical systems.
- 0744 Ductwork insulation.
- 0791 Mechanical commissioning.

1.3 STANDARDS

General

Flexible ductwork: To AS 4254.1.

Rigid ductwork: To AS 4254.2.

Proprietary and non-standard systems

Standard: Conform to functional criteria in AS 4254.2.

Microbial control

Microbial control: To AS/NZS 3666.1 as required by the BCA and the recommendations of SAA/SNZ HB 32.

2 DUCTWORK, DIFFUSERS AND GRILLES

2.1 SCOPE

Design, construction and site installation of airtight, rigid, corrosion resistant, quiet, airflow adjustable and firmly supported ductwork systems to layout principles shown on drawings.

Design and install ductwork to ensure smooth airways paths free of backfilling, fluttering, vibrations, rattles and generated noise.

Requirement: Ductwork, air diffusion equipment and grilles as required.

2.2 RIGID DUCTWORK

Refer to insulation section for insulation requirements.

Standard: AS 4254

Dimensions: Duct dimensions shown on the drawing are clear internal sizes, the first dimensions given being the side shown in that view. Where ducts are acoustically lined increase internal dimensions accordingly.

Construction: Manufacture from galvanised steel sheet machine bend, free from waves and buckles with Pittsburgh lock longitudinal seams as follows, all dimensions being in mm.

Seams: Do not use snap lock seams.

Maximum Side	Thickness	Transverse Joints	Bracing- All 4 Sides
To 300	0.6	Drive Slip	Nil
Over 300 to 600	0.8	Drive Slip	Nil
Over 600 to 1000	0.8	25 x 25 x 3 angle	25 x 25 x 1.6 angle
Over 1000 to 1500	0.8	30 x 38 x 3 angle	30 x 30 x 1.6 angle

Duct Intrusion: Remove burrs and sharp edges and ensure these are no protrusions into the air ways.

Flanged Joints: Soft jointing material eg. 'Prestik' between flanged joints, with bolt centres not greater than 150mm.

Cross breaking: Cross break all sides exceeding 300 mm in width, except where duct is acoustically treated internally or where exposed inside the building in occupied areas.

Alternative Construction: Alternatives of not less than the above standard must be agreed with the Architect before manufacture.

Radius Bends: Internal radius greater than or equal to duct width. Where this is not possible install full radius turning vanes.

Square Bends: Use double section turning vanes to square bends.

Transitions: Limit slope of diverging or converging tapers to 15°. Where this is not possible, install acoustic internal splitters to achieve this result.

2.3 DUCTBOARD

General:

- All ductwork must be machine cut with precision routing machines. joints must be clean and free from burrs and debris.
- All profiled cuts must be sealed with a fire rated water based sealant and after assembly (folding to shape), the internal corners shall also have a bead of approved sealant applied.
- For internal ductwork, all external joints shall be taped with 75mm wide aluminium foil tape with glass fibre reinforcing.
- For external ducts, external longitudinal joints shall be covered with 50 x 50 white colourbond sheet metal angle. the angle is to be sealed internally with silicon sealant and mechanically secured to traverse duct flange joints at both ends. the angle shall be fixed with either aluminium sealed blind rivets or 16mm long galvanized needle point pan head screws at a maximum of 200mm centres.
- 25mm thick ductboard.

Traverse joints: - aluminium extrusions

All traverse joints shall use aluminium ductboard extrusions with built-in provision for an aluminium drive cleat. The corners of the extrusion shall be mitred and sealed to provide an airtight connection. Prior to fitting the extruded frame, a bead of approved sealant shall be applied to the inside of the extrusion to ensure a weatherproof and airtight joint. For external frames, a bead of silicon sealant shall be applied along the top edge of the extrusion where it meets the surface of the board.

Fixing the extrusions:

the drive cleat extrusions shall be fixed to the capping extrusions at a maximum of 150mm centres. Fasteners shall be either aluminium sealed blind rivets or 20mm long galvanized needle point pan head screws.

Installation:

Joining the ductwork:

All traverse joints shall have an approved sealant applied between the flanges to form an airtight seal. external joins or any join to external ductwork shall incorporate an over-flashing, fabricated from white colourbond sheet metal material to create a waterproof join.

Ductwork suspension

The ductwork shall be supported at a maximum of 2.4 metre spacing.

The ductwork shall be supported by 10mm galvanized threaded rods, or alternatively by an approved wire rope system. The wire must be either galvanized or stainless steel and minimum diameter is 1.5mm with nata certified adjustable locking mechanisms Use caddy speed link universal support system for ductwork suspension or equal approved.

All ductwork spanning ≥ 800 mm wide shall be supported centrally with ductboard support plates placed at 1500mm maximum centres.

For compliance with as1170.4 use the proprietary ductboard safety hanger system.

Sealant description

For all internal sealant, we recommend the use of a water based acrylic, high strength duct and metal sealant (bostik flex-e-duct ii or equivalent). The sealant shall be a fire rated polymer sealing compound for sealing of ductwork.

Equivalent sealant features must include:

- Fire rated, as1530.3.1989 (amdt 1 april 1992)
- Flexible

- Paintable
- Excellent adhesion to most building materials
- Water based
- Weather resistant

The sealant should be recommended for uses in:

- Air conditioning and ductwork
- Sealing metal sheets to ductwork
- Suitable for use with polystyrene foam

For all external sealant a water proof silicon sealant must be used.

2.4 WEATHER PROTECTION

Protect ductwork exposed to weather as follows:-

- Profile the top of the duct to shed water, alternatively provide sheet metal covers.
- Seal joints with paintable silicone mastic.
- Sheet metal capping protection to all joints
- Provide sheet metal covers to flexible connections.

2.5 FLEXIBLE DUCTWORK

Refer to insulation section for insulation requirements.

Type: Flexible ductwork to comply with AS 4254.

All materials used within flexible ductwork shall not give off toxic emissions and shall have early fire hazard properties not exceeding the following when tested in accordance with AS 1530 Part III:

Spread of Flame: 0

Ignitability: 0

Heat Evolved: 0

Smoke Developed: 3

Supply, Return and Air Relief Ductwork: Acoustic metalized inner core, Polyester insulation and reinforced metalized outer jacket to conform to the NCC requirements.

Exhaust Air Ductwork: Metalized inner core and metalized outer jacket.

Connection: Connect to ductwork and outlets using worm screw draw bands or proprietary banding system and seal with 50mm wide PVC adhesive tape.

Duct Connections: Provide sheet metal spigot with adjustable butterfly damper for connection to sheet metal ductwork.

Bends: Minimum radius bend acceptable is 1 1/2D or manufacturers specification whichever is the greater.

Duct Diameter: The full specified duct diameter is to be maintained at all times. Crushing or squashing of duct will not be accepted.

All ductwork shall not exceed the requirements of AS 1668.1 being not more than 3 metres in length per section and not exceeding 5 metres in length total without a solid tube section being provided.

All ductwork shall be supported independently and not lay or be supported by the ceiling grid.

2.6 FLEXIBLE CONNECTIONS

General: At connections to equipment containing rotating machinery, provide a clear break of 100mm and an airtight flexible connection long enough to provide slack under static conditions.

Material: Use heavy duty, waterproof, fire retardant material to AS 1668.1

Weather Protection: Provide weather protection to flexible connection located outdoors.

Alignment: Adjust ductwork hangers and supports to ensure internal airway of ductwork and equipment discharges are aligned to provide a smooth airway path.

Provide sun covers to all weather exposed flexible connections.

2.7 SPLITTERS AND DAMPERS

General: Provide full adjustability of the air distribution system at all junctions and branch take-offs in the duct system and at registers and grilles. Ensure splitters and dampers are readily accessible for adjustment after installation and that final settings are prominently marked.

Opposed Blade Dampers: Manufacture dampers from 1.6mm thick galvanised sheet with edges broken and fix with 12mm dia. stainless steel shafts to 2.5mm galvanised channel section frame. Shafts freely rotate in brass, nylon or 'oilite' bearing fixed to damper frame. Maximum 350mm single blade butterfly damper. Opposed blade dampers over 350mm. Adjust dampers with quadrants and locknuts giving full adjustment, with open and closed positions being clearly marked.

Splitter Dampers: Single blade constructed of galvanised steel with adjusting rod spindle and bearing. The blade double folded of the same thickness of the duct but not less than 0.8mm thick. Galvanised steel adjusting rod with external locking mechanism. Use 12mm spindles of bright mild steel with brass, nylon or 'oilite' bearings.

2.8 OPPOSED BLADE DAMPERS

Dampers shall be constructed of galvanised sheet steel and shall be as manufactured by Honeywell, Blendair or approved equal.

Damper sets shall be arranged in substantial supporting frames and each blade shall be mounted on a stainless steel shaft which turns in sintered bronze bearings. The blades shall incorporate spring loaded side seals and neoprene inflatable edge seals. All damper blades shall be interconnected by means of a suitable bar linkage for ganged operation.

All dampers shall be arranged with spindle horizontal and shall be sized to handle the air quantities shown on the drawings.

The maximum blade width shall not exceed 250mm and the length 1200mm.

Non-Return Dampers

Non-return dampers shall be constructed with 1.6mm Z300 Galvabond steel frames with damper blades manufactured from 0.8mm aluminum sheet. Blades shall be 150mm deep with longitudinal central swage for rigidity.

Individual blades shall be hinged on 6mm diameter bright steel rods turning in 7mm drilled holes in 1.6mm Z300 Galvabond sheet steel hat section side frames.

Damper frames shall be sized to fit inside the ductwork or opening in which the damper is to be installed.

All blades shall be individually hinged and counterweighted so that the whole assembly offers minimum resistance to the passage of air and closes by gravity to give minimal leakage back through the damper.

Where dampers are installed in sheetmetal ductwork removable panels shall be provided to give access to the counterweights and pivots for adjustment and inspection.

2.9 HANGERS AND SUPPORTS

General: Provide supports and hangers to fix the ductwork in position with adequate allowance for expansion and contraction.

Location: Fix ductwork supports to approved structural members and use suitable fixings to ensure structure is not overloaded or weakened.

Protection: Hot dip galvanised flanges, brackets and bracings exposed to view or located outside. All other areas treat with one coat of zinc chromate primer.

Supports as follows:-

Maximum Side	Support Size	Maximum Spacing
To 600	25 x 1.6 flat mild steel	2400
Over 600 to 1200	32 x 3 flat mild steel	2400
Over 1200 to 1500	38 x 38 x 3 angle with 10mm steel rod supports	2400
Over 1500	50 x 50 x 3 angle with 12mm steel rod supports	1500

Flexible Ductwork: Support flexible ducts clear of ceiling, strap suspended and within 50mm wide cradles. Maximum sag allowed is 40mm/metre. Ensure large radius bends with minimal restriction on air flow (tight radius bends will be rejected).

2.10 FIXING DEVICES

Approved types:-

- Wood Screws for fixing to timber.
- Bolts and metal threads.
- Metal anchoring devices for metal threads inserted in drilled holes of masonry, concrete or stonework.
- Cast-in anchor bolts or threaded metal.. Expansion devices grouted boxes or devices on approval.
- Brass, copper or galvanised steel saddles and clamps to be employed without dissimilar metal contact.

Types not permitted:-

- Plastic, fibre, wooden wall plugs.
- Explosive or power fired devices, including staples.
- Masonry (hardened) nails.

Types subject to prior approval:-

- Self-tapping screws in sheet metal applications.
- Pop-rivets.
- Cements and adhesives.

2.11 PLENUM HOUSINGS (FILTER PANEL)

Rigid assembly for plenum housings using panels constructed from galvanized steel, 1.6mm minimum thickness. If reinforcing is required to achieve the necessary strength apply it internally. Plenum housings shall be designed and constructed using transitions or air splitters to ensure uniform air flow across filters at the design velocities identified in the specification clause for filters.

Filter Frame: Provide filter frame as specified in filter specification, together with sealed blanking panels to ensure no air bypass.

Access Panels: Incorporate brass hinged access panel with brass catch for filter removal. Provide neoprene seal around panel.

Provide hinged access panels to both sides of the plenum for alternative access points, and for the potential use of half filters.

External plenum housings weather protected as follows:-

- Profile the top of the plenum with a cross break to shed water, alternatively provide sheet metal covers.
- Seal joints with paintable silicone mastic.

2.12 ACCESS PANELS

Location

Access Panels

Provide and nominate access panel requirements in the following locations:-

- Adjacent to each component located inside the duct requiring regular inspection and maintenance including, but not limited to:-
 - . Condensate pumps
 - . In-ceiling air conditioning and heat recovery units
 - . Filter plenum boxes.
- In other locations specified and/or shown on the drawings.

Access Panels

Sizes

Access panels: Minimum clear opening:-

- Personnel Access: 450 x 600 mm.
- Hand Access: 200 x 300 mm.

0746 AIR GRILLES**1 RESPONSIBILITIES****1.1 GENERAL**

Requirement: Provide air grilles, as documented.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0171 General requirements.
- 0701 Mechanical systems.
- 0744 Ductwork insulation.

1.3 STANDARDS**General**

Requirement: To AS 4254.1 and AS 4254.2.

1.4 AIR OUTLETS AND GRILLES**General**

Manufacture: Outlets and grilles which are commercially proven and in current volume production and, from the one manufacturer.

Noise Levels: Select outlets and grilles that meet suitable noise level requirements for the required application.

Note: Prior to ordering confirm air outlet and grille sizes, neck, face slot numbers, etc with actual equipment suppliers test data to ensure the air diffusion selection satisfies the installation requirements.

Select grilles and neck sizes and adjust during commissioning to achieve draught free air distribution with not more than 0.25m/s room velocities.

Material and Finish: Aluminium construction finished in powder coating to AS 3715:-

- In doors to match door colour
- In walls to match wall colour
- In ceilings to match ceiling colour

Paint dampers behind them matt black.

Ductwork and Cushion Heads Behind Grilles: Where visible, paint matt black.

Louvre Ceiling Diffusers

Diffusers with the following features:-

- Square or rectangular aluminium 4 way blow louvre face configuration, fitted with blanking plate where 1, 2 or 3-way blow is nominated.
- Cores easily removable and replaceable.

Frame Type: To suit ceiling type in which diffuser is installed.

Ceiling Return Air, Air Relief Grilles and Ceiling Exhaust Grilles

Ceiling mounted: 12 x 12mm egg-crate type with removable clip in/out core and flanged surround. Fit exhaust grilles with adjustable opposed blade damper to plenum box (return air is not to contain OBD at the grille, volume control is to be via main ductwork spigot). Provide vermin mesh to grilles located outside.

Cushion Head Boxes - Acoustic

On top of each **supply air diffuser** and grille connected to flexible ductwork, an independently supported acoustically lined sheet metal cushion head box of the minimum dimensions shown on drawings and ensuring uniform air flow.

Cushion Head Boxes - Plain

On top of each **toilet exhaust grille** connected to flexible ductwork, an independently supported acoustically lined sheet metal cushion head box of the minimum dimensions shown on drawings and ensuring uniform air flow.

Return Air Boxes - Acoustic

On top of each **return air grille** connected to flexible ductwork, an independently supported acoustically lined sheet metal cushion head box of the minimum dimensions shown on drawings and ensuring uniform air flow.

Door Grilles (Air Relief)

Make: Holyoake or similar approved model half Chevron grille complete with flange surround to both sides of the door. The door grille louvre shall be manufacture in aluminium and powder coated in a colour to be nominated by the Architect.

Door grilles to have a minimum free area of 60%.

Weatherproof Louvre

50 mm Thick

Make: Holyoake or similar approved slim line horizontal weatherproof louvre with angle frame. The louvre shall be manufacture in aluminium and powder coated in a colour to be nominated by the Superintendent. The blades shall be nominal 50 mm thick and shall have a minimum free area of 55%. The grille size shall ensure a maximum velocity of 2.5 m/s.

0744 DUCTWORK INSULATION**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide insulation of ductwork and related items, as documented.

Alternative insulation methods and materials

General: Do not submit alternatives for materials or methods that have lesser quality or characteristics in terms of the following:

- Cold bridging.
- Corrosion resistance.
- Durability during and after installation.
- Performance.
- R-Value.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0171 General requirements.
- 0701 Mechanical systems.

1.3 STANDARDS**General**

Ductwork insulation: To AS 4254.1 and AS 4254.2.

Performance and technical provisions: To AS/NZS 4859.1.

Installation of glass wool and rock wool insulation

Glass Wool and Rock Wool insulation: Conform to the ICANZ Industry code of practice for the safe use of glass wool and rock wool insulation Industry Code of Practice for the Safe Use of Glass Wool and Rock Wool.

Marking: Deliver mineral wool products to site in packaging labelled FBS-1 BIOSOLUBLE INSULATION.

2 INSULATION**2.1 GENERAL**

Note: All insulation used on this project shall be manufactured without the use of ozone depleting substances. Substances that have an Ozone Depleting Potential (ODP) of greater than zero are to be avoided in the manufacture of all thermal and acoustic insulants whilst satisfying all other criteria. Provide manufacturers literature and testing that prove the insulation to be used on this project complies with the Zero ODP. Submit all tech data including required R-Values for review prior to the ordering of materials.

Early fire hazard properties: To AS 1668.1 and AS 1530 Parts I and II.

Duct linings, including adhesives and surfacing materials shall have a Spread of Flame Index not greater than zero and a Smoke Developed Index not greater than 3, both as determined by the Standard Fire Test in accordance with AS 1530 Part III.

All insulating or acoustical materials used within ductwork, shafts, attenuating chambers, and the like shall be Non-combustible in terms of AS 1530 Part I and under conditions of fire or intense heat shall not give off toxic emissions and shall have Early Fire Hazard Properties not exceeding the following Indices when tested in accordance with AS 1530 Part III :

Spread of Flame: 0

Ignitability:	0
Heat Evolved:	0
Smoke Developed:	3

All adhesives, vapour barriers, breather coatings used on ductwork, plant and services, shall have Early Fire Hazard Properties not exceeding the above indices when tested in accordance with AS 1530 Part III.

All adhesives, vapour coatings and sealers shall be selected and applied in accordance with the manufacturer's recommendations for the application to give a permanent bond and/or seal under all conditions of installation and operation.

2.2 DUCTWORK INSULATION

General

Supply and return air ductwork not shown on the drawings to be acoustically insulated shall be thermally insulated.

Flexible Ductwork Thermal Insulation

Flexible ductwork thermally insulated shall comply with the current NCC minimum R-value requirements, all product complying to AS 4254.

Maximum single length of duct is to be 3.0 metres and not exceeding 5 metres in length total without a solid tube section being provided.

Rigid Duct Thermal Insulation

For rigid ducts to be externally insulated install mineral wool flexible duct insulation with aluminium foil laminate facing to comply to minimum NCC R-value requirements.

Fixing: Fix insulation to the ducts using 12mm side polypropylene strapping at 600mm centres or using weld pins and disc clips spaced at 380mm maximum centres. Maintain the vapour barrier at the joints and pins.

Acoustic Insulation

For ducts to be internally insulated install (refer to drawings) tontine semi rigid polyester duct liner with perforated aluminium foil laminate facing to comply to minimum NCC R-value requirements.

Minimum Absorption Coefficients Table

Insulation	Absorption coefficients (nominal) to AS 1045 at				
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz
Perforated foil faced:					
- 25mm thick	0.08	0.24	0.68	0.96	1.01
- 50mm thick	0.26	0.66	1.09	1.09	1.05

Maximum thermal conductivity: 0.036 w/mK at 20°C

Restrain the insulation inside rectangular ducts using weld pins and disc clips, and either:

- Corner angles, cover strips and end channels; or
- Turn back and bond the facing under the insulation at the edges with the insulation extending proud of the ductwork at each end (free edge method).

0752 MECHANICAL PIPING INSULATION**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide insulation to hot and cold piping, flues, exhaust pipes, tanks vessels and plant, as documented.

Alternative insulation methods and materials

General: Do not submit alternatives for materials or methods that have lesser quality or characteristics in terms of the following:

- Cold bridging.
- Corrosion resistance.
- Durability during and after installation.
- Fire and thermal performance.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0171 *General requirements.*
- 0701 *Mechanical systems.*

1.3 STANDARDS**General**

Standard: To AS/NZS 4859.1.

Installation of glass wool and rock wool insulation

General: Conform to the
ICANZ Industry code of practice for the safe use of glass wool and rock wool insulation.

Marking: Deliver glass wool and rock wool products to site in packaging labelled FBS-1 BIO-SOLUBLE INSULATION.

2 INSULATION**2.1 GENERAL**

Note: All insulation used on this project shall be manufactured without the use of ozone depleting substances. Substances that have an Ozone Depleting Potential (ODP) of greater than zero are to be avoided in the manufacture of all thermal and acoustic insulants whilst satisfying all other criteria. Provide manufacturers literature and testing that prove the insulation to be used on this project complies with the Zero ODP. Submit all tech data including required R-Values for review prior to the ordering of materials.

Early fire hazard properties: To AS 1668.1 and AS 1530 Parts I and II.

Duct linings, including adhesives and surfacing materials shall have a Spread of Flame Index not greater than zero and a Smoke Developed Index not greater than 3, both as determined by the Standard Fire Test in accordance with AS 1530 Part III.

All insulating or acoustical materials used within ductwork, shafts, attenuating chambers, and the like shall be Non-combustible in terms of AS 1530 Part I and under conditions of fire or intense heat shall not give off toxic emissions and shall have Early Fire Hazard Properties not exceeding the following Indices when tested in accordance with AS 1530 Part III :

Spread of Flame:	0
Ignitability:	0
Heat Evolved:	0
Smoke Developed:	3

All adhesives, vapour barriers, breather coatings used on ductwork, plant and services, shall have Early Fire Hazard Properties not exceeding the above indices when tested in accordance with AS 1530 Part III.

All adhesives, vapour coatings and sealers shall be selected and applied in accordance with the manufacturer's recommendations for the application to give a permanent bond and/or seal under all conditions of installation and operation.

2.2 PIPEWORK INSULATION

Refrigerant Piping

Insulate refrigerant lines using flexible closed cell black nitrite rubber in sleeve from Armacell or equivalent.

Rating – **FR Fire Rated.**

Install separate insulation to liquid and suction lines for the full length.

Comply with the current minimum NCC R-values requirements.

Conduits: Refrigerant pipes installed underground shall be encased in PVC pipe conduits.

Foam seal pipe ends between conduit and pipework.

Condensate Drains

Insulate internal condensate drain lines for 1m from connection point to unit using flexible closed cell block nitrite rubber. Armacell or equivalent in accordance to the NCC requirements.

Installation

Slide into place before jointing pipework. Do not cut longitudinally. Glue all joints with weatherproof adhesive and tape all joints and ends.

Metal Cover

Provide colourbond capping to all external refrigerant pipes. Ensure no insulation is exposed to the elements.

0781 MECHANICAL ELECTRICAL**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide mechanical electrical installations, as documented.

Surge protection devices (SPD)

General: Provide surge protection as documented.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0171 General requirements.
- 0701 Mechanical systems.
- 0223 Service trenching.

2 ELECTRICAL**2.1 SCOPE**

The complete electrical installation necessary for the satisfactory operation of all plant and equipment included in this specification.

Include:-

- Final connection of power supplies from isolators provided adjacent each item of equipment by the Electrical Services Contractor.

2.2 EARTHING SYSTEM

In addition to the requirements of AS 3000, the exposed metal of all fixed electrical equipment shall be earthed.

2.3 REGULATIONS

The entire electrical installation shall be in accordance with the current regulations and requirements of the local Supply Authority, and with the relevant SAA Specifications and Codes.

2.4 ELECTRIC MOTORS

All electric motors shall comply with the high efficiency requirements of AS1359.5

2.5 SETTING OUT OF RETICULATION AND WIRING

Wiring shall be generally concealed TPS cables and shall be protected by conduit drops to switches, controls and similar terminations.

Where unavoidably exposed to view, wiring shall be enclosed in conduit or ducting to the approval of the Architect.

Cables and conduits shall be fixed parallel to building members, walls and doors, and shall be run orthogonally wherever possible.

Cables and conduits shall be arranged in a neat and workmanlike manner.

Where sheet insulation is used in roof spaces directly below the roofing material, conduits shall be run so as to enable the conduits to be accessible after completion of the building.

2.6 CABLES AND JOINTS

Cables, fittings and accessories shall be of approved type and manufacture, suitable for the voltage and temperature ratings applicable.

Particular care shall be taken in handling cables to ensure that the cable serving or sheathing is not damaged. Cables showing evidence of abrasion or other damage will not be accepted.

In conduit installations, drawing in of cables shall not be commenced until the particular section of the conduit system is completed.

2.7 CONDUITS, FITTINGS AND JOINTS

Conduits shall be rigid metallic conduit, galvanised steel conduit, galvanised steel water pipe, thermoplastic pressure pipe or high impact rigid PVC conduit and shall not be less than 20mm Nominal Bore in size. All conduits, fittings and accessories shall be of approved type and manufacture.

Fixings to building members shall be neatly and securely carried out with conduit matching saddles, fixed with round head cadmium-plated wood screws to woodwork or to lead or other approved plugs in properly formed holes in masonry. Metal thread screws shall be used for fixing to steelwork.

Conduits shall be adequately supported during all stages of the building construction.

Conduits shall be long lengths, straight, smooth, free from rags, burrs and sharp edges. Off-cuts shall not be used to fabricate long lengths of conduit.

Where conduits are installed in accessible plantrooms and air conditioning cupboards and the like, conduits which may be walked on shall be adequately supported by timber battens throughout the length of the run.

Inspection elbows, tee pieces, etc., shall be accessible.

Approved metal troughing may be used in lieu of conduit as applicable.

Draw-in boxes shall be provided at suitable intervals not exceeding 30 metres in straight runs at intervals not exceeding 25 metres in runs including directional changes. Draw-in box positions shall be agreed with the Architect prior to installation.

Rigid Metallic Conduits and Fittings

Rigid metallic conduits shall comply with AS 2052, and have screwed joints and terminations. The conduits shall be installed as specified in AS 2052.

Unless otherwise specified the conduits shall have a protective coating classed as "heavy protection" as defined in the Standard.

Steel conduits shall have all ends and joint threads painted with aluminium paint and shall be electrically and mechanically continuous. Electrical continuity tests shall be carried out prior to draw-wires being installed.

Rigid Non-Metallic Conduits and Fittings

Non-metallic conduits installed shall comply with AS 2053 and shall be of the "heavy duty" type as defined in the Standard. Associated fittings shall be of the same material as specified for the conduit.

Conduits, fittings and adhesive cement shall be procured from the same manufacturer, and the manufacturer's recommended procedures shall be adopted for the making of the joints.

Standard size wall boxes shall preferably be of the same material as the conduit. Where special size boxes are specified, and where such boxes are not obtainable in PVC, pre-fabricated metal boxes shall be used where approved by the Architect.

Horizontal runs of conduit in concealed areas likely to be affected by heat, shall be supported by timber battens continuously for the length of the run.

Bends shall be of large radii and shall be formed with approved formers. Correctly sized springs shall be used to form bends in rigid PVC conduit. Conduits manipulated or bent must maintain true effective diameter and shape at all parts of the bend. Conduit sets distorted or showing evidence of kinks, wrinkles, flats or having been heated will not be accepted. Inspection type fittings shall be used where conduits are exposed. Wherever possible, PVC conduits should be pre-formed by the manufacturer.

Flexible couplings shall be installed wherever expansion or contraction joints occur in a building. A sample of the type of expansion fitting to be used shall be submitted for approval prior to installation. Conduit clips shall be installed so as to allow the conduit to move freely while expanding or contracting.

Thermoplastic pressure piping shall comply with AS 1477. All fittings shall be of material specified for the piping and all joints shall be made with an approved adhesive cement which shall include a contrasting colour.

Flexible conduits will not be permitted unless otherwise approved prior to installation.

0771 AUTOMATIC CONTROLS**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide automatic control systems to provide the documented control functions and system performance.

2 CONTROLS**2.1 SCOPE**

Controls, instrumentation and associated items necessary for correct, efficient and safe operation of the installed plant.

On faceplates secure the mechanism with retaining screws, or construct the faceplate and mechanism so that the mechanism cannot be displaced during normal operation.

Controls shall be of a type suitable for their intended use and shall have adjustable set points and adjustable differentials appropriate to the individual control ranges required.

Timers shall be arranged to fail in the safe position. No system control shall be allowed to over-ride a safety control.

Safety interlocks and controls necessary for the protection of all plant shall be provided and these shall be of the manual reset type. Protection devices shall not be used for normal operation control.

Detailed control diagrams for each system shall be submitted for approval by the Architect before commencing installation.

2.2 TEMPERATURE SENSORS

Temperature sensors shall be wall type with a temperature range of approximately 16°C and 32°C with separate adjustable set points for heating and cooling and adjustable differentials.

All temperature sensors shall have a vandal proof cover, shall require the use of a special tool for manual adjustment and shall not incorporate a thermometer or other indication of room temperature

2.3 MOVEMENT DETECTORS

General: Provide movement detectors to cover designated areas where toilet and heat recovery systems are used.

Timer: Adjustment 30 minutes

Type: 360° PIR motion sensor connected in series with associated heat recovery unit. Recessed, white, 230v with dual technology.

Manufacturer: Pierlite smart scan or equivalent.

Note: Sensors may be provided by electrical services contractor – coordinate requirements – provide credit where 2-pole sensors are provided by electrician.

2.4 CENTRALISED CONTROLLER

The control systems shall be fully proven, readily available and in commercial production.

The following functions shall be provided;

- Touch control
- Control of up to 50 indoor units
- Weekly programmable timer
- Group controller
- Ability to prohibit controls of associated/ linked indoor units
- Restrict the operation range of the associated connected indoor unit
- External input from the Security system for activation

Provide connection/ interface with security system to enable and disable the system each day.

Provide a controller similar to Mitsubishi "AG150" controller or equal and approved. Confirm final location required with Superintendent prior to installation.

The control panel shall be provided with an easy to use touch panel, interface with each air conditioning unit and be capable of controlling all air conditioning units.

The controller shall allow as a minimum the following functions for each connected indoor unit:

- Unit ON/OFF
- Temperature set point
- Fan control
- Error reporting of connected equipment
- Timeclock scheduling

Wall Mounted Controllers

The FCU control panels located in each individual space as identified in the drawing and described below shall be type Mitsubishi 'PAR-31' or equal and approved equivalent. The controller shall be a wall mounted wired type with liquid crystal display. Confirm final locations required with Superintendent prior to installation.

The unit controller shall control the following unit functions at a minimum:-

- ON/OFF
- Temperature set point
- Fan speed,
- Mode select,
- Time scheduling,
- Run-on Timer (set for 2hours),
- Lock functions,
- Vane swing (cassette units)

2.5 ON/OFF EQUIPMENT CONTROL TIMER - PROGRAMMABLE

Install a programmable timer as manufactured by Clipsal, model VETR or similar approved for all air conditioning equipment. Timer switch to be initiated via a rocker on push button incorporating a red or green neon.

Timed function shall allow for up to 2 hours with cancellation by pressing the button for 3 seconds.

Allow for interlock cards for interface to equipment as necessary.

2.6 CONTROLS

The mechanical equipment shall be controlled as set out below:-

General

Provide an adjustable delay start timer control system to all air conditioning units to ensure that all units do not start at the same time.

2.7 VRF SYSTEMS (TYPICAL)

The indoor units shall be controlled by an ON/OFF adjustable time switch (initially set for 2 hours).

The unit temperature, fan speed, mode etc shall be controlled by proprietary wired control panels and via the master centralised controller. Confirm final controls requirements with the client prior to building handover (eg locked proprietary controllers to all general rooms with only localised control via time switch, staff rooms with enabled functions to proprietary controllers)

Control room dry bulb temperature via the in-built unit DX controller by cycling coil cooling and heating to maintain the preset room temperature. Provide a deadband to allow the temperature to drift between the designs tolerances. Set the plant to maintain $24 \pm 2^{\circ}\text{C}$ dB.

Mount all controllers and timer switches 1500mm above floor.

Confirm final control requirements with Client including required operating hours, ON timer parameters, holidays, control panel mounting heights, etc. (Note: The mechanical contractor is responsible for liaising with the architect and relevant School representative for the required information).

Provide all applicable interconnecting control wiring.

Connect to electrical isolating switches provided for each item of equipment by electrical contractor.

2.8 TOILET EXHAUST FAN (TYPICAL)

The fans shall be controlled via a motion detector.

Fan is set to operate on activation of motion detector, with adjustable run-on timer for 5mins once no motion has been detected.

Provide all electrical and control wiring between the isolators and fan.

Connect to weatherproof isolating switch adjacent the fan (isolator provided by electrical contractor).

2.9 CARPARK EXHAUST FAN – SUPPLY AND EXHAUST (VENTILATION AS1668.2)

Connect fans to weatherproof isolators provided by electrical contractor.

Provide all required motion detectors, electrical and control wiring.

The fans (supply and exhaust) shall be provided with a variable speed drives to control fan speed and airflow rates.

The fans shall be provided with a flow switch to ensure the fan is operating at the desired level. If airflows fall 10% below that nominated the sensor shall activate the alarm.

The fans shall be controlled by an AUTO/OFF/MANUAL switch located within the basement area.

When the switch is in the AUTO position the fans shall be controlled by carbon monoxide monitoring adjustable sensors mounted between 900mm and 1500mm as shown on the mechanical drawings.

When the switch is in the 'AUTO' position the fan shall run as follows:

CO levels detected are between 9 – 15ppm the fan shall operate at 50%

CO levels are between 15 – 30 ppm the fan shall operate on 100% speed setting

CO level exceed 30ppm the fan shall run at 100% until the CO levels drop below 15ppm

When the switch is in the 'OFF' position the fan shall be isolated from operation.

When no motion is detected for 2hrs the system may automatically shut down.

If a fault signal is detected from any sensor the system shall provide a visible alarm.

2.10 GENERAL EXHAUST FAN

The fans shall be controlled via a motion detector and c/w speed controller and indicator light located within storeroom.

Fan is set to operate on activation of motion detector, with adjustable run-on timer for 5mins once no motion has been detected.

Provide all electrical and control wiring between the isolators and fan.

Connect to weatherproof isolating switch adjacent the fan (isolator provided by electrical contractor).

2.11 POWER FAILURE

In the event of a power failure all units shall automatically reset and restart upon reinstatement of power supply to the building. All systems are to stage start as per normal operation.

2.12 SECURITY SYSTEM SHUTDOWN

Provide wiring from the mechanical systems to the security system to shut down when the security system is energised (except for comms room A/C unit)

2.13 FIRE SHUTDOWN

The Mechanical Contractor will provide a 24V DC (normally energised) control cable to each main air conditioning system. Provide a control relay in each unit to shut the units down in the event of a fire.

Upon cancellation of the signal the units shall automatically restart.

Provide all interconnecting fire rated electrical wiring and controls from fire shutdown signal – confirm and coordinate with electrical services contractor for receipt of fire alarm signal.

0791 MECHANICAL COMMISSIONING**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide commissioning of all mechanical systems, as documented.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0171 General requirements.
- 0701 Mechanical systems.
- 0751 Mechanical piping.
- 0752 Mechanical piping insulation.
- 0771 Automatic controls.

1.3 STANDARDS**General**

Measurement of fan and duct air quantities > 1000 L/s: To ISO 5802.

Testing, balancing and commissioning except fan and duct air quantity measurement: Select from the following:

- ASHRAE STD 111.
- CIBSE CCA, CIBSE CCB, CIBSE CCC, CIBSE CCR and CIBSE CCW.
- National Environmental Balancing Bureau (NEBB) Procedural Standards.
- AIRAH DA24.
- AIRAH DA27.
- AIRAH DA28.

Statistical analysis: To ASHRAE Guideline 2.

Fire operation of air handling systems: To AS/NZS 1668.1.

Orifice plates and venturi meters: To BS 1042.

Microbial control: To AS/NZS 3666.1 as required by BCA and the recommendations of SAA/SNZ HB 32.

Pressure equipment: To AS/NZS 3788.

Fume cupboards: To AS/NZS 2243.8.

2 TESTING AND COMMISSIONING**2.1 GENERAL**

On completion of the installation works allow to, test, commission and balance all Mechanical Services systems using competent personnel trained for this type of work.

Allow to adjust and monitor all items to ensure appropriate performance, safety, energy and maintenance objectives are achieved.

Pre-plan and coordinate the work with all other trades to ensure minimum inconvenience to all concerned.

Submit proposed testing programs and schedules for approval prior to commencing this phase of the work.

2.2 MECHANICAL SERVICES COMMISSIONING DATA

The Mechanical Services Contractor will be required to provide documentary evidence of the successful completion of the commissioning of the mechanical services systems, and supply the information detailed below, before Practical Completion will be granted.

2.3 AUTHORITIES TESTING

Carry out all tests required by the relevant authorities and perform without charge any making good necessary to obtain approvals. Give the Architect 48 hours notice of such tests. Hand over test certificates and approvals on completion; leave a copy of all such items in the Maintenance Manual. Give sufficient notices required for interruptions to supply.

2.4 INSPECTIONS

Give 5 clear working days written notice so that the Architect, and where applicable, the authorized representative of the relevant regulatory authority, may attend and inspect testing required by the Contract. State the date, time and place of the test.

2.5 CONCEALED WORK

Do not cover or conceal underground or enclosed work until it has been inspected and tested in sections where necessary. Leave pipe joints exposed to enable observation during testing.

2.6 INSPECTION AND TEST PLANS

Prepare and provide ITPs for all mechanical services systems complete with the following details for each plan. Allow to submit 30 days prior to commencement.

- testing method
- testing instruments
- test log sheets
- any authority test requirements
- approval certificates

2.7 PRE COMMISSIONING PROCEDURES

Ensure the following works are carried out prior to the commencement of the commissioning of the mechanical systems.

- pressure test all piping systems, check and rectify any leaks
- test all condensate drains, verify drainage, check and rectify any leaks
- pressure test all air distribution systems, check and rectify any leaks
- clean out all air plenums and provide temporary filter media for air handling systems
- submit all manufacturers test certificates for all equipment for review
- submit motor / pump alignment certification for review
- submit instrumentation calibration certificates for review
- submit commissioning and test log sheets for review

2.8 COMMISSIONING PROCEDURES

Carry out all testing and commissioning necessary to ensure that all system function in an automatic and safe manner providing optimum efficiency under all conditions.

Allow to provide the following testing and commissioning procedures.

Plant and Equipment:-

- Check the correct operation of all equipment including the direction of rotation of motors, pressures and flows, operating temperatures, noise and vibration levels
- Prove performance at full and part load
- Prove safety controls

Refrigeration Systems:-

- Do not cover or conceal pipework until it has been inspected and tested
- Charge systems with applicable refrigerant. Pressure test with dry nitrogen to 300kPa on high side and 700kPa on low side for 6 hours with no measurable pressure drop.

- Evacuate each system to 300 microns and maintain for a minimum of 12 hours. Any pipework recording a pressure rise of more than +5% shall be checked for leaks and repaired prior to repeating the above testing.
- Prove operation of all relief devices
- Prove operation of expansion devices
- Check and record all operating and safety pressure settings
- If a section of pipework fails a required test, repair the fault and re-test.

Condensate Drain Systems:-

- Cap off and static test drains and visually check all joints for leaks.
- Confirm correct fall to drain point

Air Distribution Systems:-

- Balance the air distribution systems to give flow rates within + 10% -0% of the specified air quantities.
- Balancing at main duct and branch duct take-offs with minor balancing at outlet dampers
- For purposes of establishing the air balance.
 - . All air conditioning systems must be operating concurrently;
 - . The building is clean and sealed with all partitions and ceilings in place;
 - . All components of the air conditioning systems are installed eg, air registers, grilles;
 - . The resistance across filter banks, where installed, shall be simulated to provide the means of the initial and final resistance of the filter bank.
- Adjust air quantities at outlets to ensure direction and throw of air is uniform over the face and free from draughts. If required provide blanking plates in outlets.
- Prior to Practical Completion adjust air quantities to ensure even temperatures throughout the space. Further balancing may be required during the defects liability period.

Ductwork Systems:-

- Test the completed ductwork visually and audibly for air leakage, noise and vibration transmission.
- With the ductwork at test pressure, survey the joints for leaks and mark each leak. Depressurize, repair the leaks, and re-test. Repeat until the audible and visible leaks are eliminated.
- Record the details of the tests and submit for approval.

Electrical Systems:-

- Progressively and finally test each component for function, activate each overload or circuit, and demonstrate the correct operation and function
- Check all clamps, fixings and termination points
- Check phase identification
- Check for any excessive heating at all joints

Control Systems:-

- Test each component for correct function and operation
- Demonstrate that protective devices perform their safety function by simulating fault conditions, not by electrical short-circuiting or manual tripping
- Check inputs and outputs, and verify calibration
- Check the operation of controlled devices to ensure that they operate in the correct direction and through the correct range of physical movement in relation to the applied control signal
- Check the operation of the plant and control system in the specified modes to ensure that the specified plant operation and controlled variable conditions are consistently achieved in a stable manner
- Demonstrate satisfactorily the operation and correct setting of the control system for all plant prior to Practical Completion

Noise and Vibration:-

- Where sound power levels are specified for individual items of equipment, submit type test data stating the sound power level of the equipment offered and the method of determination used

- If requested during commissioning, carry out noise level acceptance tests in conjunction with the acceptance tests of the completed installation. Demonstrate that individual items of equipment and the complete service system do not exceed the required noise level limits under operating conditions.
- Take noise level measurements with details of sound pressure levels in each octave band mid frequency from 125 Hz to 4000 Hz inclusive.
- The measurement position shall be not less than 1 m above the floor, not closer than 1 m from walls or equipment.
- Where excessive vibration is evident measure the vibration levels.

Safety Equipment:-

- All items of safety equipment provided on plant and equipment shall be tested by creating the appropriate fault conditions. Provide skilled technicians to commission controls and demonstrate to the satisfaction of the engineer.

2.9 INSTRUMENTATION CALIBRATION

For each measuring instrument apparatus provide a current calibration certificate from an approved authority, showing the information listed in AS 2415 clause 4.9.

Recalibrate each instrument on or before the certified date for recalibration. Recalibrate or replace faulty instruments or instruments rejected by the Architect.

Electrical instrument scales shall be such that readings will be at least one half of the full scale deflection. Scales for other instruments such as gauges, thermometers and the like shall be calibrated over the range of test readings.

Accuracy of Measuring Instruments shall be +/- 1% of full scale deflection.

2.10 COMMISSIONING AND PERFORMANCE RECORDS

For each of the above tests, provide for review typed copies of all data recorded during the commissioning and testing of the installation together with all necessary inspection certificates from local authorities within 7 days prior to completing the works.

2.11 REMEDIAL WORK

If a tested item fails to meet the performance requirements before Practical Completion the item may not be accepted by the Architect. Alternatively remedial or replacement work during the Defects Liability Period may be subject to restricted access conditions for which the Builder shall bear any additional costs.

2.12 PRACTICAL COMPLETION INSPECTION

The Mechanical Services sub-contractor shall make themselves available at the PC inspection(s) as organized with the builder or head contractor for this project, in order to guide the Engineer through the installation and prove operation of each system as deemed necessary.

Failure to comply may result in additional inspections and costs incurred by the client.

2.13 PRACTICAL COMPLETION

Practical Completion will occur when the Acceptance Tests demonstrate that the required performance has been achieved.

The date for Practical Completion shall not be prior to that given for the whole or the works. See Preliminaries Clause for further details.

If so required or approved, bring designated sections of the plant progressively up to the stage of Practical Completion.

0792 MECHANICAL MAINTENANCE**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Maintain the mechanical systems for the documented maintenance period so that the performance and service delivery including indoor conditions and indoor air quality, reliability, service life, compliance with statutory requirements, energy efficiency and safety of the system is equal to or better than that at the beginning of the maintenance period in parallel with and including:

- Periodic and statutory maintenance, cleaning and replacement of consumables.
- Emergency repairs.
- Condition reporting.

Maintenance period: As documented.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0171 General requirements.
- 0701 Mechanical systems.
- 0791 Mechanical commissioning.

1.3 STANDARDS**General**

Air handling system maintenance: To AS 1851.

Microbial control: To AS/NZS 3666.2.

Pressure equipment:

- Maintain to AS 3873.
- Inspect to AS/NZS 3788.

Respiratory protective devices: Maintain to AS/NZS 1715.

2 MAINTENANCE**2.1 SCOPE**

Provide a comprehensive maintenance service from the date of Practical Completion during the 12 months Defects Liability Period for all items in the Contract, including regular preventative maintenance and attendance at breakdown call-outs on 24 hours per day, 7 days per week.

Maintenance shall include routine servicing in accordance with manufacturers recommended procedures to achieve safe and reliable operation, the attendance at all emergency call outs, and the repair of break downs including provision of associated consumables and replacement components.

Maintenance shall be at manufacturer's recommended intervals or 3-monthly, whichever is the most frequent.

Service Contract: Prior to the expiration of the Defects Liability Period, prepare and submit an annual service contract for consideration.

Ensure all installed mechanical services equipment can be accessed and serviced safely in accordance with relevant applicable standards (ie AS3666.2)

2.2 MAINTENANCE REQUIREMENTS

Service Visits: Make service visits at the specified intervals and carry out the regular maintenance procedures.

Faults: Make good faults or damage cause by defects in the installation, and replace defective parts.

Materials: Supply the necessary maintenance materials including lubricants and cleaning materials.

Program: Before the start of the maintenance period, submit to the Architect a maintenance program showing the proposed dates of required service visits. State the contact telephone numbers of the service operators to be provided, and describe the arrangements for the prompt attention to emergency calls.

Results: Record the result of each service visit in the log book, including comments on the functioning of the system, work carried out, items requiring corrective action, adjustments made, name of service operator and obtain the signature of the Proprietor's designated representative.

Report: Report to the Proprietor's designated representative on arriving and before leaving the site.

End of Defects: At the end of the defect's liability period, make a final service visit and upon satisfactory completion of the above procedures, certify in writing that the system is operating correctly and has been fully and properly maintained during the Maintenance Period.

2.3 ROUTINE MAINTENANCE AND SERVICE

The Mechanical Contractor shall provide all materials, labour, tools and services necessary to service the plant during the Defects Liability Period. Including but not limited to filter media, belts, refrigerants, fuses, globes and all items referred to as consumable.

The contractor shall carry out regular inspections at periods no greater than one calendar months.

Monthly Maintenance

The contractor shall carry out the following functions at each monthly visit in compliance with AS3666.2.

- Air intakes and exhaust outlets shall be inspected and cleaned, where necessary.
- Air filters where installed shall be inspected, cleaned or replaced where necessary.
- Coils where installed shall be inspected and cleaned, where necessary.
- Trays and sumps shall be inspected and cleaned, where necessary.
- Condensate drains, tundishes and traps are to be checked for effectiveness and drainage lines flushed clean.

3 Monthly Maintenance

The contractor shall carry out the following functions at each visit.

- Attend to any defects and / or complaints
- Carry out all lubrication necessary
- Check and adjust all drives as necessary
- Check and clean fan impellers and check fan balance
- Check all anti-vibration mounts, hangers, clamps and holding down bolts for deterioration
- Check all bearings for correct operation
- Check all flexible duct connections for air leakage
- Check all drains and clean out as necessary
- Check coils for fin damage
- Check and prove correct operations of all safety controls
- Check filters and replace as necessary
- Repair or replace all items found defective.

6 Monthly Maintenance

The contractor shall carry out the following functions at each visit in addition to those listed above.

- Inspect and clean as necessary all fans, coils etc
- Clean and adjust all switchgear, contactors and starters
- Prove operation of all safety controls
- Check and repair any corrosion
- Check and repair any air leakage from ductwork and joins.
- Check motorised dampers seal airtight and check operation and lubricate linkages as necessary
- Remove any rubbish and clean equipment as necessary.
- Repair or replace all items found defective.

Service

The contractor shall undertake to provide a comprehensive breakdown service whereby a qualified technician attends to the plant promptly after a breakdown is reported and carries out immediate remedial work.

If the contractor fails to attend the plant within eight (8) working hours of being notified of a breakdown and where remedial work is interrupted other than for obtaining spare parts, the proprietor reserves the right to order such action as necessary in order to expedite completion of the works at the sub-contractors expense.

Service reports: During each visit the contractor shall provide a service report in the form of a check list which shall indicate the readings of the gauges, the condition of all items, any remedial work provided. Reports are to be countersigned by the proprietor or their representative prior to leaving site.

Final payment: retention monies will be release only upon receipt of all service reports which indicate that the scheduled functions have been regularly completed.

2.4 PIPING

Inspect pipework, insulation and labelling three monthly and repair leaks, defects and corrosion.

2.5 MECHANICAL PLANT AND EQUIPMENT

Inspect all air conditioners, fans and condensate pumps and carry out maintenance at the frequency and as recommended by the manufacturer or 3 monthly whichever is the most frequent.

2.6 DUCTWORK

Inspect ductwork including filters and coils 3 monthly for signs of air leaks, water leaks, corrosion or erosion of insulation. Repair all defects.

Clean and replace any defective filter media at 3 monthly intervals for the duration of the defects liability period.

2.7 NOISE AND VIBRATION

Inspect all noise and vibration suppression equipment 3 monthly. Ensure excessive static deflection does not occur, and that original design objectives are achieved.

2.8 CONTROL SYSTEMS

Carry out preventative maintenance on an annual cycle including four three-monthly checks of functional, operational and plant controls, and two six-monthly checks of calibration and settings.

2.9 ELECTRICAL

Inspect all electrical components and switchboards, controls and wiring 3 monthly. Remove all dust, tighten joints, check for visible cable overheating.

2.10 WARRANTIES

Obtain and supply to the Architect at Practical Completion the warranties offered by the manufacturers of the equipment and accessories used in the Works.

3 OPERATING AND MAINTENANCE MANUALS

3.1 GENERAL

Within 30 days of Practical Completion hand over 3 copies of the installation manual.

Initially submit one copy for review by the mechanical engineer prior to practical completion of the project.

3.2 SPECIFICATION:

A suitable quality storage device, in the form of a USB Flash drive, with editing capability, containing all specified electronic files including index, and supplied in a protective storage case.

The protective storage case must be able to be included in the manuals and be supplied complete with printed details as follows:

Front Cover of case: Clearly print details including Project Name, Name of Consulting Engineer, Service Discipline, Name of Contractor, Name of Architect and Name of Owner.

Spine of case: Project Name and Service Discipline.

The manual shall be prepared using Adobe Acrobat (.pdf), Microsoft (MS) Word, and Excel files (or equivalent).

All drawings shall be supplied in both AutoCAD .dwg format and Adobe Acrobat (.pdf) format (or equivalent).

All digital images shall be supplied in .jpg format (or equivalent).

Files must be prepared in accordance with this specification and comply with the sub headings and required contents.

The manual shall include all necessary demonstrations and explanations of the correct sequence of operation and the function of each piece of equipment under both automatic and manual control.

Pages shall be reinforced loose leaf A4 size.

"As Installed" plans (hard copy and computer disc copy) showing the layout and location of all equipment installed.

Following the submission and approval of a draft copy, prepare three (3) copies of a reviewed manual and one (1) soft copy.

The manuals shall be written in clear concise English, printed or typed on durable printing paper with each page consecutively numbered.

Provide dividers between sections with plastic covered labelled tags.

The manual shall be professionally prepared and bound in a vinyl hard backed folder with insert sleeves on the front and spine. The front cover to include the following wording:-

- **PROPOSED COMMERCIAL DEVELOPMENT, 97 KING WILLIAM STREET, KENT TOWN**
- Mechanical Services
- Secon Consulting Engineers
- "Builders Name"

The spine to include the following wording:-

- **PROPOSED COMMERCIAL DEVELOPMENT, 97 KING WILLIAM STREET, KENT TOWN**
- Mechanical Services

The components of the manuals shall include the following:-

- Title page with telephone numbers of maintenance personnel.
- Index and sub-index for each section.
- Practical completion date
- General Description of each plant and system
- Plant operating instructions. Include setting up, starting and stopping procedures, control, alarm, test and emergency Procedures.
- Schedule of inspection and preventative maintenance and repair instructions for each individual item of equipment. Include routine and Preventative.
- Provide maintenance log sheets for each individual item of equipment – with each sheet labelled for each item of equipment. Allow sufficient space for the yearly recording of maintenance check as well as call-out and defect items – a separate sheet is required for each individual item of equipment.
- Provide electrical certificate of compliance, authorities test certificates.
- List of equipment supplier details and source of supply of replacement components.
- Schedule of technical data.
- Refrigeration commissioning and air balance test sheets.
- Electrical wiring and controls diagrams.
- Warrantees signed with defects liability period dates.
- MSDS (air conditioning refrigerant)
- Corrected "As-Installed" drawings on DWG CAD format (hard print copies and electronic copies).
- All information contained within the final manual is to be provided in soft copy form on a CD (including drawings, manufactures literature, written text, electrical CoCs, commissioning data etc)

Technical Manuals: The Manuals shall include but not be limited to the following items:-

- Condensing units

- Fan coil units
- Air filters
- Fans
- Control systems
- Condensate pumps

Manufacturer's catalogues, instructions and generally descriptive pamphlets as appropriate shall be included, both to reduce the text and to provide prime source information.

3.3 SERVICE BOOK

Arrange all service personnel whether for routine or breakdown maintenance to:-

- All service personnel must log in with the Practice Manager at the centre prior to carrying out service works.
- Provide a service log book and leave on site with the client.
- 'log in' in the log book on arrival in site
- Provide a written report in the log book describing nature of the call out, problems identified and action taken
- Have the report witnessed by the Proprietor Representative or his delegate
- 'Log off' on completion of the work

3.4 PROJECT HANDOVER & PROPRIETOR'S INSTRUCTION

Complete the testing, commissioning and balancing of all systems; provide associated data and the installation manual including all final drawings prior to handing over the installation.

Project completion will not be granted until the above requirements have all been provided.

At times to be agreed, instruct the Proprietor's operational maintenance staff in the recommended methods of operation and maintenance of the systems.

One month before Practical completion, submit for review one copy of the proposed scope of topics to be covered and schedule of dates for the Proprietors Instruction.

Include information in the front of the Maintenance Manual indicating:

- What training was provided
- Who was present at the training
- Date that the training was provided

3.5 TRAINING BUILDING MANAGEMENT STAFF

Train building management staff, provide sufficient training to ensure that building managers or staff have all the information and understanding needed to operate and maintain the commissioned features and systems. Training issues to include:

- Design intent (including energy I environmental features).
- Review of controls set up, programming, alarms and troubleshooting.
- O&M Manuals.
- Building operation (start up, normal operation, unoccupied operation, seasonal changeover, shutdown).
- Interactions with other systems, the scope for using them in parallel and how to avoid possible conflicts.
- Optimizing energy efficiency.
- OH&S issues.
- Maintenance requirements and sourcing replacements.
- Occupant satisfaction feedback.
- Controls systems including adjustments of time schedules, alarm recognition and acknowledgements.

0700S SCHEDULES – MECHANICAL SERVICES
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1 SCHEDULE OF CAPACITIES

Note: Static pressures nominated in the unit schedules are for the purposes of tendering only. Prior to ordering equipment calculate actual static pressure imposed on the equipment based on workshop drawings and obtain approval from the Architect and Engineer. Failure to comply with this will result in rectification and or replacement of the equipment at no charge to the client.

Ensure units selected are suitable for the capacities specified at maximum ambient conditions and the required refrigerant length and lift.

1.1 DESIGN BASIS

The Air Conditioning systems shall be selected to satisfy the following designed conditions.

- Indoor room temperatures:
 - . Maximum 24°C DB/50% RH
 - . Minimum 20°C DB
- Maximum outdoor air temperature 38°C DB/21°C WB.
- Minimum outdoor air temperature 0°C.
- Maximum extreme ambient outdoor air temperature at which condenser plant will keep running 50°C DB.

1.2 AIR CONDITIONING UNITS

Mechanical contractor shall check and confirm all pipe runs and ensure the equipment selected and pipe sizes are suitable for these runs. No variations will be paid for incorrect selection of equipment.

All units are to be Inverter technology.

While we list the units we have based our design on they are to be checked for accuracy and confirmed suitable, or reselected to meet the performance shown in the tables below.

VRF

GENERAL	UNIT NAME	FCU-1-01	FCU-1-02	FCU-1-03	FCU-1-04	
	Condenser No.	ACC-1-01	ACC-1-01	ACC-1-01	ACC-1-01	ACC-1-01
	Type	VRF Ducted	VRF Ducted	VRF Ducted	VRF Ducted	VRF Condenser
CAPACITY	Total Cooling (kW)	21.04	10.52	10.52	21.04	63.1
	Sensible Cooling (kW)	15.77	8.29	8.29	15.77	48.1
	Total Heating capacity (kW)	25.00	12.50	12.50	25.00	75.0
	Coil entering air DB(°C)	24.4	23.3	24.0	28.0	
	WB (°C)	17.1	16.8	17.0	18.4	
	Supply Air (l/s)	967	383 - 467 - 550	383 - 467 - 550	967	
	Outside Air (l/s)	30	30		300	
	Ext. Static Pressure (Pa)	220(380V)/260(400,415V)	150	150	220(380V)/260(400,415V)	
ELECTRICAL	Volts/Phase	240/1	240/1	240/1	240/1	415/3
	Amps (MCA)	2.03	3.19	3.19	2.03	52
FILTERS	Filter Type	100mm Panel	100mm Panel	100mm Panel	100mm Panel	
COMMENTS						Heat Recovery

GENERAL	UNIT NAME	FCU-2-01	FCU-2-02	FCU-2-03	FCU-2-04	
	Condenser No.	ACC-2-01	ACC-2-01	ACC-2-01	ACC-2-01	ACC-2-01
	Type	VRF Ducted	VRF Ducted	VRF Ducted	VRF Ducted	VRF Condenser
CAPACITY	Total Cooling (kW)	21.04	10.52	10.52	21.04	63.1
	Sensible Cooling (kW)	15.77	8.29	8.29	15.77	48.1
	Total Heating capacity (kW)	25.00	12.50	12.50	25.00	75.0
	Coil entering air DB(°C)	24.4	23.3	24.0	28.0	
	WB (°C)	17.1	16.8	17.0	18.4	
	Supply Air (l/s)	967	383 - 467 - 550	383 - 467 - 550	967	
	Outside Air (l/s)	30	30		300	
	Ext. Static Pressure (Pa)	220(380V)/260(400,415V)	150	150	220(380V)/260(400,415V)	
ELECTRICAL	Volts/Phase	240/1	240/1	240/1	240/1	415/3
	Amps (MCA)	2.03	3.19	3.19	2.03	52
FILTERS	Filter Type	100mm Panel	100mm Panel	100mm Panel	100mm Panel	
COMMENTS						Heat Recovery

GENERAL	UNIT NAME	FCU-3-01	FCU-3-02	FCU-3-03	FCU-3-04	
	Condenser No.	ACC-3-01	ACC-3-01	ACC-3-01	ACC-3-01	ACC-3-01
	Type	VRF Ducted	VRF Ducted	VRF Ducted	VRF Ducted	VRF Condenser
CAPACITY	Total Cooling (kW)	21.04	10.52	10.52	21.04	63.1
	Sensible Cooling (kW)	15.77	8.29	8.29	15.77	48.1
	Total Heating capacity (kW)	25.00	12.50	12.50	25.00	75.0
	Coil entering air DB(°C)	24.4	23.3	24.0	28.0	
	WB (°C)	17.1	16.8	17.0	18.4	
	Supply Air (l/s)	967	383 - 467 - 550	383 - 467 - 550	967	
	Outside Air (l/s)	30	30		300	
	Ext. Static Pressure (Pa)	220(380V)/260(400,415V)	150	150	220(380V)/260(400,415V)	
ELECTRICAL	Volts/Phase	240/1	240/1	240/1	240/1	415/3
	Amps (MCA)	2.03	3.19	3.19	2.03	52
FILTERS	Filter Type	100mm Panel	100mm Panel	100mm Panel	100mm Panel	
COMMENTS						Heat Recovery

Split Units

GENERAL	UNIT NAME	FCU-G-01	
	Condenser No.	ACC-G-01	ACC-G-01
	Type	VRF Ducted	VRF Condenser
CAPACITY	Total Cooling (kW)	15.08	15.08
	Sensible Cooling (kW)	11.38	11.38
	Total Heating capacity (kW)	18.00	18.00
	Coil entering air DB(°C)	23.4	
	WB (°C)	16.8	
	Supply Air (l/s)	492 - 592 - 700	
	Outside Air (l/s)	30	
	Ext. Static Pressure (Pa)	150	
ELECTRICAL	Volts/Phase	240/1	415/3
	Amps (MCA)	3.17	29.5
FILTERS	Filter Type	100mm Panel	
COMMENTS			Heat Pump

1.3 FANS

GENERAL	ITEM NAME	CPEF-01	TEF-G-01	GEF-(1-3)-01	TEF-(1-3)-01	GEF-(2-3)-02
	Type Serving	Inline Axial	Window Mounted	Inline Axial	Inline Axial	Inline Axial
CAPACITY	Capacity (l/s)	4000	100	200	100	200
	Static Pressure (Pa)	350	50	130	130	130
	Fan diameter (mm)	630	300	200	150	200
	Max Speed r/sec	24	19	46	42	46
ELECTRICAL	Volts/Phase	415/3	240/1	240/1	240/1	240/1
	Fan motor kW / amps	5.50/10.60	0.07/0.90	0.10/1.35	0.05/0.66	0.10/1.35
SOUND	Sound level dBA – spl @ 3m max	62	46	42	40	42
COMMENTS	Max Fan Motor Shaft Power to Air Flow Ratio w/(l/s) & Input Power to Air Flow Ratio w/(l/s)	To comply with section “J” of the NCC Provide VSD Control with soft Startup mode	To comply with section “J” of the NCC	To comply with section “J” of the NCC	To comply with section “J” of the NCC	To comply with section “J” of the NCC

GENERAL	ITEM NAME Type Serving	EAF-01 Inline Axial	LEF-01 Window Mounted
CAPACITY	Capacity (l/s)	870	300
	Static Pressure (Pa)	250	150
	Fan diameter (mm)	560	280
	Max Speed r/sec	15	24
ELECTRICAL	Volts/Phase	240/1	240/1
	Fan motor kW / amps	0.84/4.10	0.13/0.66
SOUND	Sound level dBA – spl @ 3m max	54	41
COMMENTS	Max Fan Motor Shaft Power to Air Flow Ratio w/(l/s) & Input Power to Air Flow Ratio w/(l/s)	To comply with section “J” of the NCC	To comply with section “J” of the NCC

1.4 COWLS

GENERAL	ITEM NAME Type	OACs, EACs and RACs Roof Cowl
CAPACITY	Capacity (l/s) Static Pressure (Pa)	15
COMMENTS	Based on Fantech	RV Series

General Note

- A. The Tenderer shall take full responsibility for final unit selections including external static pressure to achieve the specified capacities. Mechanical Services Sub-Contractor shall calculate actual system resistance based on final ductwork layouts and submit calculations for approval by Superintendent and engineer. Failure to do so will result in the ownership of full cost rectification works by the Contractor.**
- B. Tenderer is required to submit full details of equipment offered at time of tender submission.**
- C. Tenderer is required to offer equipment which conforms with the maintenance access provision for this project and in particular the following requirements:**
- D. Vertical discharge condensing units shall have front access provisions (side or rear access not acceptable unless otherwise indicated).**
- E. All units shall be fitted with a low pressure bridging timer to ensure that the unit does not drop out on low pressure on cold morning start ups.**
- F. All air conditioning units to be suitable for R410A refrigerant**
- G. All air conditioning units are to be provided with inverter or digital scroll compressor technology.**
- H. For installation within 10km of the Ocean or located in a highly corrosive atmosphere, the condensing units shall be complete with the following:**
 - a) Powder coated unit**
 - b) Powder coated condenser fans**
 - c) Stainless steel fixings**
 - d) Heresite coatings on condenser coils**

MECHANICAL SERVICES TENDER FORMS**2 SCHEDULE OF TECHNICAL DATA**

The equipment selected and scheduled shall fully comply with the Specification and Schedule of Capacities. It is the tenderers responsibility to point out where any item of equipment, etc does not comply with this specification. Failure to comply with this will result in rectification and or replacement of the equipment at no charge to the client.

2.1 AIR CONDITIONING UNITS

VRF

GENERAL	UNIT NAME	FCU-1-01	FCU-1-02	FCU-1-03	FCU-1-04	
	Condenser No.	ACC-1-01	ACC-1-01	ACC-1-01	ACC-1-01	ACC-1-01
	Type					
CAPACITY	Total Cooling (kW)					
	Sensible Cooling (kW)					
	Total Heating capacity (kW)					
	Coil entering air DB(°C)					
	WB (°C)					
	Supply Air (l/s)					
	Outside Air (l/s)					
	Ext. Static Pressure (Pa)					
ELECTRICAL	Volts/Phase					
	Amps (MCA)					
FILTERS	Filter Type					
COMMENTS						

GENERAL	UNIT NAME	FCU-2-01	FCU-2-02	FCU-2-03	FCU-2-04	
	Condenser No.	ACC-2-01	ACC-2-01	ACC-2-01	ACC-2-01	ACC-2-01
	Type					
CAPACITY	Total Cooling (kW)					
	Sensible Cooling (kW)					
	Total Heating capacity (kW)					
	Coil entering air DB(°C)					
	WB (°C)					
	Supply Air (l/s)					
	Outside Air (l/s)					
	Ext. Static Pressure (Pa)					
ELECTRICAL	Volts/Phase					
	Amps (MCA)					
FILTERS	Filter Type					
COMMENTS						

GENERAL	UNIT NAME	FCU-3-01	FCU-3-02	FCU-3-03	FCU-3-04	
	Condenser No.	ACC-3-01	ACC-3-01	ACC-3-01	ACC-3-01	ACC-3-01
	Type					
CAPACITY	Total Cooling (kW)					
	Sensible Cooling (kW)					
	Total Heating capacity (kW)					
	Coil entering air DB(°C)					
	WB (°C)					
	Supply Air (l/s)					
	Outside Air (l/s)					
	Ext. Static Pressure (Pa)					
ELECTRICAL	Volts/Phase					
	Amps (MCA)					
FILTERS	Filter Type					
COMMENTS						

Split Units

GENERAL	UNIT NAME	FCU-G-01	
	Condenser No.	ACC-G-01	ACC-G-01
	Type		
CAPACITY	Total Cooling (kW)		
	Sensible Cooling (kW)		
	Total Heating capacity (kW)		
	Coil entering air DB(°C)		
	WB (°C)		
	Supply Air (l/s)		
	Outside Air (l/s)		
	Ext. Static Pressure (Pa)		
ELECTRICAL	Volts/Phase		
	Amps (MCA)		
FILTERS	Filter Type		
COMMENTS			

2.2 FANS

GENERAL	ITEM NAME	CPEF-01	TEF-G-01	GEF-(1-3)-01	TEF-(1-3)-01	GEF-(2-3)-02
	Type Serving	Inline Axial	Window Mounted	Inline Axial	Inline Axial	Inline Axial
CAPACITY	Capacity (l/s)					
	Static Pressure (Pa)					
	Fan diameter (mm)					
	Max Speed r/sec					
ELECTRICAL	Volts/Phase					
	Fan motor kW / amps					
SOUND	Sound level dBA – spl @ 3m max					
COMMENTS	Max Fan Motor Shaft Power to Air Flow Ratio w/(l/s) & Input Power to Air Flow Ratio w/(l/s)					

GENERAL	ITEM NAME Type Serving	EAF-01 Inline Axial	LEF-01 Window Mounted
CAPACITY	Capacity (l/s)		
	Static Pressure (Pa)		
	Fan diameter (mm)		
	Max Speed r/sec		
ELECTRICAL	Volts/Phase		
	Fan motor kW / amps		
SOUND	Sound level dBA – spl @ 3m max		
COMMENTS	Max Fan Motor Shaft Power to Air Flow Ratio w/(l/s) & Input Power to Air Flow Ratio w/(l/s)		

2.3 COWLS

GENERAL	ITEM NAME Type	OACs, EACs and RACs Roof Cowl
CAPACITY	Capacity (l/s) Static Pressure (Pa)	
COMMENTS		

MECHANICAL SERVICES TENDER FORMS**3 MECHANICAL SERVICES TENDER FORMS****3.1 TENDER PRICE**

We the undersigned hereby provide our Fixed Lump Sum Tender Offer to carry out the entire works in accordance to the specification, drawings, addenda's and general conditions of contract

TENDER PRICE: \$.....

ADDENDA'S No: \$.....

GST: \$.....

TOTAL TENDER PRICE: \$.....

Amount in words:

.....
.....

COMPANY:.....

ADDRESS & CONTACT Ph:

SIGNED BY:

TITLE:

DATE:

MECHANICAL SERVICES TENDER FORMS**3.2 SUMMARY OF COSTS**

The costs indicated below make up the "Tender Price", including supply, delivery, installation, testing and warranty maintenance, overhead and profits for the various sections of the work.

Item	Fixed Lump Sum
VRF Air Conditioning Equipment	\$
Split Units	\$
Fans	\$
Filters	\$
Air Diffusers, Registers, Grilles, Flex & fittings	\$
Anti vibration control	\$
Ductwork	\$
Site labour & materials	\$
Pipework labour & materials	\$
Electrical installation	\$
Automatic Controls	\$
Shop drawings	\$
Engineering	\$
O & M manuals inc client tuition	\$
Project management	\$
Painting	\$
Hoisting & cartage	\$
Testing, Commissioning & balancing	\$
52 Weeks Preventative Maintenance & service	\$
Sundries / Misc	\$
GST where applicable	\$
TOTAL TENDER PRICE	\$

MECHANICAL SERVICES TENDER FORMS**3.3 SCHEDULE OF ALTERNATIVE OFFERS**

We advise herein the following individual adjustments to the Fixed Tender Offer indicated above for the alternative items of equipment listed below.

Alternative offers MUST be accompanied by all relevant technical data if they are to be reviewed.

Alternatives Offered**Cost Adjustment**

COMPANY:.....

ADDRESS & CONTACT Ph:

SIGNED BY:

TITLE:

DATE:

MECHANICAL SERVICES TENDER FORMS**3.4 SCHEDULE OF PERSONNEL**

The following list of personnel will be assigned to this project.

Personnel Experience	Name	Years with Company	Years In this role
Contract Manager in charge of the project	_____	_____	_____
Project Manager	_____	_____	_____
Off site foreman	_____	_____	_____
On site foreman	_____	_____	_____
Supervisor	_____	_____	_____
Drafter	_____	_____	_____

COMPANY:.....

ADDRESS & CONTACT Ph:

SIGNED BY:

TITLE:

DATE:

MECHANICAL SERVICES TENDER FORMS**3.5 SCHEDULE OF SUB CONTRACTORS**

Sub-Contract	Company
- Pipework	_____
- Ductwork	_____
- Installation – site work	_____
- Electrical	_____
- Automatic Controls	_____
- Commissioning	_____
- Maintenance & Service	_____
- Shop Drawings	_____
- O & M Manuals	_____

COMPANY:.....

ADDRESS & CONTACT Ph:

SIGNED BY:

TITLE:

DATE:

MECHANICAL SERVICES TENDER FORMS**3.6 SCHEDULE OF MISCELLANEOUS MANUFACTURERS AND MATERIALS**

The following list of manufacturers and materials have been included in the tender offer and fully meet the specified requirements.

Equipment	Manufacturer
- Filters	_____
- Air Diffusers & Grilles	_____
- Controls	_____
- Ductwork	_____
- Air Conditioning Units	_____
- Pipework Insulation	_____
- Fans	_____

COMPANY:.....

ADDRESS & CONTACT Ph:

SIGNED BY:

TITLE:

DATE:

MECHANICAL SERVICES TENDER FORMS**3.7 EQUIPMENT ACCOMMODATION**

The tenderer shall ensure that equipment, fittings and materials offered in the tender can be accommodated in the space allocated on the drawings and can be readily accessible for maintenance. Itemise any items that cannot be accommodated.

.....

.....

.....

.....

MECHANICAL SERVICES TENDER FORMS**3.8 EQUIPMENT CONFORMITY**

The tenderer shall itemise all points where tendered items depart from the specification. Any point not itemised will be deemed to have been tendered in strict conformance to the specification.

.....

.....

.....

.....

COMPANY:

ADDRESS & CONTACT Ph:

SIGNED BY:

TITLE:

DATE:

MECHANICAL SERVICES TENDER FORMS**3.9 SCHEDULE OF RATES**

Provide a comprehensive schedule of rates as listed below

Air Distribution Systems:-

Unit rates include supply and installation of ductwork per meter run and shall exclude GST.

Duct Size mm	Plain Straight Lengths	Acoustically Insulated 50mm Straight Lengths
450 x 200	\$	\$
450 x 400	\$	\$
600 x 400	\$	\$
Duct Size mm	Plain Radius Bend	Acoustically Insulated 50mm Radius Bend
450 x 200	\$	\$
450 x 400	\$	\$
600 x 400	\$	\$
1000 x 600	\$	\$
Duct Size mm	Plain Transition	Acoustically Insulated 50mm Transition
450x400 to 450x200	\$	\$
450x400 to 350x200	\$	\$
600x400 to 400x400	\$	\$

SCHEDULE OF RATES**Air Distribution Systems (cont.):-**

Duct Size mm	Flexible 50mm Insulated	Flexible 50mm Insulated	
200 diam.	\$	400 diam.	\$
250 diam.	\$	450 diam.	\$
300 diam.	\$	500 diam.	\$
350 diam.	\$		

Supply and installation of a 600mm x 600mm face / 450mm x 450mm neck louvre face diffuser complete with cushion head, 3000mm of 350mm diameter flexible ductwork, 90° branch take-off and blade damper, excluding GST.

\$ _____

Piping Systems:-

Unit rates including the supply, installation and insulation (where applicable) of straight lengths of pipework per meter run, excluding GST

Pipe Dia mm	Copper Type 'B' Plain	Copper Type 'B' Insulated 25mm	PVC
15 diam.	\$	\$	\$
20 diam.	\$	\$	\$
25 diam.	\$	\$	\$
50 diam.	\$	\$	\$
75 diam.	\$	\$	\$
100 diam.	\$	\$	\$
150 diam.	\$	\$	\$
200 diam.	\$	\$	\$

SCHEDULE OF RATES**Labour and Mark-Up**

Labour rates applicable to the contract and include all on-costs, loading, allowances, overhead recovery and profits, excluding GST.

	Normal Time	Time & Half	Double Time
Sheetmetal Worker – Factory	\$	\$	\$
Sheetmetal Worker – Installation	\$	\$	\$
Electrician – Site	\$	\$	\$
Refrig mechanic – installation	\$	\$	\$
Pipe Fitter – Site	\$	\$	\$
Foreman / Leading Hand – Site	\$	\$	\$
Commissioning Technician – Site	\$	\$	\$
Project Manager – Site / Office	\$	\$	\$
CAD Draftsperson – Site / Office	\$	\$	\$
Maintenance / Service Technician	\$	\$	\$

Mark-up to be applied on the total costs to purchase goods and materials:- %

Mark-up to be applied on the total costs of sub-contractors:- %