

THE WILLCOX APARTMENTS

117 PROSPECT ROAD PROSPECT

Project No: LCE13523

Mechanical Services Specification

For Construction
Revision A

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**STRUCTURAL AND CIVIL CONSULTING
ENGINEERS**

TMK Consulting Engineers

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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
- Principal's Project Requirements Document
- Architectural Documentation
- Electrical, Hydraulic, Fire and Vertical Transportation Services Documentation
- Structural and Civil Documentation
- Fire Engineering Report

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 for the Willcox Apartments at 117 Prospect Road, Prospect. The works involve the construction of a new 5 storey apartment building consisting of 33 apartments, Ground Floor Café Tenancy, Ground Floor Office Tenancy and carparking on Ground Floor and Basement Level.

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

Local Fire Authority - South Australian Metropolitan Fire Services (SAMFS)

1.4 CONTRACT

Fixed Price Lump Sum Contract

The Mechanical Services Contractor is to enter into a fixed price lump sum type contract. The following specification and accompanying drawings outline the general scope of works and have been prepared to enable specialist Contractors to submit fixed sum tender prices for the plumbing installation. The drawings are intended to indicate the principles of design and should not be taken to define all offsets, bends etc which may be required to complete the installation and or be coordinated with other services. The Mechanical Services Contractor will be responsible for final coordination with other trades and for final coordination with Architectural Drawings and building structure.

The tender drawings are not to be used for architectural or structural work but are to be read in conjunction with architectural, structural and other relevant drawings.

Coordinate all pipe runs with "HYDRAULIC, FIRE AND ELECTRICAL SERVICES" trade to ensure non-clashing of services.

Deviation from the design principals shown will not be permitted without the written consent of the Superintendent.

Any discrepancies which may affect the installations shall be brought to the Superintendents attention before the work proceeds.

The Contractor shall also familiarise himself with the location of existing pipe and cable runs. No variation will be issued for any damage caused to existing services.

1.5 DRAWINGS

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

Drawing No.	Drawing Title	Revision
LCE13523-M01	Legend of Symbols, Drawing Index and General Notes	A
LCE13523-M02	Basement Level Air Conditioning & Ventilation Arrangement	A
LCE13523-M03	Ground Floor Air Conditioning & Ventilation Arrangement	A
LCE13523-M04	Level 1 Air Conditioning & Ventilation Arrangement	A
LCE13523-M05	Level 2 Air Conditioning & Ventilation Arrangement	A
LCE13523-M06	Level 3 Air Conditioning & Ventilation Arrangement	A
LCE13523-M07	Level 4 Air Conditioning & Ventilation Arrangement	A
LCE13523-M08	Level 5 Air Conditioning & Ventilation Arrangement	A

LCE13523-M09

Details

A

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

1.6 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:

- Provision of air cooled, reverse cycle, inverter driven, multi-head high wall split type air conditioning systems to serve each (Ground Floor to Level 4) apartment. Condensing units will be located on balconies.
- Provision of air cooled, reverse cycle, inverter driven, ducted split type air conditioning systems to serve each Level 5 apartment. Condensing units will be located at roof level.
- Provision of air cooled, reverse cycle, inverter driven, ducted split and type air conditioning systems to serve the Ground Floor commercial tenancy. Condensing units will be located adjacent tenancy.
- Provision of ducted exhaust systems to serve all apartment amenities and laundry, comprising ceiling mounted type fans complete with backdraft dampers.
- Provision of kitchen exhaust ductwork for discharge of apartment kitchen exhausts (kitchen exhaust hood and associated fan by others).
- Provision of carpark exhaust system, comprising high level supply and exhaust ductwork within the carpark, supply air fan within carpark level and riser to exhaust fan at roof level. System shall be controlled via carbon monoxide monitoring system to vary the speed of

the supply/exhaust fans to maintain acceptable levels of carbon monoxide as per this specification.

- Provision of refuse exhaust system, comprising high level exhaust ductwork within refuse area and carpark, and riser to fan at roof level.
- Provision of kitchen exhaust ductwork risers from roof level to ground floor. Ductwork to be capped at roof level and at ground floor ceiling space for future connection by others.
- Balcony mounted condenser units to be installed on "Inaba PR" type stands or equal equivalent. All exposed refrigeration pipework and controls/electrical cabling to be enclosed within "Inaba Slimduct" capping.
- Fire pump room exhaust system, comprising low level intake and wall mounted exhaust fan. Mechanical services contractor to terminate all control signal cabling at start/stop relay terminal to operate fan during fire mode and when in testing of fire pump equipment
- Air distribution systems associated with the above systems.
- Refrigeration and condensate piping systems 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.

Note: Apartment Bathrooms shall be POD Bathrooms constructed by the builder off site and delivered to site for final connection by services contractors. POD Bathroom shall include ceiling mounted exhaust fan and flexible ductwork, backdraft damper and condensate pipework within wet areas to tundish as documented. Mechanical Services Contractor shall allow to connect flexible exhaust ductwork to solid duct outside of POD, and extend condensate drainage pipework from POD to indoor air conditioning unit as indicated on drawings.

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.

1.7 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 switched isolators adjacent to each balcony and roof level air conditioning unit (final termination by Mechanical Services).
- Electrical power supply incorporating switched isolators adjacent basement level carpark and refuse exhaust fans (final termination by Mechanical Services).
- Electrical power supply incorporating switched isolators adjacent to roof level carpark and refuse exhaust fans (final termination by Mechanical Services).
- Electrical power supply incorporating a socket outlet in the ceiling space, with dedicated control switch mounted in local lighting switchplate, for toilet and laundry exhaust fans (final termination by Mechanical Services).

Hydraulic Services

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

Fire Services

- Provision of control relay and terminal strip on the fire pump control panel for termination of fire pump room exhaust fan control cabling. Start/stop relay and terminal strip by Fire Services (cabling and termination by Mechanical Services).

Building Related Trades

- Provision of balcony strip drains for discharge of balcony condenser unit condensate.
- 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.
- Under cuts to doors and door grilles as nominated (by Door Contractor).
- 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.
- Louvres within the external walls and roof level plantroom will be the responsibility of the façade contractor, however blanking/sealing of any unused portions not connected to by mechanical ductwork will be the responsibility of the mechanical trade to achieve the necessary fire rating as required in compliance with the BCA.

1.8 STANDARDS

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

- Building Code of Australia
- 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 (identify as an SA only relevant clause please)

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 2625	Mechanical Vibration
AS 2670	Vibration
AS 2700	Colour standards for general purposes
AS 3000	SAA Wiring Rules
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 SAMPLES

Submit the following sample fittings and accessories to obtain approval prior to ordering:

- Supply air grilles and diffusers
- Control panels and switches
- Temperature sensors

Deliver the samples to the consulting engineer at least 14 days before approval is required and notify the Head Contractor of their arrival. Make due allowance to courier samples to and from the consulting engineers office for all required sample reviews (including re-submitted samples).

2.2.2 TRADE DOCUMENTATION AND INSTALLATION COORDINATION

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 shop 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.

2.2.3 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.
- Electrical and automatic control schematics including BMS points list and MSSB layout.

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.

2.2.4 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 manual 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 COMMISSIONING AND WITNESSING PLANS

The contractor shall submit for approval a detailed commissioning plan indicating step by step testing strategy for all equipment. The commissioning plan shall be developed in conjunction with the building trade construction programme and shall be required to be submitted to the head contractor and consulting engineer for review prior to any commencement of commissioning. The mechanical services contractor shall be responsible for providing commissioning duration period to head contractor for inclusion in the construction programme.

Any witnessing of commissioning required by the consulting engineer, prior to practical completion, shall be allowed for within the commissioning plan. The consulting engineer will hold the right to refuse witnessing any plant until the mechanical contractor provides all commissioning results in accordance with Appendix E of this specification.

2.3.4 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:-

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 PAINTING

Utilise “Low VOC” paints throughout the project.

Metal surfaces shall be painted, where scheduled, with one prep coat and two finishing gloss coats to selected colours. Carry out any other treatment (e.g. etch priming for galvanised surfaces, degreasing) to ensure a satisfactory result.

All internal surfaces of air outlets and openings exposed to view shall be painted with one coat of matt black paint to approval.

Galvanised surfaces shall be etch primed before painting.

Damaged or unsatisfactory painting shall be made good.

3.7 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.

3.8 IDENTIFICATION

Designation labels

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

- Control equipment

- Air-conditioning and ventilation equipment
- T-Bar ceiling grid and plasterboard access panels where maintenance above is required

Engraved traffolyte labels with 5mm Arial font type and white lettering on black background shall be provided to the T-bar grid or plasterboard ceiling access panel below the above equipment (indoor units, fans, controllers, filters and the like)

Labels to be engraved traffolyte with 10mm (smaller where mounted to T-bar grid and plasterboard access panels) Arial font type black lettering on white background.

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.

Provide labelling to all fire protection systems in accordance with the requirements of AS16681.1 Clauses 4.12.4 Isolation Switches and 4.13.4 Notices and Labels.

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.

Electrical supply and Refrigerant Charge labels

Provide an engraved traffolyte label adjacent each item of Mechanical Services equipment with a connected power and/or controls circuit. Provide label in a location concealed from general view in occupied spaces, but obvious to maintenance personnel accessing the equipment for maintenance purposes, and not further than 1m from the item of equipment.

Labels to be engraved traffolyte with 5mm Arial font type white lettering on black background.

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.

Include the following information as a minimum:

- Equipment designations
- All power cable connections/circuits and source location
- All control cable connections/circuits and source location
- All equipment connected to and operating in conjunction with the associated power/controls source.
- Refrigerant charge for connected system (where applicable)

Refer to the example label as follows:

EQUIPMENT DESIGNATIONS	
Indoor Unit: FCU 1-2	
Outdoor Unit: ACC 1-2	
CONNECTED POWER/CONTROLS CIRCUITS:	
DB-1	Room 100
ACC 1-2	Roof platform
Fan	OAF 1-2
Temp sensor	Room 100
Control panel	Room 100
Lighting relay	N/A
REFRIGERANT:	
Type	R410a
Charge	18.5 kg
CAUTION! MORE THAN ONE ELECTRICAL SUPPLY EXISTS!	

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 evaporative cooling equipment 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. Ensure condenser units are selected to meet the spatial constraints for maintenance access and pipework connection points to suit balcony installation locations as documented.
- Incorporate compressor capacity control through inverter technology.
- 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 or Digital) 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 ducted or wall mounted type as scheduled below.
- Incorporate multiple indoor units to outdoor units where scheduled below.

Casing:

- Complete with airtight, gasketted 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.

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.
- Smoke Spill Systems to comply with AS1668.1 1998.

- 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.
- Vertical discharge fans shall have maglocks fitted to backdraft dampers to prevent opening when system is not in operation.

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.

Roof Mounted Centrifugal Fans

- Provide factory assembled and tested in quantity production fans, suitable for mounting on roof similar to Fantech Gamma series or approved equal.
- Casing shall be manufactured from pressed galvanised steel, complete with magnetically locked shutters.
- Impeller blades shall be GRP.

Ceiling Mounted Header Box Fans

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

4.4 AIR FILTERS

General

- All filters shall be in accordance with AS 1324.
- Filter holding frames shall be constructed from rigid beverage board.
- The sealing between filter media and frames and filter frames and plenum casing shall be such that no air bypasses the filter.
- Where filter frames are required to be mounted together, approved felt sealing strips shall be supplied. Filter frames shall be of adequate strength and rigidity to resist distortion and buckling under any multiple arrangement of filter cells.
- Filters shall be held into plenums by means of slides such that they shall be easily removable for replacement.
- Filters shall be selected based on 1.9m/s maximum face velocity, producing a maximum clean pressure drop of 75 Pa.
- The filters shall be Camfil manufacture or equal approved, thickness as scheduled.

Washable Type

- Class G2 in accordance with AS 1324.

Pleated Panel Type

- Class G4 (commercial areas) in accordance with AS 1324. -
- Class G2 (residential areas) in accordance with AS 1324.

4.5 CARBON MONOXIDE MONITORING SYSTEM

Supply and install a carbon monoxide monitoring and control system in accordance with the requirements of Australian Standard 1668 - 2012 - Mechanical ventilation for acceptable indoor air quality, including all associated sampling points.

The gas monitoring system shall comprise the following:

- One (1) microprocessor-based programmable controller complete with colour display.
- Carbon Monoxide/Nitrogen Dioxide transmitter (no. of as shown on drawings)

The location of all sampling points shall be positioned to ensure accurate measurement of CO levels within the car park in accordance with AS1668.2-2012.

Carbon Monoxide Controller

- "Distect Controls ECL-253 manufacture/model
- Full colour back-lit display for servicing and calibration requirement in accordance with AS1668.2-2012.

- PID capability
- 4-20 mA inputs from transmitter
- BMS compatible

Carbon Monoxide Transmitter

- 4-20 mA analogue signals
- IP65 enclosure
- Wall mounted application
- $\pm 3\%$ Stability and Resolution
- ≤ 50 s response time
- Accuracy/Drift of $< 5\%$ p.a

4.6 CONDENSATE PUMPS

General

- The unit shall be factory assembled and tested of Little Giant NXT Gen medium profile, or where equally approved.
- Incorporate external overflow safety switch to connect air-handler shutdown and to activate fault alarm.
- External test/run lever for quick and easy drainage of tank for servicing.
- Pump and tank shall be a slim footprint type.
- 1/4 turn check valve allows servicing without removal of tubing, eliminating water spills.
- External Tank shall incorporate anti-sweat sleeve to prevent condensation forming on tank.
- Incorporate thermal overload protection.
- System shall be cCSAus listed.

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 CIRCULAR SHEETMETAL DUCTWORK

- Application – Use for air conditioning system branches or exhaust systems as shown on drawings, and to limit flexible duct lengths to 6 metres maximum or where specifically documented for exposed supply air systems.
- Construction – Manufacture from full size galvanised sheet steel conforming to AS 1397 grade GCZ 300. Circular ducts shall be machine formed with spiral generally and shall not exceed 2400mm (nominal) in length. Longitudinal seams for ductwork shall be acceptable subject to approval of the mechanical engineer.
- Insulation shall be provided as required to satisfy the minimum requirements outlined in the Building Code of Australia or as specified where greater.
- Longitudinal seams shall be lock seam type providing an air tight joint with sealant provided to the seam.
- End connections shall be made using socket and spigot “Swage” coupling generally or with angle flanged joints for ductwork with a nominal diameter of 200mm or less. All exhaust ductwork shall incorporate double swages to each end.
- All joints shall be sealed with a synthetic rubber sealing compound similar to 3M E.C. 800 or approved equivalent applied to the metal surfaces prior to making the joints.

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.

For kitchen exhaust applications use non-combustible woven glass fabric of 'Thermo Fab' manufacture type "MFT-4-1000" or approved equivalent capable of withstanding 250° under continuous operation.

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.

Backdraft Dampers – In-Line Fans (BCA Compliance Minor Exhaust)

- Fantech Manufacture, RSK Model or equal approved.
- Circular galvanised steel casing complete with aluminium flaps.
- Spring Loaded when fan is switched off

Splitter dampers – Sheetmetal Branch Duct Take-Offs

- Single blade constructed from zinc coated steel.
- Minimum blade thickness 0.8mm.
- Braced or folded edges to prevent distortion and rattling.
- Blade securely fixed to rod, pivoted in bronze or nylon bushes fixed to the duct.

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.

Intumescent Type

- Provide intumescent fire dampers of "Lorient" manufacture "LVH" Series or equal approved.
- Construct from heavy gauge galvanised steel casing. Incorporate evenly spaced, fixed parallel aerodynamic intumescent slats with 20mm pitch.
- Provide for operation in accordance with Australian/New Zealand Standard 1668.1 - Fire precautions in buildings with air handling systems.
- Test in accordance with Australian Standard 1530.4 - Fire resistance tests of elements of building construction.
- Install in accordance with Australian Standard 1682.2 - Fire dampers – Installation and manufacturer's recommendations.
- Size dampers to provide for a maximum pressure drop of 20 Pa at 5 m/s air flow.

Multi-Blade Type

- Provide multi-blade fire dampers of "Bullock" manufacture "4800" Series or equal approved.
- 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.
- Construct from heavy gauge galvanised steel casing, engineered body with any exposed welds to be coated with cold zinc primer paint to prevent rusting.
- Damper expansion gap shall be maintained incorporating metal expansion gap sealant system complying with AS1682.1 as a minimum.

- Fusible links shall operate at the greater of 68.0°C or the requirements satisfying the AS1682.1 rating.
- Incorporate flange channels where required to allow construction to be securely fixed to adjoining ductwork.
- Size dampers to provide for a maximum pressure drop of 20 Pa at 5 m/s air flow.

5.9 ACCESS PANELS

General

Provide access panels in ducts and plenums adjacent to each fire damper, modulating damper, air filter and in kitchen exhaust ducts at each change of direction and at not less than 3000mm intervals in horizontal runs, 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 KITCHEN EXHAUST DUCTWORK

General

- All exhaust ductwork shall comply with AS 1668 Part 1 and the requirements of all local Authorities having jurisdiction.
- All ductwork shall be fabricated from no less than 1.2mm thick galvabond sheet steel with ductwork joints made grease and water tight with "3M EC.800" adhesive sealing compound or continuous soldering as required by the relevant local authority. Exposed ductwork above roof shall be 1.2mm thick stainless steel.

Access Panels

- Access panels shall be provided adjacent to each change of direction and in horizontal duct runs at intervals not greater than 3000mm.
- Access openings located in the side of ducts.
- Fabricate by fixing a hot dipped galvanised steel stiffening ring and studs to the duct and provided with a galvanised steel plate cover, a neoprene gasket and sash clamps.

5.11 DUCTWORK EXPOSED TO THE WEATHER

General

- Cross break the top surface of all ductwork exposed to the weather.
- Orientate ductwork such that edges of sheets on longitudinal joints are not located on the top surface.

Joints

- Ensure ductwork joints are sealed water tight with "3M EC.800" adhesive sealing compound.
- Provide sheetmetal angle covers or top hat sections over all flanged joints to prevent rain entering or water becoming trapped along the top edge.

Access Panels

- Access openings located in the side of ducts.
- Fabricate by fixing a hot dipped galvanised steel stiffening ring provided with a galvanised cover with equivalent insulation to the surrounding ductwork.
- Utilise only corrosion resistant stainless steel or galvanised steel fixings including hinges and sash clamps.
- Provide weather covers or shields over access panels to prevent rain entering or becoming trapped along the top seal.

5.12 DUCTWORK INSULATION

Scope

All ductwork shall comply with fire hazard properties set out in AS 4254 and thermally insulated in accordance with AS/NZS 4859.1.

All ductwork shown hatched on drawings or specified elsewhere in this specification or indicated on drawings shall be insulated in accordance with the following requirements:

System	Description	Reference Clause	Thermal Rating/Insulation Thickness
Air Conditioning	Flexible ductwork no more than 3m in length to an outlet or from an inlet	Thermal Insulation	Minimum R value=1.0
Air Conditioning	Ductwork within a conditioned space	Thermal Insulation	Minimum R value=1.2
Air Conditioning	Ductwork exposed to direct sunlight	Thermal Insulation	Minimum R value=3.0
Air Conditioning	Ductwork all other locations	Thermal Insulation	Minimum R value=2.0
Air Conditioning	Cushion Head boxes	Thermal Insulation	Refer to the above for the applicable arrangement
Ventilation	Outside Air, General And Toilet Exhaust ductwork	Acoustic Insulation	Single cross hatched – 25mm Double cross hatched - 50mm Triple cross-hatched – 75mm Quadruple cross hatched - 100mm

General

- All Insulation shall be internally applied as herein specified, where shown on the drawings and as scheduled.
- Ductwork shall be increased in size to maintain the internal dimensions shown on the drawings.
- Where a transition occurs from thermal or acoustic insulation there shall be a 300mm overlap to protect against thermal losses.
- All joints in the insulation shall be butted firmly together to prevent thermal losses. Acoustic insulation shall have concealed flanges.
- All insulation shall be manufactured from materials complying with Australian Standard AS 1530 – Part 3 “Test For Early Hazard Properties of Materials” and having the following test results;
 - Ignitability Index 0
 - Spread of Flame Index 0
 - Heat Evolved Index 0
 - Smoke Developed Index not greater than 3.
- Acoustic insulation shall be manufactured from ‘Tontine’ bonded polyester, have a density of not less than 30 kg/m³ and a thermal conductivity of not more than 0.04 w/m²k at a mean temperature of 24°K, complete with a perforated foil facing.
- Provide “Melinex” lining to all acoustic insulation associated with evaporative cooling or kitchen/dishwasher exhaust systems.

- Fasten insulation to sheet metal ducts with welded pins and speed clips located at not more than 75mm from the edges of the ducts and spaced at not more than 400mm centres. Provide sheet metal nosings / corner angles and covers to prevent unsealed edges being exposed to the air stream.
- All joints between insulation batts shall have the aluminium foil laminate face lining overlapped.
- Insulation shall have random incidence sound absorption coefficients when tested in accordance with AS ISO 354-2006 of not less than the following:

Thickness	Octave Band Centre Frequency (Hertz)					
	125	250	500	1000	2000	NRC
25mm foil laminate	0.10	0.25	0.65	0.80	0.90	0.65
50mm foil laminate	0.25	0.60	0.95	0.95	0.95	1.00
75mm foil laminate	0.35	1.00	1.00	1.00	0.95	1.00
100mm foil laminate	0.55	1.00	1.00	1.00	1.00	1.15

5.13 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.

Return Air Grilles – Ceiling Mounted

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

Supply Air Diffusers – Ceiling Mounted

- Louvre face four way blow type.
- Aluminium construction, powder coat finish.
- Provide neck plates to achieve throw distance as scheduled on the drawings.
- Provide blanking plates to achieve throw directions as shown on drawings.
- Cores to be readily removable for cleaning or adjustment of air direction.
- Cores to comprise a minimum of 6 blades to each quarter.

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.
- 50% (min) free area.

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

Chilled & Heating Hot Water

- 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, 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.
- Utilise Kingspan Kooltherm type or equal approved insulation for all pipework requiring insulation of R-Value of 2.0 or greater in accordance with BCA Volume One, Specification J5, Insulating Piping, Vessels, Heat Exchangers and Tanks.
- 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.
- Provide removable insulated casings to all valves comprising insulation, metal covers and quick release type hinge and catches. Accurately shape insulation to closely fit all valves and fittings. Ensure that the insulation can be removed and replaced to provide a vapour seal upon replacement.
- When insulating vertical pipework with a diameter of 80mm or greater, all over adhesive coverage must be applied to both the pipework and the facing elastomeric nitrile rubber sheet regardless.
- 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.
- 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.
- Replace the insulation material with non-compressible ferrules (pipe support blocks) such as "Insulco - Insubloc", or equal approved, at all support points

- Thoroughly clean the pipework prior to the application of the insulation.
- Provide galvanised sheetmetal capping to all external pipework insulation and within plantrooms up to a height of 2100mm above floor level.
- Refer to Manufacturers Application Guide for further recommendations.

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:

- Air Conditioning Units
- Fan Coil Units
- Condensing Units
- Drip Trays

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).
- Condensate Drip Trays shall be insulated on the underside of trays with 25mm of rigid, non-hygroscopic cellular foam insulation to prevent condensation.
- Insulate the all condensate drainage with non-hygroscopic cellular foam insulation to prevent condensation to tundish. Where drainage pipework from tundish is above ground continue insulation to and include floor waste. Extend insulation to vertical stack or point at which the condensate discharge is sufficiently diluted so that condensation can no longer occur.

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 CONTROL FUNCTIONS AND STRATEGIES (SMALL PROJECTS)

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 23.0°C
- Heating set point 21.0°C
- Dead band 21.0°C to 23.0°C
- Set point target for economy cycle 22.0°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 hard wired manufacturer's standard LCD controllers, located as shown on the drawings and incorporate in-built temperature sensors.

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.

Toilet and Laundry Exhaust Fan

The toilet and Laundry Exhaust systems shall be operated via local switch panels (provided by electrical services contractor). Connect to controlled socket outlet provided by electrical services contractor.

Refuse Exhaust Fan

The refuse exhaust system shall be operated via local switch panels within the ground floor refuse room. Fan shall operate on a 24hr / 7-day basis.

Fire Pump Room Fan

Fire pump room exhaust fan to operate upon receipt of fire signal. Terminate all control signal cabling at start/stop relay terminal to operate fan during fire mode and when in testing of fire pump equipment

Car Park Ventilation System

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.
- 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 and CPSAF-1 Exhaust air flow rate
0-9 ppm	1 air change per day
9-15 ppm	Intermittent operation at xxx l/s (25%)
15-30 ppm	Constant fan speed at xxx l/s (25%)
30-45 ppm	Ramp fan speed linearly between xxx l/s and xxx l/s (25% to 75%)
+ 45 ppm	Constant fan speed at xxx l/s (100%)

7.3 CONTROLS HARDWARE

Provide all necessary controls hardware to complete the installation and to achieve the functionality described above. The items scheduled below indicate the minimum standard for specific items of hardware. Any types of equipment not mentioned below are to conform to

relevant codes and standards as required by legislation and be compatible with manufacturer's recommendations of all other associated equipment.

Temperature Sensors and Control Panels

- Utilise proprietry temperature sensors and control panels.

Variable Frequency Drive Units

Standard: To AS 60947 Set.

Manufacture: Provide by an established manufacturer of variable frequency drive units and of standard type for which spares and service are readily available.

Include the following features of the unit and associated switchgear:

- Electromagnetic contactor on input to drive to isolate supply from non-duty drives;
- Variable voltage, variable frequency output;
- Solid state logic control unit with immunity to supply transients;
- Full wave diode bridge rectifier and inverter with transistors to provide PWM sinusoidal waveform output;
- Power factor of at least 0.95;
- Speed control by 4-20mA input;
- Protection against supply system transients;
- Torque-speed characteristic adjustable to suit drive;
- Adjustable acceleration rate with motor limited to 110% FLC;
- Status and fault indication generally by LED;
- Thermistor protection unit for motor;
- Indication of motor load current and speed and signal with output proportional to each value for remote indication;
- Air cooled natural convection with fan cooling of compartment where required.
- Appropriate IP ratings and corrosion resistance for use outdoors, in plant rooms or specific applications.

Motor: Incorporate thermistor protection and rate to operate drive continuously within required speed range without overheating. Provide independent fan cooling where necessary.

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.
- 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.
- Underground cables: Use X-90 (XLPE) insulation and PVC sheath cable in underground enclosures 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.

Cable Ladders and Trays

- Support system: Bends, connectors, trays, ladders, brackets, and other supports necessary to make a complete cable or conduit support system shall be of the same manufacture, sized to adequately support the installed cabling.
- Cable ladders and trays shall be a perforated pre-galvanised steel material. Minimum steel thickness shall be as follows:
 - Trays up to 150mm wide: 1.0mm
 - Trays from 150mm to 300mm wide: 1.2mm
 - Trays over 300mm wide: 1.6mm
- Folded edge: Minimum height 20 mm, radiused.
- Slotting: Normal or reverse with no burrs or sharp edges on the side to which cables are attached.

- Construction: Manufacture cable ladder trays and cable ladder from two folded steel or extruded structural grade aluminium side rails with cable support rungs between the two rails spaced at intervals of not more than 300mm (ladder) and 100mm (ladder trays).
- Small cable: Do not run cables smaller than 13mm outside diameter on the cable ladder unless continuously supported.
- Cable fixing: Slots or ladder rails shall be suitable for fixing cable ties, strapping or saddles. Communications cabling shall be fixed with Velcro cable ties. Trim cable ties prior to installation of ceiling/practical completion.
- Bend radius: Bends shall have a minimum inside radius of not less than twelve times the outside diameter of the largest diameter cable carried.
- Spare capacity: Provide sufficient space on the tray or ladder for not less than 20% more cables or conduits than specified, irrespective of sizes indicated on the drawings. The sizes and quantities nominated on the drawings are indicative, and are to be confirmed by the Mechanical Contractor based on final cable quantities, sizes and locations.
- Route: Mechanical Contractor to co-ordinate Mech/Elect cabling with the Electrical Trade installation. Trades shall ensure Structural Engineers drawings and other services are referenced and co-ordinated prior to installation. In any case, cable trays shall be run parallel and perpendicular to the building structure.
- Access: Position the support system to give adequate access for inspecting, replacing, or adding cable.
- Support: Provide support brackets of the cantilever type (i.e. one side of the bracket left open), cold galvanised after fabrication. Mount brackets to manufacturer's recommendations, with no appreciable sag between supports.
- Cable strapping: Fix cable to the support system by proprietary nylon ties, straps or saddles, at 500 mm centres for vertical runs and 1000mm centres for horizontal runs. Use nylon ties for smaller cables (up to 15mm diameter single core cables, 25mm multicore cables), non-magnetic saddles or strapping for larger cables.
- Cable protection: Provide a slightly curved support surface under cables leaving the tray or cable ladder to protect the cable sheath from impingement by the tray or ladder edge.
- Clearance: Maintain the following clearances as a minimum:
 - 200 mm clearance from hot water pipes
 - 500 mm clearance from boilers or furnaces
 - 100 mm clearance (minimum) from all other services
- Earthing: Earth all cable trays, ladder trays and ladders in accordance with the requirements of AS/NZS 3000 and ACMA technical standards.

Catenaries

- Construction: Provide commercial manufactured catenaries as follows:
 - Properly rated for the weight of the cabling to be installed.
 - Provide uniform support throughout cable length.

- Be fixed at each end.
- Capable of withstanding any mechanical stresses within the environment installed.
- Consist of material equally resistant to corrosion and deterioration.
- 2.7mm minimum diameter.
- 1.5kN minimum break force.
- Zinc coated.
- Cables themselves shall not be used as catenaries.
- Installation: Install catenaries as follows:
 - Provide no more than 3 groups of 5 bundles cables to each catenary.
 - Provide hangers at 1000mm intervals.
 - Shall be supported off the Building structure, and not off other plant and/or equipment.
 - Installed so as to run parallel and/or perpendicular to building structure.
- Cable fixing: Nylon cables ties shall be provided for fixing electric cabling, and Velcro cable ties shall be provided for communications cabling at 500mm intervals.
- Clearance: Locate cabling 10mm from moving parts of any equipment operating at elevated temperature.
- Earthing: Earth all catenaries in accordance with the requirements of AS/NZS 3000 and ACMA technical standards.

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.
- Corrugated Plastic Conduit: May be used where embedded in concrete and to effect changes in direction of surface runs of rigid PVC conduit and for final connections to equipment. Use with manufacturer's approved accessories.

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.

Cable Ducts

- Fabrication: Provide cable ducts of sheet steel manufacture unless shown otherwise.
- Size: Ensure that the size of cable ducts comply with AS/NZS 3000 requirements. Adequately size for the installation of 30% additional cables.
- Installation: All ducts shall be installed parallel or perpendicular to the building structure.
- Support: Provide substantial supports comprising plain or angle brackets of galvanised steel angle, Unistrut or similar, fixed to walls or floors or suspended from structure where

applicable. Provide corrosion resistant spacers between duct and surface where fixed direct to a wall.

- Steel Ducts shall be in provided accordance with the following:
 - Construction: Galvabond or Zincanneal (where painted) sheet steel of thickness to prevent deformation.
 - Lids: Provide unless specified otherwise. Ensure duct lids are installed to maintain earth continuity. Provide 10 mm to 15 mm return edge for fastening and stiffening purposes.
 - Fixings: Fasten lids at ends and at maximum 1500 mm intervals between with galvanised steel gutter bolts and captive nuts.
 - Retaining: Hold lids by retaining chains or nylon cords properly anchored and approx. 300 long.
 - Cable Installation: Provide vertical runs with an approved means of supporting the cable at intervals of 1000 mm maximum, or as recommended by the manufacturer

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, incorporating the following:-

Criteria	Unit	Factor
Importance Level	I	2
Annual Probability of Exceedance	yr	1:500
Soil Classification		De
Hazard Factor	Z	0.10
Probability Factor	Kp	1.0
Structural Classification	EDC	2

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 round air-handling ductwork less than 700mm in diameter
- 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, fans, air conditioning units, fan coil units & packaged air conditioning units.
- Spring isolation hangers for ducted fan coil units, ducted fans & equipment and all ductwork not isolated from equipment by flexible connections.
- Spring isolation hangers for pipework within plant rooms.

- Neoprene double deflection mounts under condensing units and other equipment.
- Neoprene pads under boilers and plate heat exchangers.

Equipment	Vibration Isolation Mounts and Hangers	Minimum Isolation Efficiency	Static Deflection	Mounting Base
		%	mm	
Outdoor condensing units	Neoprene double deflection mounts	90	10	N/A
Fan coil units - ceiling mounted	Spring hangers with neoprene inserts	95	50	N/A
Axial flow fans - suspended	Spring hangers with neoprene mounts	95	50	N/A
Pipework - all pipework not spring mounted	Rubber inserts between pipes and clamps	80	2	N/A

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.

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).

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.
- Ensure all controls 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.
- 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.

10.3 COMMISSIONING

Test all systems to the satisfaction of the Mechanical Consulting Engineer and in strict accordance with the CIBSE Commissioning Codes or ASHRAE Commissioning Guideline 1-1996 including but not limited to the below additional information.

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.

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.

Incorporate blank flanges and valves as necessary for piping systems to prevent excessive pressures on plant and equipment. Ensure test procedures do not place undue stresses on the system and building structure.

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 +10% 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.

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 3100 kPa on the high side and 700 kPa on the low side with a dry inert gas. Hold test for 6 hours with no 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 QUARTERLY AND 12 MONTH COMMISSIONING CHECKS

Tuning of all building systems is to be provided for a period of 12 months from date of Practical Completion.

The objectives of the building tuning process are as follows:-

- Verify that systems are performing to their design potential during all variations in climate and occupancy;
- Optimise time schedules to best match occupant needs and system performance
- Align the systems' operation to the attributes of the built space they serve.

10.5 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.

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 procedures shall be taken in strict accordance with those defined in "*DA19 HVAC and R Maintenance Schedules*".

11.2 HALF YEARLY 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 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 – Split Inverter type	\$
	Filters	\$
	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 Installation/Labour	
	Café Tenancy Air Conditioning - PC SUM	\$15,000.00
4.	Air Conditioning & Mechanical Services General	
	Engineering Calculations	\$
	Manuals	\$
	For Approval/Workshop Drawings (Revit/CAD)	\$
	As-Installed Drawings	\$

Tenderer **Date**

	User Training	\$	
	Defects Liability/Comprehensive Maintenance	\$	
	SUB TOTAL	\$	
	PLUS 10% GST	\$	
	TOTAL	\$	
5.	Ongoing preventative maintenance costs (post 12 month DLP)		
	2 year contract	\$	
	3 year contract	\$	
	5 year contract	\$	
6.	Trade Rates		
	Tradesman	\$	/hour
	4th 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.

Air Cooled DX

Provide Manufacturer's technical data and selections

Fans

Provide Manufacturer's technical data and selections

Tenderer **Date**

Air Filters

Designation

Manufacturer

.....

Type

.....

Rating

.....

Air Diffusion Equipment

Return Air Grilles – Ceiling Mounted

Manufacturer

.....

Type

.....

Return Air Diffusers – Ceiling Mounted

Manufacturer

.....

Type

.....

Exhaust Air Diffusers – Ceiling Mounted

Manufacturer

.....

Type

.....

Supply Air Grille – Duct Mounted Type

Manufacturer

.....

Type

.....

Exhaust Air Grille – Duct Mounted Type

Manufacturer

.....

Type

.....

Tenderer **Date**

Weatherproof Louvre

Manufacturer

Type

Automatic Controls

Individual Air Conditioning Controller

Manufacturer

Type/Model

Carbon Monoxide Monitoring System

Manufacturer

Model

Number of.

Ductwork Insulation

Confirmation of Polyester Material

Manufacturer

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**

APPENDIX E – EXAMPLE COMMISSIONING SHEET

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 SCHEDULES

Tenderer **Date**

PERFORMANCE SCHEDULES

Plant & EquipmentAir Conditioning Units, Air Cooled, Direct Expansion

Project NameWilcox Apartments

Project No.LCE13523

EngineerTR / DG

Issue Date-

Revision-

						Airflow			Cooling				Heating		Electrical			
Unit Designation	Area served	Unit Type	ESP (Pa)	Ambient Design Max (°C db)	Ambient Design Min (°C db)	Supply (L/s)	Return (L/s)	Outside (L/s)	Total (kW)	Sensible (kW)	Evap Coil Air On (°C db)	Evap Coil Air On (°C wb)	Total (kW)	Evap Coil Air On (°C db)	Essential	Amps (A) (MFA)	Phase (Φ)	Volts (V)
ACC-1.03	Ground Floor Apt 1.03	Wall Mounted		38.0	5.0				6.4	6.4			2.6			20	1	230
FCU-1.03	Ground Floor Apt 1.03 Living	Wall Mounted		38.0	5.0	320	320	0	3.7	3.7	24.5	17.5	1.5	19.5				
FCU-1.03B	Ground Floor Apt 1.03 Bed 1	Wall Mounted		38.0	5.0	275	275	0	2.7	2.7	24.5	17.5	1.1	19.5				
ACC/FCU-Office	Ground Floor Office	Ducted type	150	38.0	5.0	1355	1355	0	16.0	15.6	24.5	17.5	8.0	19.5				
ACC-2.01	Level 2 Apt 2.01	Wall Mounted		38.0	5.0				6.0	6.0			3.0			20	1	230
FCU-2.01	Level 2 Apt 2.01 Living	Wall Mounted		38.0	5.0	340	340	0	3.9	3.9	24.5	17.5	2.2	19.5				
FCU-2.01B	Level 2 Apt 2.01 Bed 1	Wall Mounted		38.0	5.0	215	215	0	2.1	2.1	24.5	17.5	0.8	19.5				
ACC-2.02	Level 2 Apt 2.02	Wall Mounted		38.0	5.0				6.0	6.0			1.9			20	1	230
FCU-2.02	Level 2 Apt 2.02 Living	Wall Mounted		38.0	5.0	340	340	0	3.9	3.9	24.5	17.5	1.4	19.5				
FCU-2.02B	Level 2 Apt 2.02 Bed 1	Wall Mounted		38.0	5.0	200	200	0	2.1	2.1	24.5	17.5	0.5	19.5				
ACC-2.03	Level 2 Apt 2.03	Wall Mounted		38.0	5.0				7.1	7.1			4.1			20	1	230
FCU-2.03	Level 2 Apt 2.03 Living	Wall Mounted		38.0	5.0	400	400	0	4.5	4.5	24.5	17.5	2.9	19.5				
FCU-2.03B	Level 2 Apt 2.03 Bed 1	Wall Mounted		38.0	5.0	255	255	0	2.6	2.6	24.5	17.5	1.2	19.5				
ACC-2.04	Level 2 Apt 2.04	Wall Mounted			5.0				7.2	7.2			4.1			20	1	230
FCU-2.04	Level 2 Apt 2.04 Living	Wall Mounted		38.0	5.0	400	400	0	4.5	4.5	24.5	17.5	3.1	19.5				
FCU-2.04B	Level 2 Aot 2.04 Bed 1	Wall Mounted		38.0	5.0	255	255	0	2.7	2.7	24.5	17.5	1.0	19.5				
ACC-2.05	Level 2 Apt 2.05	Wall Mounted			5.0				6.1	6.1			3.4			20	1	230
FCU-2.05	Level 2 Apt 2.05 Living	Wall Mounted		38.0	5.0	370	370	0	4.2	4.2	24.5	17.5	2.6	19.5				
FCU-2.05B	Level 2 Apt 2.05 Bed 1	Wall Mounted		38.0	5.0	200	200	0	1.9	1.9	24.5	17.5	0.8	19.5				
ACC-2.06	Level 2 Apt 2.06	Wall Mounted		38.0	5.0				6.6	6.5			4.0			20	1	230
FCU-2.06	Level 2 Apt 2.06 Living	Wall Mounted		38.0	5.0	400	400	0	4.5	4.5	24.5	17.5	3.3	19.5				
FCU-2.06B	Level 2 Apt 2.06 Bed 1	Wall Mounted		38.0	5.0	255	255	0	2.1	2.0	24.5	17.5	0.7	19.5				
ACC-2.07	Level 2 Apt 2.07	Wall Mounted		38.0	5.0				6.5	6.5			3.6			20	1	230
FCU-2.07	Level 2 Apt 2.07 Living	Wall Mounted		38.0	5.0	400	400	0	4.3	4.3	24.5	17.5	2.9	19.5				
FCU-2.07B	Level 2 Apt 2.07 Bed 1	Wall Mounted		38.0	5.0	200	200	0	2.2	2.2	24.5	17.5	0.7	19.5				
ACC-2.08	Level 2 Apt 2.08	Wall Mounted		38.0	5.0				6.6	6.6			3.2			20	1	230
FCU-2.08	Level 2 Apt 2.08 Living	Wall Mounted		38.0	5.0	375	375	0	4.3	4.3	24.5	17.5	2.3	19.5				
FCU-2.08B	Level 2 Apt 2.08 Bed 1	Wall Mounted		38.0	5.0	230	230	0	2.3	2.3	24.5	17.5	0.9	19.5				
ACC-2.09	Level 2 Apt 2.09	Wall Mounted		38.0	5.0				7.0	7.0			3.3			20	1	230
FCU-2.09	Level 2 Apt 2.09 Living	Wall Mounted		38.0	5.0	400	400	0	4.4	4.4	24.5	17.5	2.4	19.5				
FCU-2.09B	Level 2 Apt 2.09 Bed 1	Wall Mounted		38.0	5.0	265	265	0	2.6	2.6	24.5	17.5	0.9	19.5				
ACC-2.10	Level 2 Apt 2.10	Wall Mounted		38.0	5.0				6.1	6.1			3.1			20	1	230
FCU-2.10	Level 2 Apt 2.10 Living	Wall Mounted		38.0	5.0	350	350	0	3.9	3.9	24.5	17.5	2.4	19.5				
FCU-2.10B	Level 2 Apt 2.10 Bed 1	Wall Mounted		38.0	5.0	220	220	0	2.2	2.2	24.5	17.5	0.7	19.5				
ACC-3.03	Level 3 Apt 3.03	Wall Mounted		38.0	5.0				5.9	5.9			2.1			20	1	230
FCU-3.03	Level 3 Apt 3.03 Living	Wall Mounted		38.0	5.0	350	350	0	4.0	3.9	24.5	17.5	1.8	19.5				
FCU-3.03B	Level 3 Apt 3.03 Bed 1	Wall Mounted		38.0	5.0	190	190	0	1.9	2.0	24.5	17.5	0.3	19.5				
ACC-3.04	Level 3 Apt 3.04	Wall Mounted		38.0	5.0				6.0	5.9			2.1			20	1	230
FCU-3.04	Level 3 Apt 3.04 Living	Wall Mounted		38.0	5.0	350	350	0	3.9	3.9	24.5	17.5	1.7	19.5				

PERFORMANCE SCHEDULES

Plant & Equipment	Air Conditioning Units, Air Cooled, Direct Expansion
Project Name	Wilcox Apartments
Project No.	LCE13523

Engineer	TR / DG
Issue Date	-
Revision	-

[illegible]

Performance Schedules

Performance Schedules

Plant & Equipment	Air Filters
Project Name	Wilcox Apartments
Project No.	LCE13523

Engineer	TR/DG
Issue Date	-
Revision	-

Filter AFR - L/s	150	310	620	300	380	450	750	900
Weight - (kg)	0.4	0.65	1.2	0.75	1.05	1.5	2.2	2.6

Area Served	Unit Designation	100mm Pleated Panel W x H (mm)					600mm Deep Bed W x H (mm)			Air Flow Rate L/s	Filter Total L/s	Total Check L/s
		300x300	600x300	600x600	500x400	600x500	300x600	500x600	600x600			
Ground Floor Office	ACC/FCU-Office	0	1	2	0	0	0	0	0	1355	1550	195
Level 5 Apt 5.01	ACC-5.01	0	1	2	0	0	0	0	0	1375	1550	175
Level 5 Apt 5.02	ACC-5.02	0	2	2	0	0	0	0	0	1590	1860	270
Level 5 Apt 5.03	ACC-5.03	0	1	2	0	0	0	0	0	1300	1550	250
Level 5 Apt 5.04	ACC-5.04	0	0	2	0	0	0	0	0	1165	1240	75