

APARTMENT DEVELOPMENT

11-13 WEST STREET, HINDMARSH SA

Project No: LCE13404

Mechanical Services Specification

Tender Issue

Revision T2

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1 GENERAL

1.1 CROSS REFERENCES

All work covered within this specification shall be read in conjunction with the following trade packages and contracts. Should any discrepancy occur between the references the larger/greater shall be assumed and referred to the Engineer prior to proceeding with any works.

- Head Contractors Preliminaries and General Contract Conditions
- Architectural Documentation
- Electrical, Hydraulic, Fire and Vertical Transportation Services Documentation
- Structural and Civil Documentation

The above documents shall be made available on request through the head contractor.

1.2 PROJECT DETAILS

The works described within this specification pertain to the Mechanical Services installation at 11-13 West Street, Hindmarsh.

The contractor should note the specific requirement for connection of services off the adjacent site located at 17 West Street. All access is to be arranged in conjunction with the builder and strata manager for the property.

The works involve the provision of air conditioning and ventilation systems to the 11 apartments.

Air conditioning systems shall comprise multi-head type systems to Levels 01, 02 and 03, complete with a wall mounted air conditioning system(s) within each apartment. Associated air cooled condensing units are to be located at the roof level.

Ventilation systems shall comprise of in-line exhaust fans to each bathroom and laundry area. Kitchens shall be equipped with ducted rangehoods, with discharge ducted to the building façade on level 1 and 2, and via the roof on level 03, hood by others.

Ventilation systems shall be provided at ground level to the bin storage and car park complete with an exhaust discharging at roof level and a duct mounted exhaust fan. Ventilation to the shaft via weatherproof louvres shall also be provided.

1.3 DEFINITION OF TERMS

- | | |
|-----------------|--|
| Proprietor | - Client or end user of the proposed building |
| Head Contractor | - Building Contractor appointed to carry out the construction of the building. Mechanical Contractor shall enter contract to undertake the Mechanical Services installation with the successful Head Contractor. |
| Contractor | - Installer undertaking the works. |

Works	- As described within this specification
Provide	- Supply, install, commission and place into service
Equal Approved	- Alternative product/method of installation which is presented to the consulting engineer and written approval is received.
Local Power Authority	- SA Power Networks
Local Gas Authority	- Envestra (APA Group)
Local Water Authority	- SA Water Corporation
Local Fire Authority	- South Australian Metropolitan Fire Services (SAMFS)

1.4 DRAWINGS

Drawings associated with and forming part of this specification are scheduled below:

Drawing No.	Drawing Title
LCE13404-M00	General Notes, Drawing Index, Legend of Symbols and Locality Plan
LCE13404-M01	Ground and First Floor Mechanical Services Arrangement
LCE13404-M02	Second and Third Floor Mechanical Services Arrangement
LCE13404-M03	Roof Level Mechanical Services Arrangement and Typical Details

The arrangements and details indicated on the above drawings are approximate only. Check all dimensions and building details prior to commencement of the work.

1.5 SCOPE

General Requirements

The work covered by this specification includes the following:

- The supply, installation, testing, commissioning, maintenance, service and warranty and all sundry and material items, whether mentioned in detail or not, required to complete the installation and place into working order.
- The planning, scheduling, procurement of components and installation to meet the programme, coordination and liaison with the head contractor and other trade packages.
- Full responsibility for the execution of the complete installation in accordance with the specification and drawings.
- The provision of a Mechanical Services installation that satisfies all statutory legislative, local authority, code requirements and satisfies the general details herein.
- Compliance with all relevant Occupational Health, Safety and Welfare legislation and best practice including any site specific requirements or regulations such as attendance at site inductions and adherence to the procedures covered in such inductions.

Description of the Installation

The following systems and services shall be included:

- The provision of eleven (11x) air cooled, reverse cycle, multi-head type systems, complete with wall mounted type indoor unit(s) to serve each residential apartment. Associated air cooled condensing units located at roof level.
- Ventilation systems to serve each residential apartment including header box type exhaust air fan within each bathroom and laundry enclosure.
- Provision of exhaust air ductwork from the kitchen range hoods to an exhaust air grille within the façade or to roof discharge cowl on roof. Rangehood by others, however final connection of ductwork to rangehood by Mechanical Services.
- Provision of exhaust system to serve the ground level bin storage comprising exhaust air grilles, ductwork, roof cowl and exhaust fan.
- Provision of exhaust system to serve the ground level carpark complete with grilles, ductwork, cowl and in-line fan complete with VSD, controlled via CO2 monitoring.
- Ventilation to lift shaft, via provision of weatherproof louvre within lift overrun.
- Air distribution systems associated with the above systems.
- Refrigeration and condensate piping systems associated with the above systems, inclusive of common condensate stacks required to serve multiple apartment levels, with discharge in basement.
- Electrical installation associated with the above systems.
- Automatic controls associated with the above systems.
- Vibration isolation and noise control associated with the above systems.
- Provision of overflashing to roof penetrations and flashing angles to wall penetrations.
- All hoisting and scaffolding required for the installation of the above systems.
- Painting, identification and labelling of equipment, and air distribution systems.
- Testing and commissioning of the above systems. Make allowance for qualified commissioning technicians to undertake commissioning and supply results in accordance with this specification. Make due allowance for additional time to complete a full witness with the consultant prior to practical completion.
- Maintenance and servicing, defects liability and warranty for 12 months from date of practical completion.
- Three (3) copies of approved Operation and Maintenance Manual including hard copies of work-as-executed drawings and electronic Auto Cad Version 2012 (or later) copies on CD.

Variations to the Scope

Instructions may be issued throughout the project which may alter the scope of works. Any aspects of any such works which are not specifically mentioned in any instruction are to comply with this specification.

Any claims for any additional costs or credits for any such variations must be submitted with a complete breakdown of costs including quantities and rates for all labour, materials and equipment. Variation Claims submitted without breakdowns will be rejected.

Substitutions to the Scope

Where a substitution to the specification is proposed, the contractor shall submit each substitution, incorporating technical details and a cost breakdown, to the head contractor. The substitution shall be reviewed by the consulting engineer and the client for consideration. Unless approved by the consulting engineer and the client, the substitution will not be acceptable as an equal or approved approach to the specification.

1.6 ASSOCIATED WORKS

The following works related to the Mechanical Services installation shall be carried out under other trade packages at the direction of the head contractor unless otherwise indicated.

Coordinate all cable locations, runs / routes, terminal strip locations and ensure that information is provided to other trades to facilitate cabling and termination.

Electrical Services

- Electrical power supply incorporating weatherproof switched isolators mounted to upstands at roof level adjacent to each air cooled condensing unit (final termination by Mechanical Services). Power to be fed from respective apartment load centre.
- Electrical power supply incorporating switched isolators at ground level adjacent to each duct mounted exhaust air fan (final termination by Mechanical Services).
- Electrical power supply incorporating a switched socket outlet in the ceiling space, switched for connection to bathroom and laundry exhaust fans (final termination by Mechanical Services). Switched socket outlet to be controlled via separate switch on combined lighting/fan control switch plate provided by electrical services trade.

Hydraulic Services

- Provision of tundishes for receipt of discharge from plant and condensate drains.

Building Related Trades

- Provision of domestic type rangehoods within apartment kitchens.
- Provision of drainage sumps at Ground Level for collection of common condensate dropper pipework.
- All associated building works. The Mechanical Services trade shall set-out locations of all associated building works.

- Provision of formed penetrations to roof, walls and ceilings for the passage of mechanical equipment. Mechanical Services trade to provide dimensioned shop drawings for the penetrations required. Roof penetrations shall be formed with upstands.
- Construction of roof plant deck and roof access walkway to support mechanical services roof mounted equipment.
- Mechanical contractor to produce a coordinated dimensioned shop drawing with all formed slab penetrations relevant to the Mechanical, Refrigeration, Electrical, Hydraulic and Fire Service Trades for submission to the Head Contractor. Coordinate all Head Contractors work and penetrations and accept responsibility for the accuracy of the consolidated drawings.
- Under cuts to doors and door grilles will be the responsibility of the Door Contractor with the size to be nominated by the mechanical trade contractor.

1.7 STANDARDS

Comply in all respects with the requirements of the following codes and regulations applicable to the works:

- Building Code of Australia
- Local Power, Water & Gas Authority Regulations
- Occupational Health, Welfare and Safety Regulations
- Local and State Government Acts governing the works
- SA 76 – Ministers Specification – testing and maintenance of essential safety provisions

Comply in all respects with the requirements of the following Australian Standards applicable to the works (most recent revision unless previous revision is referenced in the current BCA):

AS 1055	Acoustics – Description and Measurement for environmental noise
AS 1132	Methods of tests for air filters for use in air conditioning and general ventilation
AS 1170.4	SAA Loading Code – Earthquake
AS 1259	Acoustics – sound level meters
AS 1345	Identification of the contents of piping, conduits and ducts
AS 1359 Part 51	Noise level limits rotating electrical machines general requirements
AS 1432	Copper tubes for plumbing, gas fitting and drainage applications
AS 1530	Methods of fire tests on building materials, components and structures

AS 1571	Copper seamless tubes for air conditioning and refrigeration
AS 1668 Part 1, 2 and 3	The use of mechanical ventilation and air conditioning in buildings
AS 1677	Refrigeration systems
AS 1851	Maintenance of Fire Protection Equipment
AS 1894	The storage and handling of non-cryogenic and refrigerated liquids
AS 2625	Mechanical Vibration
AS 2670	Vibration
AS 2700	Colour standards for general purposes
AS 3000	SAA Wiring Rules
AS 3666	Air handling and water systems of buildings – microbial control
AS 4041	Pressure piping
AS 4254	Ductwork for air handling systems in buildings

2 CONTRACT SUBMISSIONS

The contractor shall prepare and submit the items in each section identified below to the consulting engineer for approval.

2.1 TENDER SUBMISSIONS

The submissions required at Tender shall incorporate, as a minimum, all information defined within the Appendices of this Specification. Any appendices not completely filled out will be rejected.

Tenderers are required to submit full manufacturer's selection details of equipment offered at time of tender submission for approval, incorporating the following as a minimum:

- Electrical full load amps, voltage and phase data
- Performance data relevant to the equipment specification clause
- Acoustic data measured in Sound Power as per the equipment specification clause
- Size and weight information including maintenance clearance

Identical equipment to that approved by the consulting engineer must be installed on site. Equipment will only be considered "equal approved" if it has been approved by the consulting engineer. Approval of equipment does not override the requirement to comply with the requirements of the specification.

Select manufacturers with local representation, technical support and expertise, proven local long-term performance and readily-available spare parts.

2.2 PRE-CONSTRUCTION SUBMISSIONS

2.2.1 TRADE DOCUMENTATION AND INSTALLATION COORDINATION

The Mechanical Services Contractor shall take the lead role in the shop drawings process. Produce a combined services (Mechanical, Electrical, Communications, Hydraulic and Fire Services as a minimum) set of working drawings outlining the trade coordination and builder's work drawings for all formed structural penetrations (roof, floor, walls, etc.).

The drawings shall be submitted to the Managing/Head Contractor, prior to concrete placement or equipment order/manufacture/installation onsite.

All building services related trades shall submit workshop drawings to the Mechanical contractor to develop the fully coordinated workshop and Head Contractor's work drawings. The Mechanical contractor will be responsible for providing the appropriate deadlines to each trade for their submission of drawings to the mechanical contractor.

Obtain all available up-to-date CAD drawings from all other trades and overlay to ensure that all services are fully coordinated.

All trades shall make the necessary arrangements with all services trades and the head contractor to undertake coordination sessions and changes to their respective documents to accommodate the coordination set of drawings.

The final coordinated set of drawings shall be submitted to the consulting engineers and architects (base building and fit-out) for review and approval before proceeding with any manufacture of equipment/materials and installation.

2.2.2 WORKSHOP DRAWINGS

Prepare and submit for approval before commencing manufacture or installation, 1 copy of shop drawings from which the contract works shall be built. Further copies shall be required upon review of the preliminary issue of workshop drawings.

Shop drawings shall all be on the same size drawings sheets and shall be of a scale not less than 1:100 and larger where necessary.

AutoCAD version 2012 files in DWG format of the tender drawings are available from Lucid Consulting Engineers at nil cost via the Head Contractor (one single coordinated electronic transfer to the Head Contractor).

Shop drawings shall cover the following parts of the work.

- All wall, ceiling and roof penetrations, location of ceiling access panels including full dimensions.
- Plant, ductwork and pipework layouts including manufacturer's equipment details.
- Major equipment support details including details of loads imposed on the building structure.
- Reflected ceiling plans showing all air outlets, lights, fire detectors and sprinklers.
- Location of other building engineering services for coordination purposes.

Examination of shop drawings shall not remove from the Contractor the responsibility for the correctness of the dimensions on such drawings nor compliance with Statutory Regulations or the requirements of the tender documentation.

The Mechanical Services Contractor shall co-ordinate with all other trades to ensure non-clashing of services. Obtain all available up-to-date CAD drawings from all other trades and overlay to ensure that all services are fully coordinated.

The Mechanical Services Contractor shall take the lead role in the shop drawings process and produce a combined services formed slab and pre-cast wall penetration drawing for review and use by the concrete trade contractor.

Submit shop drawings with due account for the construction programme. Allow for 5 working days for the return of such drawings. Complete shop drawings, ordering of equipment and accept responsibility for dimensions and configuration of equipment ordered to suit the spatial restrictions of the project.

2.2.3 CALCULATIONS

Submit the following engineering calculations based on the equipment as shown on the workshop drawings:

- Airside Static Calculations

All the above information shall be submitted for review prior to any order being placed on equipment.

2.3 CONSTRUCTION SUBMISSIONS

2.3.1 OPERATING AND MAINTENANCE INSTRUCTIONS

General

The Contractor shall instruct the Proprietor's representative in the correct practice, routine adjustment and maintenance of the installation before it has reached practical completion.

Instructions shall continue as required during the period of operation preceding the date of issue of the Certificate of Practical Completion during which time the Contractor shall be responsible for operation supervision and correcting faults.

Operating and Maintenance Manuals

Within 30 days of reaching Practical Completion hand over three (3) copies of an Installation Manual.

Initially one (1) copy shall be prepared and submitted to the Consulting Engineer for approval. Make due allowance to courier manuals to and from the consulting engineers office for all required reviews (all draft and final reviews).

The manuals shall contain the following as a minimum:

- Index
- General Description of Plant and systems
- Plant Operation Instructions which provides a description of all control strategies and functions, with instructions for starting, stopping re-setting and adjusting controls.
- Schedule of Technical Data
- List of Equipment Suppliers
- Equipment Suppliers Literature
- Routine and Preventative Maintenance Instructions
- 'As-Installed' Drawings (Mechanical, Head Contractor's Works and Electrical Switchboard and Wiring Diagrams)
- Copy of completed training record (refer Appendix D)
- USB with the full PDF copy of Operating and Maintenance manual (including CAD 'As-Installed' drawings)

The manual shall be professionally prepared and bound in a vinyl hard-back folder with insert sleeves on the front to an approved format.

In addition, the project title and "Mechanical Services" shall be inserted vertically along the spine insert sleeve of the folder.

Operating Instruction Summary

Provide a brief summary of plant operating instructions including project specific features and control procedures on a single laminated card to be handed to the client's representative. Submit a draft of the Operating Instruction summary with the Installation Manual.

Apartment Owner Information

In addition to the Installation Manual provided for the builder owner and/or facilities management, provide an abbreviated Information Manual for each apartment owner.

Initially one copy shall be prepared and submitted to the Consulting Engineer for approval.

The Apartment Owner Information Manual shall contain the following documents:

- General Description of Plant and systems
- Original copy of the Manufacturer's Literature
- Maintenance Instructions (Routine and Preventative)
- List of Equipment Suppliers

The manual shall be professionally prepared and bound in a vinyl hard-back folder with insert sleeves on the front to an approved format.

2.3.2 USER TRAINING

Carry out training on systems as nominated within this specification with user groups and other parties as nominated by the Superintendent. Provide a program for user training for approval by the Superintendent and Building Services Consulting Engineer.

The contractor shall confirm instruction of Proprietor's representative by completing training record (refer Appendix D) and incorporating into Operating and Maintenance manual.

2.3.3 WORK-AS-EXECUTED DRAWINGS

Before the date of practical completion "as-installed" drawings shall be provided with the installation manuals. These drawings are to be prepared on AutoCAD computer aided drafting system version 2012 or later. Hard copies of the work-as-executed drawings along with copies of the AutoCAD Drawings are to be included on CD within the Operation and Maintenance Instructions. The work-as-executed drawings must indicate the full installation within the area of the works as it exists at the completion of the project including any design modifications which occurred during the project and any existing equipment.

3 MATERIALS & WORKMANSHIP

3.1 UNIFORMITY AND QUALITY

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

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

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

Support all equipment including pipework, cabling and the like, independently of other services and/or non-structural building elements in accordance with Section 9, Noise and Vibration.

3.2 WARRANTIES

Warranties shall extend for a minimum of 12 months.

All equipment and workmanship to be provided with a warranty.

Warranty to commence at date of practical completion, not the date of installation.

3.3 INSTALLATION COORDINATION

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

General

The positions of equipment shown on Drawings accompanying the Specification are for Tender purposes and are diagrammatic only. Check on site for positions and obtain approval and verification of all locations with the Principal and mounting heights prior to first fixing.

When any relocating is required to conform to the above, undertake such relocation without additional costs to the Principal. Allow relocation of accessories and equipment a distance of 3m before and during first fix without variation to the contract.

Verify locations of all equipment, including automatic controls to ensure:-

- Co-ordination with final furniture arrangements and interior design;
- Co-ordination with other trades construction workshop drawings;
- The work of any other trade does not interfere with the mechanical installation;
- Equipment is not obstructed by door swings and tracks, furniture or equipment;
- Conformity with any pattern formed by ceilings, panels, tiles, beams and the like;

- Full compliance with relevant Authorities and Australian Standards.

Anomalies

Promptly report any anomalies, for consideration and instructions. Work proceeding without obtaining approval, and subsequently rejected by the Superintendent shall be made good at nil additional expense to the Principal.

Co-ordination

Ensure all equipment has been coordinated with other trades and reviewed by the consulting engineer and architect before placing orders and before commencement of the relevant trade construction workshop drawings.

3.4 PENETRATIONS

Provide treatment to the penetrations as follows. Refer to architectural drawings for indication of all fire walls, floors ceilings, and the like, for allowance required to fire rated penetrations throughout.

Penetrating Fire Rated Barriers (Ductwork, Pipework, Cabling)

Contractor shall ensure all penetrations are maintained in accordance with AS4072.1 and AS1530.4 to maintain the integrity of the building fabric.

Provide fire rated penetration to ductwork, pipework and cabling in compliance with manufacturer (Promat or equal approved) recommendations, where systems are installed within fire rated, floors, walls or ceilings. Obtain approval from fire protection system manufacturer for correct installation procedures to maintain integrity of wall. Maintain vapour seal to pipework and ductwork insulation in accordance with the applicable sections of this specification. Pipework and cabling penetrations shall incorporate collars or the like in accordance with the manufacturers requirements. Ductwork shall incorporate fire dampers, complete with an inspection duct access panels on the upstream side of the damper. Seal around the penetration with an approved sealant, to finish the fire rating. Extent of filler (depth) or type of fire collar shall be appropriate to maintain the integrity of the fire barrier. It shall be mandatory the contractor obtain certification from manufacturer for the installation on completion. Refer to treatment of penetrations in this section for further details.

Obtain approval from the manufacturer and certification for the installation on completion

Major External Penetrations

Install weatherproof overflashings to upstand and complete with appropriate silicone sealant to prevent water ingress through penetration. Provide trimmer beams or other reinforcement necessary to support equipment, ducts, pipes, electrical and controls conduits and flues passing through the penetration.

On completion the Mechanical Services Contractor shall test all penetrations for leaks to the satisfaction of the Architect.

Minor External Penetrations

Utilise "Dektite" or "Roofite" seal or equal approved and silicon sealant. Utilise a single seal for each pipe / conduit where not concealed under flashings. Utilise a multiple seal where seal is protected under sheetmetal flashing, not exceeding three (3) services through the Seal. Appropriately size all seals, silicone around the top of each seal and install clamps.

On completion the Mechanical Services Contractor shall test all penetrations for leaks to the satisfaction of the Architect.

Exposed Penetrations

In addition to the above, flash pipework and ductwork penetrations where exposed to view with sheet metal escutcheon plates. Paint sheet metal to the architects approved colour

Protection of Penetrations

All floor and wall penetrations shall be protected to ensure no personnel can fall through the penetration at all times.

Temporarily seal all ductwork penetrations with sheet metal blanking plates.

Temporarily seal open ends of pipes with fitted covers of pressed steel or UPVC. Rags, paper or wood plugs are not acceptable.

3.5 CONCEALED SERVICES

Conceal all services in areas other than plant or utility areas. Install services as follows:

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

Single leaf brickwork, concrete – surface mounted conduit or "mini-duct" and seek approval prior to installation.

Do not chase walls or floors without prior approval from structural engineer.

3.6 DISSIMILAR METALS

Provide complete material separation between components of dissimilar metal as follows:

Pipework

Where clips, brackets, supports or the like are of dissimilar metal to the associated pipework, completely insulate the piping at all fixing points with at least four layers of 50mm wide black polyethylene tape wrapped around the pipe prior to fixing in position.

Roofing & Structure

Where brackets, stands, supports or the like for equipment or ductwork are of dissimilar metal to the supporting roof sheet or structure, provide complete separation with waffle pad or approved equal. Waffle pad shall extend no less than 25 mm outside the area of contact in all directions.

3.7 IDENTIFICATION

Designation labels

Provide engraved traffolyte labels with equipment designation (e.g. FCU 1-2, ACC 1-2, etc.) to the following items:

- Air-conditioning and ventilation equipment

For outdoor use, utilise UV rated traffolyte.

Round or bevel the edges of labels exceeding 1.5 mm thickness.

Fix each label by not less than two chrome plated screws. Where adjacent to terminations, locate the label so that the installed wiring does not mask the label.

Isolating Switches

Provide colour coded IPA studs to all isolating switches and power outlets. Studs shall not affect the integrity of the isolating switch.

Pipework & Fittings

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

Use the following identification:

Service	Code
Refrigerant	Refrigerant

Provide identification tags to all critical valves within the plant room, indicating the 'normally open', normally closed' and the like.

4 EQUIPMENT

4.1 EQUIPMENT PERFORMANCE

General

The Contractor shall be responsible for complying fully with this Specification and for ensuring that good trade practice is observed and that all work is completed in a tradesman-like manner.

In particular, the capacities and outputs of the various items of installed equipment shall be not less than those specified and the Contractor shall balance air quantities and make all necessary adjustments to the plant to satisfy the Consulting Engineer that the installation meets the requirements of this Specification.

Use equipment which operates within the required noise and vibration limits. Prevent the transmission of vibration from rotating or reciprocating equipment to other building elements using static and dynamic balancing, and anti-vibration mounting supports and hangers.

Select equipment to suit the equipment arrangements, configurations and spatial restrictions as indicated on the drawings such as refrigerant pipe runs and routes, flue configurations, horizontal (side) or vertical (top) discharge arrangements for air conditioning and the like.

Select equipment to comply with the Building Code of Australia – Section J (Energy Provisions), MEPS rating scheme and Australian Standard 1359.5 (Motor Efficiency).

Equipment Compliance

The Contractor shall be fully responsible for providing plant complying with all items in the following specification clauses and achieve the all performance specified below. The Contractor shall guarantee the performance of all the systems installed under this contract.

Continuous Operation

All plant selected and installed shall be capable of continuous reliable operation within the following extremes:

Maximum Temperature:	46.0°C dry bulb/28.0°C wet bulb Full Solar Load
Minimum Temperature:	0.0°C dry bulb
Electricity Supply:	415 V, +4%, -8%, 50 Hz + 1 Hz three phase earthed neutral generally in accordance with local power authority rules and conditions of supply. Voltage drop within the air conditioning installation shall not exceed 3%.

Minimum Performance Requirements

Air conditioning system capacities have been calculated to achieve the minimum performance requirement specified below:

External Ambient conditions

- Summer: Design day of maximum external ambient temperature
38.0°C dry bulb/21.0°C wet bulb
Full Solar Load
- Winter: Ambient temperature 5.0 degrees C dry bulb

Internal conditions

- Summer: Maximum 23.5°C dry bulb/50% RH.
- Winter: Minimum 21.0°C dry bulb.
- Note: Conditions can only be guaranteed to be maintained when all doors and windows are closed

4.2 AIR CONDITIONING UNITS - AIR COOLED

Supply and install air cooled reverse cycle air conditioning units complying with the following performance and construction criteria.

General

- Factory assembled and tested of Fujitsu, Mitsubishi or Daikin Manufacture or equal approved equivalent.
- Incorporate compressor capacity control through inverter.
- Systems capable of achieving refrigerant piping length and level difference as indicated on the drawings (without necessity for oil traps).
- Connect and run all refrigerant pipes and electrical wiring to present a neat and workmanlike appearance.

Outdoor Unit

Compressors:

- Hermetic type operating on Refrigerant 410a.
- Scroll compressors (DC) complete with internal discharge muffler.
- Supported on casing base by neoprene double deflection or spring type vibration isolation mounts.
- Motors suitable for direct on line starting or incorporating soft starters.
- Thermal overload incorporating thermostats located directly in the motor windings connected to automatic re-set lout out relays.

- Compressors, safety controls and electrical components shall be housed in an insulated serviceable compartment with access panel separated from condenser airflow.

Condenser Air Fans:

- Propeller direct drive type.
- Condenser air discharge orientation as shown on the drawings.
- Guard mesh to fan discharges.
- Fan motor drive totally enclosed fan cooled type, rated to IP54 (minimum).
- Electric motors in accordance with minimum efficiency rating, contained in this section shall be high temperature with Class F insulation and of TEFC construction.

Coils and refrigerant circuits:

- Direct expansion aluminium fin copper tube type.
- Corrosion protection to condenser coils incorporating epoxy coating or passivated treatment.
- Rifled bore type with capillaries arranged to ensure even distribution of liquid refrigerant.
- Maximum face velocity 2.75 m/s evaporator coils and maximum fin spacing 514 fins/m.
- Electronic or thermostatic type expansion valves.
- Incorporate filter/drier to each compressor.
- Incorporate additional refrigeration charge to system where the pipework lengths to the air conditioning system exceed the maximum allowable length for the refrigeration change provided as standard.

Electrical:

- Incorporate crankcase heaters served by separately fused sub-circuits.
- Main power entering shall be protected by HRC fuses and HRC fuses shall also protect the control circuit primary and secondary.
- All packaged electrical and safety controls to be factory fitted and tested. Operating controls on each compressor / circuit / motor including shall include the following as a minimum:
 - Start delay timers
 - Low refrigerant head pressure switch
 - High refrigerant head pressure switch
 - Current overload
 - Thermal overload
 - HP Control
 - Compressor motor temps auto-reset
 - Compressor current overload, auto-reset

- Supply fan overload, auto-reset
 - Outdoor fan overload, auto-reset
 - Automatic defrost operation
 - Control fuse
 - Sump heater
 - Start delay timers on all compressor circuit
- Incorporating automatic defrost operation utilising hot gas, and ensure that supply air fan is disabled to prevent over cooling of the space.
- Incorporate crankcase heaters served by separately fused sub-circuits.
- The electrical panel incorporated in the outdoor unit shall be fully internally wired and housed within weatherproof area and must conform to relative Australian Standards and relevant state electrical authorities.
- Incorporate independent lock out of each refrigeration circuit.
- Mount all electrical components within a separate segregated weatherproof compartment.
- Label all components.
- Provide wiring diagram, complete with protective finish and schedule of fan and compressor motor over load settings, fixed permanently within the electrical compartment.

Indoor Units

General:

- Indoor evaporator unit configuration shall be of wall mounted type as scheduled below.
- All wall mounted type indoor units shall be of maximum height 300mm.
- Incorporate multiple indoor units to outdoor units where scheduled below.

Casing:

- Complete with airtight, gasketed access panels to facilitate access to all major components.
- Internally insulated casing with aluminium foil faced closed cell foam insulation glued to all internal surfaces, with insulation manufactured and composed without the use of ozone depleting substances.
- Incorporate corrosion resistant, 1 piece drip tray under the coil sections with 20mm drain connection.
- Fabricate all brackets and bracing from galvanised steel and affix using stainless steel screws.

- Where fan coil units are installed in ceiling spaces incorporate an additional galvanised steel 1 piece drip tray complete with drain connection to the underside of each unit.

Fans - supply air:

- Centrifugal type to suit unit configuration incorporating lubricated and sealed for life, self-aligning ball type bearings.
- Motor power capacity sufficient to supply 110% of design air quantity against the corresponding increase in system resistance with the air filters operating at half of their dust holding capacity.
- Direct drive with multiple (minimum 3) fan speed settings adjustable via dip switch or wiring tapping.
- Fan motor drive totally enclosed fan cooled type, rated to IP54 (minimum), in accordance with minimum efficiency rating.
- Statically and dynamically balanced.
- Maximum fan discharge velocity 8 m/s.

Electrical/Controls:

- Wire each fan coil unit from the respective condensing unit and incorporate an isolating switch on the fan coil unit.
- Mount all electrical components within a separate segregated compartment.
- Label all components.
- Provide wiring diagram, complete with protective finish and schedule of fan and compressor motor over load settings, fixed permanently within the electrical compartment.
- All electrical cables shall be crimp pin terminated and all wiring shall be independently colour coded. The unit shall incorporate an independent earth bar which shall earth all electrical components.
- Overloads, relays and contactors shall be installed for each motor circuit. The wiring throughout the unit shall be 2.5mm square power and 1.00mm square control run through PVC cable duct throughout the unit.
- Indoor units shall be complete with dew proof heater, air sweep function, auto restart after power failure, heating mode indoor fan auto speed control and compressor restart time delay.
- Each unit shall be provided with the following minimum control functions:
 - OFF/ON control function.
 - Auto Swing louvre with shut-off function.
 - Automatic heat/cool changeover or manual selection.
 - Automatic or manual fan speed modulation.
 - Self-diagnosing facility

- Seven day programmable time clock.
- Provide wiring diagram, complete with protective finish and schedule of fan and compressor motor over load settings, fixed permanently within the electrical compartment.

Performance Criteria - Refer to Appendix

Notes

- Tenderers are required to submit full manufacturer's selection details of equipment offered at time of tender submission.
- Minimum unit capacities specified above shall take into account the system refrigeration pipe length and fan motor gains de-rating factors to obtain required cooling capacity.
- Design and select refrigeration systems and condensers such that the air conditioning units continue to operate satisfactorily at ambient conditions 5°C above and 5°C below the condenser coil air on cooling and heating conditions, respectively, without exceeding the manufacturer's recommended safety control limits

4.3 FANS

General

Select fans which have quiet operation and maximum static efficiency and which deliver the required air quantity against the resistance of the systems installed.

- Statically and dynamically balance rotating parts after assembly at the manufacturer's works.
- Fan selection, blade pitch angle and motor kW shall include sufficient allowance adjustment for a 10% increase in design air quantity against the corresponding system pressure increase.
- Motors shall be squirrel-cage, induction type and suitable for continuous running in ambient temperatures of up to and including 60°C and shall be complete with ball or roller bearings lubricated and sealed for life.
- Determination of the fan sound power shall be in accordance with British Standard 848 (1966) "Methods of Testing Fans: Part 2 Fan Noise Testing".
- Provision of Internal Thermal Protection. Provide resets where applicable for fans in accordance with AS/NZS60335-2-80:2004
- Isolate rotating parts from the unit casings with proprietary resilient mountings.
- Refer to performance schedule for additional sensors and speed controllers to control fans.
- Miscellaneous Fans such as bathroom exhaust fans, domestic rangehoods, ceiling mounted fans, require backdraft dampers in compliance with the Building Code of Australia, Part J3.5.

In-Line Axial

- Provide factory assembled and tested in quantity production fans, similar to Fantech AP series or approved equal.
- Shall be arranged with the motor and impeller mounted in a flanged hot dipped galvanised steel casing, complete with GRP impeller blades, suitable for duct connection.
- Fan shall be complete with drive, motor, mounting feet, vibration isolators, and where required matching flanges and wire guards.
- The impeller shall be directly connected to the motor shaft and shall have a number of variable pitch blades of aerofoil section.
- The impeller design shall have a non-overloading characteristic, the peak power input occurring within the range of the motor.
- Provision of external terminal box.
- The casing shall be provided with an access panel for motor inspection and lubrication.

Header Box Fans

- Provide factory assembled and tested in quantity production fans, similar to Fantech Response series or approved equal.
- Incorporate a proprietary plastic injection moulded louvre-faced type grille for the fan fascia.
- Complete with integral backdraft damper.
- Incorporate proprietary potentiometer speed-controllers.
- Access to speed controller shall be via removable grille.

Performance Criteria - Refer to Appendix

4.4 ROOF COWLS

Provide factory assembled and tested in quantity production roof mounted relief air cowls, suitable for mounting on roof, similar to Fantech MRV/RV series or approved equal. The roof mounted cowls shall incorporate the following performance and construction criteria:

- Components may be manufactured from galvanised steel, GRP or polypropylene.
- Cowl shall incorporate a compact base fitted with a weathering skirt and a hinged weatherproof and bird-proof cowl.
- Roof cowls shall be selected and installed to ensure a maximum static pressure loss of 15Pa at full design flows.

5 AIR DISTRIBUTION SYSTEMS

5.1 GENERAL

This section of the Specification covers the general materials and construction standards for the supply and installation of the air distribution systems including ductwork, plenums, dampers, air diffusion equipment and all associated fittings.

The tender drawings indicate the general arrangement in which the various systems are to be installed, however, it should be noted that referenced drawings do not necessarily indicate all off-sets and transitions required for the necessary detailed co-ordination between trades and associated services and the building structure.

All air distribution systems including ductwork, acoustic and thermal insulation and fire dampers shall be constructed in accordance with the Australian Standard 1668 Parts 1, 2 and 3 and all applicable statutory requirements.

Duct dimensions indicated on the drawings are in millimetres and are clear internal sizes, the first dimension being the side shown in that view. Where ductwork is internally lined, increase sheetmetal dimensions accordingly.

5.2 RECTANGULAR SHEETMETAL DUCTWORK

Construction:

Manufacture in accordance with S.M.A.C.N.A. standards from galvanised steel sheet conforming with AS 1397 grade GCZ 300 and with Pittsburgh lock longitudinal seams as follows, all dimensions being in mm:

Duct Maximum Side (mm):	Material Thickness (mm):	Transverse Joints (mm):	Bracing – All 4 sides (mm):
To 200	0.6	Drive Slip/Cleat	Nil
Over 200 to 600	0.8	Drive Slip/Cleat	Nil
Over 600 to 1000	0.8	Proprietary Flanges or 25 x 25 x 3 angle	Duct beaded or 25 x 25 x 1.6 angle
Over 1000	1.0	Proprietary Flanges or 40 x 40 x 3 angle	Duct beaded or 40 x 40 x 1.6 angle

- Flanged Joints – Provide soft jointing material e.g. 'Prestik' between flanged joints, with bolts or clips at centres not greater than 150mm.
- Crossbreaking – Cross break all sides exceeding 300mm in width, except where duct is acoustically treated internally.
- Proprietary fan coil unit ductwork sections, fibreglass type, shall not be provided.

Duct Fittings

- Utilise radius bends where possible. Square bends when used shall include double section turning vanes, except for applications with grease laden air such as kitchen exhaust.

- Limit angle of diverging or converging transitions or tapers to 15°. Where this is not possible, provide internal splitters to achieve this result.
- Provide splitters and dampers at all branches and at registers and grilles to allow full adjustability of the air distribution system. Ensure all are readily accessible for adjustment after installation and that final settings are prominently marked.

5.3 RECTANGULAR PVC DUCTWORK

- Apartment toilet/laundry and rangehood exhaust ductwork shall be proprietary rectangular plastic ductwork of Air Systems or FanTech manufacture or approved equivalent.
- Plastic duct systems shall be compliant with AS1530.3 (1999) Building Standard Specification and AS4254 (2002).
- Plastic duct systems shall be provided complete with proprietary bends, spacers and rectangular to circular flexible duct connection pieces for fan connections.

5.4 CIRCULAR FLEXIBLE DUCTWORK

General

- Construct in accordance with Australian Standard 4254.
- Flexible ductwork shall be sized based on a maximum velocity of 3.0 m/s.
- The inner duct shall be factory wrapped in insulation and sheathed with an aluminium foil laminate outer vapour barrier.

Construction and Insulation

- Fabric reinforced aluminium foil laminate or similarly durable material. Do not use unreinforced plastic materials.

Joints

- Use full 3m lengths for connections to registers where possible.
- Fasten inner core to duct and register spigots with tape, then with mechanical bands,
- Separately tape / seal outer sheath with tape.
- Utilise 50mm wide adhesive tape fully complying with AS 4245.

Hangers and Supports

- Support ductwork with rot and fire proof webbing at all changes in direction at not more than 2000mm intervals.
- Supports to ensure that duct is clear of the ceiling and free of kinks, sufficiently wide.

5.5 DUCT SUPPORTS

General

- Manufacture in accordance with S.M.A.C.N.A, AS4254 and AS1170.4 standards as a minimum.
- In addition to above, support all ductwork from threaded rods with angle bases as a minimum. Spacing shall be in accordance with above standard. Steel straphangers will not be considered as an equal alternative to angle based mounting for equipment.
- Substitutions to the above will subject to mechanical engineer's approval.
- Fix supports to the underside of duct.
- Where duct supports are used to support other services, provide adequately increased support ratings, utilising a proprietary support system, such as "Unistrut" certified for the combined weight.

Connection to structure

- Fix hangers to solid structural members, underside of floor slabs, roof beams and the like.
- Provide adequate allowance for expansion and contraction.
- Fix supports to the building structure through the webs, not flanges of beams, purlins and the like.
- For fixing to steel and timber structure, M10 cadmium plated mild steel bolts shall be used.
- For fixing to masonry structures, expanding type plugs with M10 steel bolts or threaded drop rods of the sizes specified shall be used. Plugs shall be of the wedge action type designed to expand at the base.
- Supports shall be provided adjacent to flexible connections, branch connections, tee connections, bends and the like.

Spacing of duct supports

- Horizontal ducting - 1500mm maximum centres
- Vertical ducting - 2400mm maximum centres

5.6 FLEXIBLE CONNECTIONS

Provide flexible connections at locations shown on the details for each fan, air conditioning and air handling systems.

Construction: Neoprene glass coated fabric having a density of not less than 1kg/M² for normal applications at less than 90° C, similar to "wavebar" or approved equivalent.

5.7 VOLUME CONTROL DAMPERS

General

Dampers shall be free of rattles, fluttering or slack movement.

- Capable of adjustment over the desired range without excessive self-generated noise or the need for special tools.
- Blades shall not have sharp edges and shall be sufficiently rigid to eliminate movement when locked.
- Sizes shall be as per duct size unless shown otherwise on the drawings.

Butterfly Dampers – Flexible Branch Duct Take-Offs

- Round single blade, double folded type.
- Butterfly dampers shall be constructed of minimum 0.6 mm thickness zinc coated steel.
- Blade securely fastened to rod, pivoted in bronze or nylon bushes fixed to the spigot.
- Lockable type quadrant. The quadrant lock shall be clearly marked to indicate the "open" and "shut" positions of the damper.

Opposed Blade Dampers – Mounted Behind Air Diffusion Devices

- Multi-leaf opposed blade type.
- Zinc coated steel, painted matt black.
- Minimum of 0.8mm thickness mounting frame and 0.6mm thickness blades.
- Blades shall be linked using nylon gear trains and be fully adjustable through the face of the grille.
- Maximum unsupported blade length 600mm.

5.8 FIRE DAMPERS

General

- Install fire dampers in all duct and air outlet penetrations through fire rated barriers in accordance with Australian Standard 1668 - Part 1 - Fire Precautions in Buildings with Air Handling Systems.
- Test and certify dampers to the requirements of the Statutory Authorities.

Fusible Link Type

- Install strictly in accordance with manufacturer's recommendations Construct fire dampers in accordance with Australian Standard 1682 - Fire Dampers.

- Provide access panels in ducts sufficiently sized and arranged to enable access for inspection and re-setting.

5.9 ACCESS PANELS

General

Provide access panels in ducts and plenums adjacent to each fire damper, modulating damper, air filter and in all similar locations where access is required for maintenance purposes.

Coordinate ceiling access panels required for mechanical equipment maintenance and commissioning with the Building Related trade and all Services Trades.

- Utilise proprietary access panels with purpose built frames fabricated from galvanised sheetmetal.
- Incorporate hinged access panels where possible.
- Access panels to incorporate the equivalent standard of insulation with the surrounding ductwork.
- Incorporate high quality proprietary heavy duty hinges and latches and sealing gaskets to the frame and panel. All hardware to be either galvanised or stainless steel. Do not utilise piano hinges or latches with rivets acting as the shaft.
- Construct access panels to withstand system pressures and ensure panels are completely air and watertight.
- Where possible, locate access panels in ductwork carrying moisture and kitchen exhaust ductwork in the side of the ducts.
- Size access panels to suit the maintenance purposes envisaged.

5.10 AIR DIFFUSION

General

All air diffusers, air registers, louvres, exhaust air grilles, door relief grilles and all other such fittings shall be of an approved type and as scheduled in the following clauses of this section of the specification and as shown on the drawings.

- Provide N.A.T.A., A.D.C. or equal approved certified performance data for all air diffusion equipment to be installed. Performance data for similar but not identical equipment will not be accepted.
- All outlets shall be selected for efficient air distribution and low noise levels.
- Check neck velocities, horizontal and vertical flow patterns and noise levels prior to ordering equipment. Outlets with poor distribution and excessive noise levels shall not be used.
- Supply air outlets for air conditioning equipment are to be sized on the basis of a terminal velocity of 0.3 m/s in the occupied zone.

- Approval shall be obtained for each type of outlet, grille and register proposed for use. Samples shall be submitted for this purpose prior to manufacture.
- All internal parts of outlet, such as straightening vanes and volume controllers shall be finished matt black.
- Unless otherwise specified aluminium outlets shall be powdercoat finish, to architect's colour selection.
- Internal duct surfaces visible through any air outlet or grille shall be painted matt black.
- Outlets shall be free of rattles, provide rubber packing or sealing strips as required to eliminate noise.
- Provide acoustically lined cushion head boxes to all outlets, lined on all surfaces.
- Provide volume control dampers to all outlets as indicated on the drawings.

Exhaust Air Grilles – Eggcrate Type

- Egg-crate type.
- Aluminium construction, powder coat finish.
- Removable framed core, 13mm x 13mm x 13mm deep aluminium egg-crate.
- Minimum 90% free area.

Weather Proof Louvre

- Aluminium construction, powder coat finish.
- Fixed core, fixed horizontal blades supported and braced by means of concealed stiffeners and bars.
- Fix blades at 45° to the direction of air flow with 30mm pitch up to 900mm high otherwise 100mm pitch.
- Fully stormproof and outward draining, flash and seal to building openings.
- Install 13mm x 13mm x 1.6mm diameter removable birdscreen to inside face of all grilles.
- 30 Pa (max) pressure drop at 2.0 m/s face velocity.

6 PIPEWORK SYSTEMS

6.1 GENERAL

This section of the Specification covers the general materials and construction standards for the supply and installation of the various pipework systems required for the installation.

The tender drawings indicate the general arrangement in which the various systems are to be installed, however, it should be noted that referenced drawings do not necessarily indicate all off-sets and transitions required for the necessary detailed co-ordination between trades and associated services and the building structure.

Install pipework to achieve a neat and workmanlike appearance, correct grade and alignment, satisfactory clearances, and all necessary provisions for correct and efficient operation and maintenance.

Connections to any item of equipment shall be designed to enable removal of the item with a minimum of disturbance to the associated pipework.

6.2 REFRIGERATION PIPEWORK AND FITTINGS

General

Supply and install all refrigerant pipework, joints and associated fittings in accordance with the following:

- Copper pipework in accordance with Australian Standard 1677, Australian Standard 1571/122-0 (Nominal size up to 20mm), Australian Standard 1571/122-H (Nominal size, over 20mm).
- Tube wall thickness in accordance with Australian Standard 1432 Type B minimum and selected to suit the operating pressures and temperatures of the associated refrigerant.
- Copper alloy fittings and valves shall be dezincification-resistant to Australian Standard 1585 Clause 6.3.
- Utilise proprietary fittings for all joints, bends, reductions, tees and the like. Utilise elbows with minimum centreline radius 1.45 tube diameters to AS 1585, Table 1B. Wherever possible make reductions at elbows, tees, line devices or equipment connections using reducing fittings, otherwise use reducing bushes or reducing couplings.
- All refrigerant pipework and fitting to be installed in accordance with the associated equipment manufacturer's installation guidelines. It is the responsibility of the mechanical services contractor to review the installation guidelines and ensure compliance is achieved.

Joints

- Utilise Brazed joints wherever possible unless equipment is supplied from factory with flared compression joint fittings.
- Utilise Brazing Alloy in accordance with Australian Standard 1167.1 Table 2 B4, with 15% minimum silver content.

- For Jointing Dissimilar Metals utilise Brazing Alloy in accordance with Australian Standard 1167.1 Table 1 A10 or an alloy with an equivalent silver content (minimum 34%).
- Produce flared compression joints utilising full bore refrigerant flare fittings to SAE J533b.

6.3 PIPEWORK INSULATION

Refrigeration

- The insulating material shall be commercially available slip-on type of the non-rigid form, similar to 'Armaflex FR'.
- Insulate all sections of the piping systems including flanges, valves and fitting with compliance to the minimum R – value requirements of the BCA Volume One, Specification J5.4, Insulating Piping, Vessels, Heat Exchangers and Tanks. The R – value of preformed pipe insulation shall be calculated in accordance with AS/NZS 4859.1: 2002.
- Use only insulation materials and systems that comply with Specification C1.10 Fire Hazard Properties – General, of the Building Code of Australia Volume One.
- Insulate all sections of the piping systems including flanges, valves and fittings utilizing sectional Elastomeric nitrile – rubber foam in tubular or sheet form, with high resistance to water vapour to create a water – vapour barrier.
- Thermal conductivity of $\leq 0.036 \text{ W/(m}\cdot\text{K)}$, when measured at $23 \pm 1^\circ\text{C}$ as per AS/NZS 4859.1: 2002.
- Thoroughly clean pipework prior to the application of the insulation.
- Minimum insulation thickness shall be provided to satisfy the R-Value with respect to installation location and system capacity in accordance with the BCA.
- Select insulation to suit the exact pipe diameter and firmly apply the insulation to the pipework ensuring all joints are butted together with contact adhesive and no gaps or air spaces are left. Accurately shape insulation to closely fit all bends.
- Insulate refrigeration suction and liquid lines for all air conditioning system over their entire length between the condensing unit and the fan coil evaporator. Glue ends of insulation to condensing unit and fan coil unit casing.
- Complete the vapour seal around all bends, joints and fittings utilising proprietary sealing compound in accordance with the manufacturer's recommendations. Complete the vapour seal to all longitudinal and circumferential joints with a pressure sensitive adhesive tape.
- Provide galvanised sheetmetal capping to all external pipework insulation and within plantrooms up to a height of 2100mm above floor level.
- Provide rubber or neoprene sleeves or grommets to brackets at support points to prevent damage of the insulation.
- Thoroughly clean the pipework prior to the application of the insulation.

- Refer to Manufacturers Application Guide for further recommendations.

6.4 DRAINS & CONDENSATE DRAIN PIPEWORK

Provide condensate drains, but not limited to, to the following equipment:

- Fan Coil Units
- Condensing Units

Condensate drain should be provided in accordance with the following:

- Drain pipework shall be Copper construction.
- Minimum 20mm diameter pipework shall be provided to a single unit, unless indicated larger on the drawings.
- Common condensate drains serving more than three items of equipment shall be minimum 40mm diameter unless indicated larger on the drawings. Common condensate drains shall not serve more than six items of equipment.
- All drains shall run to sewer or stormwater – discharge over the drain points as nominated on the drawings maintaining an air gap between the drain discharge and the tundish, cone or the like.
- Where a drain connection is not available for air-cooled condensing units, provide additional drip trays or approved means of drainage collection prior to discharge to sewer or stormwater.
- Comply with local water authority and EPA regulations.
- Incorporate a removable connection at the point of connection to equipment such as a section of clear plastic hose secured by hose clamps, to enable removal and cleaning.
- Insulate the first 1500mm length of drain line downstream of equipment mounted within the ceiling space.
- Incorporate P-Traps to all equipment which operates at a pressure lower than atmosphere (draw through type fan coil units and packaged air conditioning units).

6.5 PIPEWORK SUPPORTS

Support all pipework and associated equipment to prevent deflection, movement and undue stresses on the piping systems and building structure under all operating conditions in accordance with the following:-

- Select the supports and associated expansion allowances to suit the combined loads of the pipework, valves, fittings, insulation, fluid and reactions due to thermal expansion/contraction and movement of the building structure.
- Utilise proprietary support system such as "Unistrut" or "Ezystrut" constructed completely from galvanised steel.

- Isolate all pipework from dissimilar metal bracket materials with rubber grommets.
- Install non-compressible insulating ferrules at the support points of insulated pipework and maintain the vapour seal as detailed in the pipework insulation sections above.
- Install and support pipework to achieve a neat and workmanlike appearance and parallel to building lines wherever possible.
- Install supports at intervals in accordance with the support system manufacturers recommendations, and not less than 2000mm
- Connect supports to the building structure in accordance with the support system manufacturer's recommendations, utilising threaded rod, suitable masonry anchors for concrete or proprietary clamps for structural steel members.
- Incorporate allowance for pipe movement and expansion, including spring mounts to pipework mounted in vertical riser shafts.

7 AUTOMATIC CONTROLS

7.1 GENERAL

Supply and install all automatic controls necessary to achieve the specified control functions and for the safe and satisfactory operation of the mechanical services systems described in this specification. Include all ancillary equipment as necessary to provide a complete operating system designed for safe, correct and efficient operation of the plant.

The installation, setting and putting into operation of automatic controls shall be carried out by personnel trained and experienced in this field.

The automatic controls shall be commercial quality, of approved manufacture, proven performance and reliability and compatible with the equipment to which they are connected. Controls shall be of the electronic type.

7.2 CONTROLS

The following clauses indicate the general control functions only and cover the requirements considered necessary to provide the minimum satisfactory performance of the system. Provide all necessary controls functions and strategies to complete the installation and to achieve the functionality described below. The descriptions scheduled below indicate the minimum functionality of each system. Any control strategies not mentioned below are to conform to relevant codes and standards as required by legislation and be compatible with manufacturer's recommendations of the equipment served, to provide satisfactory stable operation.

Air Conditioning Temperature Set point Strategy

Incorporate appropriate set points, dead bands and control strategies to achieve stable, energy efficient operation of the air conditioning and economy cycle system in conjunction with the air conditioning system and avoid any conflict in operation. The following air conditioning set points are suggested (fully adjustable) as an initial indication:

- Cooling set point 23.5°C
- Heating set point 21.0°C

Air Conditioning Units - Air Cooled Reverse Cycle

The air conditioning units shall be controlled by the manufacturer's proprietary control system complete with a 7 day timeclock. The timeclock shall also include battery back-up.

Provide manufacturer's wireless standard LCD controllers. Wireless controllers shall be provided to operate all indoor wall mounted fan coil units. Contractor shall allow to provide and install manufacturers proprietary wireless control wall mounting bracket, with final confirmation of location with architect on site prior to installation.

Each fan coil unit shall be controlled by its associated Liquid Crystal Display controller incorporating at the following functions as a minimum:

- ON-OFF control function.
- Temperature setting adjustment.

- Fan speed selection including AUTO mode.

Apartment Bathroom and Laundry Exhaust Fan

Exhaust fans shall be controlled via a combined lighting and fan switch plate in each bathroom/laundry. Control panel by electrical trade. Connect to controlled socket outlet provided by electrical services contractor.

Ground Level Bin Storage Exhaust Fan

Bin room exhaust air fan shall operate 24 hours per day, 7 days per week.

Car Park Exhaust Fan

The car park ventilation system shall be controlled via carbon monoxide system located within the car park, incorporating the following functions as a minimum:

- Stop/Start and fan speed control via the CO control system, 24 hours per day/ 7 days/ week.
- Sample atmospheric contaminants within the air twice every 4 minutes.
- Variable speed drive to fan shall adjust airflow rate based upon car park carbon monoxide levels.
- Locate 1-off CO sensor in discrete location within carpark.
- Progressively vary the ventilation rate in order to maintain the carbon monoxide concentration level below 5% according to the following strategy:-

CO Concentration (ppm)	CPEF-1 Exhaust air flow rate
0-9 ppm	1 air change per day
9-15 ppm	Intermittent operation at 25% maximum fan duty.
15-30 ppm	Constant fan speed at 25% fan duty
30-45 ppm	Ramp fan speed linearly between 25% to 75% of fan duty
+ 45 ppm	Constant fan speed at 100% fan duty

8 ELECTRICAL SERVICES

8.1 GENERAL

The work includes but is not limited to the detailed design, manufacture, supply, installation, testing and maintenance of electrical works associated with the mechanical services installation.

Where ratings, sizes, loads, dimensions and the like have been provided, they are to be taken as the minimum values. The Contractor shall undertake their own assessment to confirm all components of the proposed installation, and shall incorporate the greater value within the installation.

The Mechanical Services Contractor shall confirm all equipment electrical loads to the Electrical Contractor prior to ordering of electrical sub-mains, breakers, isolators and the like.

8.2 CERTIFICATE OF COMPLIANCE

Certify on completion of each component or stage that the works comply with the requirements of AS/NZS 3000, the Electricity Distributor Regulations and any other applicable rules or regulations.

Provide a separate Certificate of Compliance for each stage of the work including temporary supplies.

The Certificate shall be in a form acceptable to the Office of Energy Policy and completed in accordance with their requirements. Issue copies to the Superintendents Proprietor and the local power authority.

8.3 STANDARDS

Refer to, but not limited to, the following referenced documents for the Electrical Installation for works includes under this trade package:

AS/NZS CISPR Set:	Electromagnetic Compatibility
AS/NZS 1668.1:	The use of ventilation and air conditioning in buildings – Fire and smoke control in multi-compartment buildings
AS 1939:	Degrees of protection for enclosures
AS/NZS 3000:	Wiring Rules
AS/NZS: 3008:	Electrical installations – selection of cables – Cables for alternating voltages up to and including 0.6/1 kV
AS/NZS 3080:	Telecommunications installations – Generic cabling for commercial premises
AS/NZS 3111:	Approval and test specification- Miniature overcurrent circuit-breakers
AS/NZS 3947.4.3:	Low voltage switchgear and control gear
AS 60044.1:	Instrument Transformers

AS 60947 Set: Low voltage switchgear and controlgear

AS/NZS 61000 Set: Electromagnetic Compatibility

8.4 TESTING AND ACCEPTANCE

Test Certificates

Supply electrical Certificates of Compliance, dated and signed by a responsible person in duplicate to the Superintendent.

Site Tests

Tests must include but not be limited to the following:

- Insulation resistance using 1,000 volt Insulation and Continuity tester between each conductor and all others in cable, conduit or switchgear and between conductors and earth.
- Earth resistance tests in accordance with AS/NZS 3000.
- Verification of polarity and phase rotation.
- Functional tests of all switchgear, controls and systems including safety devices.
- Harmonic tests for variable frequency drives, and significant plant such as Chillers, pumps, air handling units, and the like
- Testing in accordance with AS/NZS 3760

8.5 ELECTRICAL INTERFERENCE

Generally in accordance with AS/NZS CISPR Set. Design and use electrical equipment which will not cause interference with electronic and electrical equipment within the vicinity. In the event that the inherent characteristics of equipment make interference possible, fit effective suppressors to eliminate the interference.

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

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

8.6 BALANCING AND PHASE ROTATION

Balancing and phase rotation shall be in accordance with AS/NZS 3000. Balance each section of the installation evenly over all phases and ensure that phase rotation is correct throughout.

8.7 TESTING AND TAGGING

All Electrical equipment and accessories are to be tested and tagged in accordance with AS/NZS 3760.

Provide tags on the flex cable (if fixed) or on the chassis (if flex cable is removable).

Provide a schedule of equipment that has been tested and tagged under this contract in the Operating and Maintenance Manual.

8.8 WIRING SYSTEMS

Cables & Enclosures

- All cabling shall be installed in accordance with the manufacturers requirements, and this specification. Wherever there exists a discrepancy between the two documents the lesser specification shall be disregarded.
- Cabling shall be rated to a minimum of 90°C using PVC/PVC V-90 cables.

Cable Selection

- Standards: Select cables in accordance with AS/NZS 3000 and AS/NZS 3008.1.
- Ratings: Use AS/NZS 3008.1 for the determination of current ratings, voltage drop and cable size.
- Voltage Drop: The maximum voltage drop to each final sub-circuit are not to exceed 5% unless specified otherwise.
- Conductors: Unless otherwise specified, use multi-stranded copper conductors. Aluminium cabling will not be accepted.
- Minimum Sub-Circuit size: The following minimum cable sizes shall be provided:
 - 20 Amp circuit – 4mm²
 - 16 Amp circuit – 2.5mm²
 - Control circuit – 1.5mm²
- The contractor shall undertake all calculations necessary to ensure cables are installed in accordance with regulatory standards and requirements, based on final equipment selections, loads and length of cabling.
- Sub-Circuit cable types: Unless otherwise specified use cabling with V-90 (PVC) insulation and PVC sheath, or R-HF-110 (Elastomer) insulation and HFS-110-TP (Elastomer) sheath for fire and life safety services, unless specified otherwise.

Cable Installation

- Installation shall be in accordance with AS/NZS 3000 and AS/NZS 3008.
- Manufacturers' recommendations: Unless otherwise specified, install, terminate and joint cables in accordance with manufacturer's recommendations.

- Terminations: Terminate each circular multicore cable, and each single core TPS cable of greater cross section than 35mm², using a nonferrous gland at each end of each cable. Provide non-ferrous gland plates for all single core cables.
- Handling cables: Handle cables so as to avoid damage to insulation and serving or sheathing. All damaged cabling shall be replaced at no cost to the project.
- Straight-through joints: Unless unavoidable due to length or difficult installation conditions, run cables for their entire route length without intermediate straight-through joints. Locate and carry out approved joints as directed.
- Installation: Install and adequately support fixed wiring as specified throughout the installation. All multi-phase circuits with single conductors shall be installed in trefoil configuration, strictly in accordance with the requirements of AS 3008. All power and control cabling shall be installed on cable trays, catenaries and fixed structure where specifically requested within this specification. Where it is not specifically stated, refer to the Consulting Engineer for approval of appropriate installation method.
- Conductors & Identification: For fixed wiring colour the conductor insulation as follows:
 - Active conductors in single phase circuits: RED.
 - Active conductors in polyphase circuits: A PHASE – RED, B PHASE – WHITE, C PHASE – BLUE
 - Neutral conductors - BLACK
 - Earth conductors - GREEN with YELLOW stripe
 - Control cables (red phase) – RED
 - Other conductors: To AS 3000 clause 3.2.
 - Sheathing: White for single phase and orange for 3-phase.
- Balancing: The Contractor is to ensure that all phases are balanced in accordance with regulatory requirements, and ensure that phase rotation is correct.
- Tagging: Identify multicore cables and trefoil groups at each end and at crowded intermediate points by means of stamped, non-ferrous tags, clipped around each cable, or trefoil group.

Conduits

- Galvanised steel where required to meet AS 3013 classification, where subject to high temperatures and where exposed to sunlight. Paint to approval.
- Rigid PVC generally otherwise.
- HDPE/HFT (or any UV stabilised alternative), ultra-violet resistant when exposed to sunlight.

Draw Cords: Install polypropylene draw cords in all spare conduits and in all conduits including submains conduits which have spare capacity which may be used in future.

9 NOISE AND VIBRATION

9.1 GENERAL

Attention shall be paid to the prevention of noise and vibration in all equipment and the contractor shall be responsible for the correction of such objectionable noise and vibration as may occur to the satisfaction of the Mechanical Services Consulting Engineer.

Provide anti-vibration mounts under all equipment. Select and install mounts to suit the weight and type of equipment proposed in accordance with mount suppliers recommendations.

Select and install equipment to operate within the required 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.

9.2 EARTHQUAKE FIXINGS AND SUPPORTS

All plant, equipment and piping systems, shall comply with the requirements of Australian Standard 1170.4 - SAA Loading Code – Earthquake, AS2670 – Vibration, AS2625 Mechanical Vibration, ISO1940:2003 – Mechanical Vibration.

Where greater incorporate the Design, Selection and Installation with requirements of ASHRAE Handbook 2011, Applications Chapter 48.

For further information regarding earthquake restraining, refer to following:-

- Gripple Seismic Installation Manual
- Tyco flow control, 2002, unistrut seismic bracing systems
- Fema e-74, January 2011, reducing the risks of non-structural earthquake damage - a practical guide.
- S.M.A.C.N.A seismic restraint manual, guidelines for mechanical systems, 1998, S.M.A.C.N.A, sheet metal and air conditioning contractors' national association.

Provide restraints and supports designed and certified by a structural engineer, to all plant, equipment, tanks pipework, isolation mounts and ductwork in accordance with Australian Standard 1170.4-2007 Section 8.

All restraints and supports shall be issued to the structural engineer to review the adequacy of the structure to support the services loads, including seismic forces. Proof of formal review and approval by structural engineer shall be provided as part of the shop drawing review process.

Where internal expertise is not available to the contractor, formal engagement of a registered structural engineer shall be sought for design of earthquake restraints. Cost of engagement shall be included in Tender pricing and listed as a separate item when applicable.

The following ductwork and piping do not require seismic bracing:

- Piping less than 32mm internal diameter in plant rooms.
- All other piping less than 64mm internal diameter
- All electrical conduit less than 64mm internal diameter
- All rectangular air-handling ductwork less than 0.40 m² in cross sectional area
- All ducts and piping suspended by individual hangers 300mm or less in length from the top of the pipe to the bottom of the support for the hanger

All ductwork to be supported in accordance with AS 4254-2002.

Transverse bracing for duct sections to be at 6.00m maximum centres and at section ends.

Longitudinal bracing for duct sections to be at 12.00m maximum centres and at section ends.

Transverse bracing on adjacent runs may be considered the longitudinal bracing for the adjacent section.

Spacing of the bracing may need to be reduced for example:

- Brace both sides of piping, conduit or ductwork at flexible connections
- Brace to avoid collision between piping, conduit or ductwork and other non-structural components
- Brace within 600mm of changes in direction, whether it be horizontal or vertical changes
- Brace where components penetrate floors or ceilings
- Brace in both directions at the top of all risers where risers exceed 900mm

The spacing of bracing along a run of piping, conduit or ductwork should not vary greatly in order to ensure uniform deflection and loading.

Each unit of equipment connected to a run of piping, conduit or ductwork shall be individually and independently braced. Thermal expansion and contraction forces, where present, must be considered in the layout of transverse and longitudinal braces. Flexibility should be provided where pipes pass through seismic or expansion joints or connect to equipment with vibration isolators.

Bracing of pipework shall be at every second support but not exceeding the spacing given for ducts.

Services braced in accordance with AS 1170.1-2007 section 8 shall have a minimum of 50mm clearance from all ceiling hangers and the ceiling grid.

Do not core through, cut through or otherwise damage steel reinforcement in concrete slabs, beams or columns when installing seismic bracing.

9.3 ANTI-VIBRATION MOUNTS

Provide anti-vibration and acoustic mounts under all equipment. Select and install mounts to suit the weight and type of equipment proposed in accordance with mount supplier's recommendations.

Select and install equipment to operate within the required vibration limits under normal operating conditions. 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.

Mounting details as follows (refer to below table for static deflection requirements):

- Flexible connections between all solid supported ductwork and fans.
- Spring isolation hangers for ducted fans and all ductwork not isolated from equipment by flexible connections.
- Neoprene double deflection mounts under condensing units and other equipment.

All components associated with vibration isolation mounts to be either hot dipped galvanised after manufacture or stainless steel.

Ensure equipment bases are sufficiently rigid to avoid distortion or deflection at the support/mounting point. Provide additional reinforcement or large washers as required to satisfy this requirement. Refer to *Workmanship and Materials* for Equipment Bases information.

10 TESTING AND COMMISSIONING

10.1 GENERAL

On completion of the work, commission the entire installation and put it into operation.

Provide qualified and experienced technicians and appropriately calibrated equipment to carry out such tests as may be necessary to satisfy the Engineer, Independent Commissioning Agent and the Client that the installation meets the requirements of this Specification. Calibrate all test instruments at an approved N.A.T.A. certified laboratory prior to carrying out the tests.

All commissioning must be undertaken by a NEBB certified commissioning technician. Submit NEBB Certification number within tender schedules.

Commissioning Information

Provide and setup commissioning information in a lever arch folder complete with dividers in the following format:

- Introduction (quick description of the purpose of the document and the general systems covered by the document, and references, i.e. CIBSE code A).
- Commissioning programme up until the end of DLP.
- Commissioning method statement.
- Pre-commissioning checklists (with check boxes and date column).
- Commissioning Results (see below).
- Commissioning instrumentation and calibration certificates (if applicable).
- All off-site pre-commissioning certificates.

Test records & Commissioning results

All test results shall be properly recorded on approved test log sheets. Proposed log sheets (blank pro-formas) shall be submitted for review prior to commencement of commissioning. Test log sheets shall contain the following information as a minimum:

- Equipment item designation (e.g. FCU 1-2).
- Manufacturer, model and serial number of equipment.
- Test information for each individual item of equipment shall be recorded on a separate sheet. Nominate 'specified' vs. 'actual' results.
- Item(s) of equipment used for each test (e.g. "Flowhood" "Anemometer", (make/model, serial number, date last calibrated).
- Control settings including field code settings, temperature set points, high and low head pressure switch settings and overload settings as applicable.

- Evidence of controls calibration such as control set point versus measured temperature.
- Programmed time schedule settings.
- Velocity reading, dimensions, area, factor for all grille air flow readings tested using any equipment other than a flowhood.
- All results shall be entered onto log sheets at the time of testing.
- A copy of all test results shall be forwarded to the Engineer for approval immediately after testing. These initial results may be handwritten to avoid transcription errors.
- A typed copy of all test sheets and calibration certificates shall be enclosed in the Operating and Maintenance Manuals.

10.2 PRE-COMMISSIONING PROCEDURES

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

- Prepare commissioning information folder as detailed above.
- Check the building fabric is complete (i.e. windows, doors, ceiling installed as per normal operating conditions).
- Check the electrical supply is live.
- Visually check ductwork for air tightness.
- Clean all ductwork and remove internal manufacturer's identification stickers.
- Slug dose with chemicals, pressure, and leak test piping systems.
- Ensure all controls (overloads, fuses etc.) are in their appropriate setting and in 'automatic' mode.
- Ensure, as required, that doors, seals, door hardware, ceiling tiles etc. are in place to avoid leakage.
- Clean and flush out all water systems including piping systems and connected equipment. Use non foaming detergent compatible with final selected water treatment to flush out the system, followed by a second flushing using clean water. Remove and clean out all strainers
- Drain down water storage tanks, clean out and flush with disinfectant, refill and check aerobic bacteria count.
- Pressure and leak test air distribution systems.
- Carry out point to point damper checks.
- Review and coordinate interfaces with other trade.

- Clean out plantrooms, conditioners and plenums and operate all air handling systems with temporary filter media.
- Submit for approval, manufacturer's test certificates, performance curves and tables for all plant, equipment and electrical components. Mount test certificates for pressure vessels in glazed frames adjacent the equipment.
- Submit for approval the controls functional specification.

10.3 COMMISSIONING

Carry out all adjustments necessary for the safe, reliable and satisfactory operation of the plant prior to the Practical Completion.

Practical completion will be certified only after the plant has been inspected and approved and the requirements of this section of the specification are fulfilled.

Undertake commissioning in strict accordance with CIBSE Commissioning Codes or ASHRAE Commissioning guideline 1-1996 including but not limited to the below additional information.

Plant and equipment

Check the operation of the plant and equipment including direction of rotation of motors, noise and vibration levels, operating temperatures, pressures and flows

Check and prove all operating and safety controls

Check and prove performance characteristics at full and part load.

Controls

Program all control inputs, time schedules, timer settings and field code settings as applicable to achieve the specified control strategies and to ensure stable operation and to meet manufacturer's recommendations. Calibrate all sensors. Record all settings and calibration results on test log sheets.

Carry out "point to point" testing for each control device and external monitoring device to demonstrate complete, correct control functionality and submit written evidence in tabular format.

Air Systems

All air quantities shall be measured and all adjustments made to obtain the specified performances.

Commission air systems utilising the following calibrated equipment:

Supply air outlets:

- Utilise "Flowhood" with appropriately sized hood, in accordance with manufacturer's recommendations.

Exhaust air grilles:

- Utilise "Flowhood" with appropriately sized hood, in accordance with manufacturer's recommendations wherever possible.
- If flowhood cannot be used due to configuration/space constraints then utilise a "Velgrid" in accordance with manufacturer's recommendations (including area factors).

The total supply air quantity shall correspond to within 0% to plus 10% of the air quantities shown on the drawings. The fans shall run at their lowest practicable speed while maintaining the specified quantities.

The air quantities through air outlets, and exhaust grilles shall correspond within -0 to +5% of the air quantities shown on the drawings.

Allow for all changes to fan motor drives necessary to obtain the required performance at no cost extra to the Contract.

Ensure ductwork mounted static pressure sensors are located 10 equivalent diameters upstream of flow measurement points where possible.

Subsequent to occupation provide fine tuning of the air balance based on temperature measurements within the space. Ensure no undue drafts are present.

Condensate Systems

Cap off at lowest point.

Fill with water and visually check all joints for leaks.

Refrigeration Systems

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

All vacuum pipework shall undergo a vacuum test equivalent to a minimum of 300 Microns maintained for a period of twelve (12) hours. If there is any pressure rise during the vacuum tests, the pipework shall be checked for leaks and after repairs have been made the test shall be repeated. If a section of pipework fails a required test, repair the fault and retest.

Pressure test refrigeration systems to 3100kPa on the high side and 700kPa on the low side with a dry inert gas. Hold test for 6 hours with no drop in pressure.

Tolerance on pressure readings: +5%.

Electrical systems

Progressively and finally test the complete installation to ensure it is mechanically and electrically safe and operates correctly under normal, emergency and fault conditions:

- Check all terminations, clamps and fixings.
- Check phase identifications match throughout the installation.

- Check for excessive heating at all joints.

Testing of Safety Equipment

All items of safety equipment on plant shall be tested by creating the appropriate fault condition. Provide skilled technicians to commission the plant and associated controls to the satisfaction of the Engineer.

10.4 ACCEPTANCE TESTS

Acceptance Tests

Acceptance tests shall commence only when the preliminary test results demonstrate that the plant is ready for test.

Consulting Engineer Witnessing

Make due allowance (time and cost) in the commissioning phase of the project for final consultant witnessing of all plant in operation. Coordinate the required consultant witnessing, for all plant, within the builder's construction programme.

The mechanical trade shall be responsible for notifying the consulting engineer to attend site and witness the mechanical services installation. A minimum of three (3) working days' notice must be provided to the consulting engineer.

Final witnessing must only be arranged once the installation is complete, the final commissioning results have been issued to the consultant and consultant comments have been reviewed and rectified.

When the installation is complete, commission the plant by putting it into working order and operating it to prove all control methodologies outlined within this specification are achieved.

Make the adjustments necessary (prior to consultant witnessing) to achieve the required performance under continuous operating service conditions, including balancing, setting the controls, checking the operation of overload and safety devices, and correcting malfunctions.

Record and submit the results to the consulting engineer prior to arranging final consultant witnessing. One (1) full working day (minimum) will be required for the consulting engineer to review the results prior to arranging the final witnessing inspection.

Controls

Demonstrate all control functions as requested and to the satisfaction of the Mechanical Services consulting engineer including control strategies, interlocks, field code settings, set points, calibration, timeclock settings/schedules, timer settings, run and fault indication and safety settings.

Electrical Requirements

Progressively test all components of the installation to ensure compliance with Statutory and Australian Standards requirements, and Manufacturer's recommendations. Check operation under normal, emergency and fault conditions.

Submit records of all tests, and provide all necessary forms and documentation required by current Statutory regulations.

Motor-Driven Appliances

Test each appliance for operation to name-plate rating. Adjust thermal overloads for actual load during maximum ambient conditions. Measure running amps for all phases, speeds of motors and driven plant (where belt drives are used), supply voltages.

Noise Testing

The noise levels within the occupied spaces shall not exceed the limits outlined in the Acoustic Engineers Report.

Provide acoustic test data, if requested, to verify the mechanical services systems do not create noise levels in excess of the acoustic limits.

Concealed Work

Do not cover or conceal underground or enclosed work until it has to be inspected and tested, in sections where necessary, to the approval of the consulting engineer and the relevant authority. Leave pipe joints exposed to enable observation during the tests.

On Completion

Check pipe joints and the like. Rectify if damaged, and retest.

Rejection: Pipework which fails a required test, or which vibrates or is noisy because of insufficient support or loose fixings, is liable to rejection.

Handover

Requirement: The Principal shall accept handover of the plant when the acceptance tests demonstrate that the required performance has been achieved and the consulting engineers has undertaken witnessing of all mechanical systems.

Remedial Work

If a tested item fails to meet the performance requirements before Practical Completion, remedial or replacement work during the Defects Liability Period, if permitted by the Client, may be subject to restricted access conditions.

Completion

Commissioning: After satisfactory completion, leave the service in full operational condition.

Warranty period will commence on the date of commissioning acceptance.

11 SERVICE AND MAINTENANCE

11.1 SCOPE

Maintain and service the complete installation for a period of 12 months from the date of Practical Completion. Routine maintenance visits shall be scheduled on a monthly basis as organised through the head contractor.

Maintain all equipment included in this contract in perfect operation during the term of the Guarantee and Maintenance Period and provide emergency service on a 24 hour call out basis.

All maintenance procedure shall be taken in strict accordance with those defined in "DA19 HVAC and R Maintenance Schedules".

11.2 QUATERLY MAINTENANCE

At each maintenance visit not less than the following functions shall be carried out in addition to the manufacturer's recommended maintenance activities.

- Inspect and clean as necessary all fans, etc.
- Inspect and replace as necessary all filters.
- Check all bearings for correct operation.
- Check all anti-vibration supports for deterioration.
- Check all flexible duct connections for air tightness.
- Check all drains and clean as necessary.
- Prove correct operation of all safety controls.
- Repair or replace all defective items.

11.3 HALF YEARLY MAINTENANCE

In addition to the Monthly Maintenance requirements and at intervals not exceeding 6 months the following minimum functions shall be carried out:

- Inspect and clean as necessary all fans, etc.
- Clean and adjust all switchgear, contactors, and starters.
- Prove operation of all thermal overloads.
- Check calibration of all thermal controls.
- Check all safety controls.

Provide all consumable necessary for the proper maintenance and servicing, including grease, oil, refrigerant, refrigeration filter/dryers, etc. Replace all components worn during the maintenance period including belt drives, fuses, globes, etc.

11.4 SERVICES

General

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

Where the Contractor fails to attend the plant within eight (8) working hours of notification of breakdown and where remedial work is interrupted during normal working hours for purposes other than obtaining spare parts from the nearest source, the Proprietor reserves the right to order such action as may reasonably expedite completion of remedial work at the Sub-Contractors expense.

Service Reports

During each service visit complete a report in the form of a check list which shall indicate the readings of all gauges, the condition of all items, any remedial work carried out. Arrange to have Service reports countersigned by the Proprietor's representative, prior to leaving site.

Final payment of retentions monies will only be certified pursuant to receipt of 12 Service Reports which indicate that the Maintenance and Service requirements have been regularly and satisfactorily completed.

APPENDIX A – TENDER PRICE BREAKDOWN

This schedule is required to be filled out at time of Tender Submission. The amounts indicated in the total Tender price including administration costs and profit for sections of the work are as follows:

SECTION COSTS

NO.	ITEM	AMOUNT TENDERED
1.	Air Conditioning & Mechanical Services Equipment	
	Air Conditioning Units – Multi-head type systems	\$
	Fans	\$
	Ductwork	\$
	Air Diffusion Equipment	\$
	Refrigeration Pipework	\$
	Electrical (Equipment)	\$
	Automatic Controls (Equipment)	\$
	Earthquake Restraining and Fixing	\$
	Other (specify)	\$
2.	Air Conditioning & Mechanical Services Installation/Labour	
	Labour General (ductwork, equipment, plant, etc.)	\$
	Electrical	\$
	Automatic Controls	\$
	Pipework	\$
	Commissioning	\$
	Other (specify)	\$
3.	Air Conditioning & Mechanical Services General	
	Engineering Calculations	\$
	Manuals	\$
	For Approval/Workshop Drawings (Revit/CAD)	\$
	As-Installed Drawings	\$
	User Training	\$
	Defects Liability/Comprehensive Maintenance	\$
	SUB TOTAL	\$
	PLUS 10% GST	\$
	TOTAL	\$
Tenderer	.....	Date

4. Ongoing preventative maintenance costs (post 12 month DLP)

2 year contract	\$
3 year contract	\$
5 year contract	\$

5. Trade Rates

Tradesman	\$	/hour
4 th Year Apprentice	\$	/hour
Draftsman - AutoCAD	\$	/hour
Draftsman - Revit	\$	/hour
Engineer - Calculations	\$	/hour
Electrical	\$	/hour
Automatic Controls	\$	/hour
Pipework	\$	/hour
Commissioning	\$	/hour

Tenderer **Date**

APPENDIX B – TECHNICAL DATA SCHEDULES

This schedule is required to be filled out at time of Tender Submission. All plant and equipment is to be in accordance with the Specification. In addition to information requested below, provide at time of tender all manufacturer's selection print-outs indicating compliance with the performance criteria specified at the nominated conditions.

Multi Head Type Units

Provide full manufacturers selections and technical data.

Fans and Roof Cows

Provide full manufacturers selections and technical data.

Air Diffusion Equipment

Supply Air Grille – Wall Mounted Type

Manufacturer

Type

Supply Air Grille – Wall Mounted Type

Manufacturer

Type

Tenderer **Date**

Weatherproof Louvre

Manufacturer

Type

Automatic Controls

Individual Controller

Manufacturer

Type/Model

Sensors

Manufacturer

Type/Model

Tenderer **Date**

APPENDIX C – SCHEDULE OF SUBCONTRACTORS AND PERSONNEL

Subcontractors

Electrical	.....
Automatic Controls	.....
Ductwork Manufacture	.....
Ductwork Installation	.....
Pipework	.....
Commissioning	.....

Personnel

Project Manager	.....
Years' Experience with Company / Industry /
Site Manager/Foreman	.....
Years' Experience with Company / Industry /

Commissioning Technician

Years' Experience with Company	.....
NEBB Certification No.	.....

Tenderer **Date**

APPENDIX D – TRAINING RECORD

System Designation	System Type	Scheduling Training	On/Off Training	Fan Speed/Temperature Set-Point Adjustment
e.g.: FCU/ACC-1	e.g.: Ducted	e.g.: Complete	e.g.: Complete	e.g.: N/A

Proprietor's Representative

Position

Name

Signature

Date

Mechanical Contractor's Representative:

Position

Name

Signature

Date

Tenderer **Date**

Direct Expansion Air Conditioning Test Report

Project Name:			
Project No:	Date:	Sheet:	of

System Designation:			Applicable Drawing:			Area Served:					
FCU Make											
FCU Model No.											
Design Outside Air			L/s								
Design Supply Air			L/s								
Fan Drive Section											
1. Motor Details - Power - Voltage			kW Speed: High/Medium/Low								
			V Nameplate Amps: .....A								
2. Measured Data - Running Amps - O/Load Set point - O/Load Set point			A W B								
Grille	Type	Area Factor	Size			Design		Prelim Readings		Final	
			MM	x	MM	VEL	L/s	1	2	L/s	Insp.
TOTAL SUPPLY AIR:											

Tested By:	Witnessed By:	Test Apparatus: Model:	Date of Last Calibration:
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Tenderer **Date**

Fan Test Report

Project Name:		
Project No:	Date:	Sheet of

System Designation:	Applicable Drawing:	Area Served:
1. Fan Make		
2. Fan Model No.		
3. Fan Type		
4. Design Duty	L/s	
5. Fan Details		
- Impeller-Diameter	mm	
6. Motor Details		
- Power	kW	
- Speed	rps	
- Voltage	V	
- Nameplate FLA	A	
7. Measured Data		
- Air Flow Rate	L/s	
- Running Amps	R:	
- O/Load Range		
- O/Load Setpoint		

Grille	Type	Area Factor	Size			Design		Prelim Readings		Final	
			MM	x	MM	Area	L/s	1	2	L/s	Insp.
TOTAL SUPPLY AIR:											

Tested By:	Witnessed By:	Test Apparatus: Model:	Date of Last Calibration:
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Note: Amend schedule to suit services on project. Alter to suit project requirements.

Tenderer **Date**

APPENDIX F – EQUIPMENT PERFORMANCE SCHEDULES

Refer schedules attached.

Tenderer **Date**

PERFORMANCE CRITERIA													
FANS													
Project		11-13 West St Apartments											
Project No.		LCE13404											
Rev Date		29.03.19											
					Airside					Electrical			
Designation	Location	Area Served	Non-Return Damper	DB(A) Max	Airflow (l/s)	Static (Pa)	Fan Type	Diameter (mm)	Speed Control	Amps (MCA)	Phase (Φ)	Volt (V)	Board Serving
GEF-BIN	Basement	Bin Room	No	55	60	150	Mixed Flow	250	No	2	1	240	Common
GEF-CARPARK	Basement	Carpark Exhaust	No	55	350	350	In-line	350	VSD	8	1	240	Common
TEF-X	Apartments	Various	Yes	37	50	90	Headerbox	150	No	1	1	240	Apt Load Ctr

PERFORMANCE CRITERIA

AIR CONDITIONING UNITS - AIR COOLED (APARTMENT)

Project	11-13 West St Apartments
Project No.	LCE13404
Rev Date	29.03.19

[illegible]